SEASONAL FRUIT AND VEGETABLE JUICE BLENDS WITH HIGH ANTIOXIDANT POTENTIAL

Thesis

by

VIGYA MISHRA

Submitted in partial fulfilment of the requirements for the degree of

DOCTOR OF PHILOSOPHY
in
HORTICULTURE

(POST HARVEST TECHNOLOGY)

COLLEGE OF HORTICULTURE
Dr Yashwant Singh Parmar University of Horticulture and Forestry, Nauni,
Solan - 173 230, (HP) INDIA
2012

Dr. K D Sharma
Professor

Department of Food Science and Technology
College of Horticulture
Dr. Y S Parmar University of Horticulture and Forestry, Nauni, Solan – 173 230

CERTIFICATE - I

This is to certify that the thesis entitled **"Seasonal fruit and vegetable juice blends with high antioxidant potential"**, submitted in partial fulfilment of the requirements for the award of degree of **DOCTOR OF PHILOSOPHY** in **HORTICULTURE (Post Harvest Technology)** to Dr. Yashwant Singh Parmar University of Horticulture and Forestry, Nauni, Solan (HP) is a record of bonafide research work carried out by **Ms. Vigya Mishra (H-08-18-D)** under my guidance and supervision. No part of this thesis has been submitted for any other degree or diploma.

The assistance and help received during the course of investigations have been fully acknowledged.

Place: Nauni, Solan
Dated: Mar, 2012

(Dr. K D Sharma)
Chairman
Advisory Committee

CERTIFICATE - II

This is to certify that the thesis entitled **"Seasonal fruit and vegetable juice blends with high antioxidant potential"**, submitted by **Ms. Vigya Mishra (H-08-18-D)** to Dr. Yashwant Singh Parmar University of Horticulture and Forestry, Nauni, Solan (HP) in partial fulfilment of the requirements for the award of degree of **DOCTOR OF PHILOSOPHY** in **HORTICULTURE (Post Harvest Technology)** has been approved by the student's advisory committee after an oral examination of the same in collaboration with the external examiner.

Dr. K D Sharma
(Professor)
Chairman, Advisory Committee

External Examiner

Members of Advisory Committee

Dr. V K Joshi
(Professor and Head)

Dr. P C Sharma
(Sr. Horticultural Technologist)

Dr. (Mrs) Nivedita Sharma
(Associate Professor)

Dr. (Mrs) Neerja Rana
(Assistant Professor)

Professor and Head
Department of Food Science and Technology

Dean's Nominee

Dean College of Horticulture

CERTIFICATE - III

This is to certify that all the mistakes and errors pointed out by the external examiner have been incorporated in the thesis entitled **"Seasonal fruit and vegetable juice blends with high antioxidant potential"**, submitted by **Ms. Vigya Mishra (H-08-18-D)** to Dr. Yashwant Singh Parmar University of Horticulture and Forestry, Nauni, Solan (HP) in partial fulfilment of the requirements for the award of degree of **DOCTOR OF PHILOSOPHY** in **HORTICULTURE (Post Harvest Technology).**

(Dr. K D Sharma)
Chairman, Advisory Committee

(Dr. V K Joshi)
Professor and Head
Department of Food Science and Technology
Dr. Y S Parmar UHF, Nauni, Solan (HP)

Acknowledgement

With limitless modesty, I am deeply indebted to 'God' - The Almighty, the creator, the supreme power, the divine light or whatever He is, who bestowed me with good health and courage enough to complete this task. He is the highest of mankind who enlighten and turned the lives of mankind into peace and good practices.

The success initiates with the role of parents to culture ethics while completes with the guidance of a teacher. I feel fortunate to be associated with my affectionate supervisor Dr. K D Sharma, Professor, Department of Food Science & Technology. He guided during the course of this research work with words of wisdom and training for patience. I am indebted for his sympathetic and kind cooperation provided for this research work as a sympathetic and encouraging supervisor.

I emphatically express my venerable thanks to worthy members of my Advisory Committee, Dr. V K Joshi, Professor & Head, Department of Food Science & Technology and Dr. P. C. Sharma, Professor, Department of Food Science & Technology for their valuable help and indispensable suggestions at every step during the course of investigations.

I emphatically owe my sincere thanks and obligations to Dr. (Mrs) Nivedita Sharma, (Associate Professor, Microbiology, Department of Basic Science) and Dr. (Mrs) Neerja Rana (Assistant Professor, Biochemistry, Department of Vegetable Science) for providing me necessary facilities, ideological contributions and prized suggestions to complete my research work.

I would like to express my deep appreciation to Mrs. Surekha Attri for providing a homely environment and encouragement for stepping ahead.

I feel immense pleasure to avail the opportunity to convey my heartfelt thanks to Dr. (Mrs) Devina Vaidya, Dr. K S Thakur, Dr. Anju Dhiman, Dr. N S Thakur, Dr. Dev Raj, Dr. Manisha Kaushal and Dr. Rakesh Sharma for their constant encouragement and invaluable suggestions during my research.

Diction is not enough to express my gratitude to my beloved parents whose filial affection, prudent persuasion, selfless sacrifices, sincere prayers, expectations and heartfelt blessings has always been the most vital source of inspiration and motivation in my life. More words cannot substitute my feelings toward my sisters Pragya and Pratigya for their love, affection and moral backup in needful time.

I sincerely acknowledge the help and encouragement received from Vinay, Pooja, Ghanshyam, Neha, Anshu, Marson, Kanika Di, Divya, Deepshikha, Neeraj, Nidhi, Siloni Di, Rohit Sir, Vikas and Reena in my needful time. My heartfelt thanks are due to Dr. Shailendra K Dwivedi for his much needed work always given at the opportune moments. Enthusiastic co-operation of friendly circle of all my seniors and juniors are also acknowledged.

Facilities and co-operation provided by Sh. Ram Das Ji, Sh. Prakash Ji, Smt. Kaushalya Ji, Sh Khemchand Ji, Sh. Hemchand Ji, Sh.Vijay Ji, Sh. Narendra Ji, Sh. Jaikishan Ji and all staff members of Department of Food Science and Technology are thankfully acknowledged.

The commendable credit for the highly efficient typing and manuscript preparation goes to Sh Ravikant Sharma and Sh Ajay Ji, Edge computers, Nauni.

I solely claim all the responsibilities for the shortcomings and limitations in this work.

Place: Nauni

Date: March, 2012

(Vigya Mishra)

CONTENTS

LIST OF TABLES

LIST OF PLATES

INTRODUCTION

Chapter-1

INTRODUCTION

Food provides not only essential nutrients needed for life but also other bioactive compounds for health promotion and disease prevention (Willet, 1994; Temple, 2000). Ancient Greek physician Hippocrates, the father of Western medicine said "*Let food thy medicine and medicine thy food*". Consumption of fruits and vegetables, as well as grains, have strongly been associated with reduced risk of cardiovascular disease, cancer, diabetes, Alzheimer disease, cataracts and age-related functional degeneration (Willet, 1995; Temple, 2000). Fruits and vegetables are indeed important components in both modern and traditional healing modalities throughout the world. Therefore, it is invariably suggested to increase the intake of fruits and vegetables in human diet, as an excellent source of bioactive compounds besides, fibers and minerals (Kris *et al.,* 2002). Diet rich in fruits and vegetables also provides important antioxidant phenolic phytochemicals which are supposed to exert positive effect on human health (Mikstacka *et al.,* 2010).

Many of the plant origin bioactive compounds act as antioxidants (Liu and Hotchkins, 1995). Antioxidants are the micronutrients that have gained interest in recent years due to their ability to neutralize the action of the free radicals (Candenas and Packer, 1996). Free radicals are potentially harmful by-products generated during natural processes in the human system, associated with aging of cells and tissues. Failure to get rid off from free radicals over a long period may lead to cardiovascular disease, cancer, diabetes, arthritis and various neurodegenerative disorders (Sies and Stahl, 1995). Antioxidants present in fruits and vegetables are responsible for the protection provided by them against diseases including cancer and cerebrovascular diseases (Steinberg, 1991). The majority of the antioxidant capacity of a fruit or vegetable may be from compounds other than vitamin C, vitamin E or β- carotene (Sies and Stahl, 1995), selenium and thiol compounds (Ou *et al.,* 2006). For example, some flavonoids (flavones, isoflavones, flavanones, anthocyanins, catechin and isocatechin) that are frequently components of the human diet have demonstrated strong antioxidant activities (Bray, 2000). Therefore, the fruits and vegetables rich in different bioactive compounds can be investigated for the production of antioxidant rich food products. Some of the antioxidant rich vegetables are sweet potato, carrot, spinach and tomato and fruits are cranberry, apple, red grape, strawberry, peach, orange, grapefruit, banana and pineapple (Sun *et al.,* 2002). Vegetables are the cheapest and most available sources of important vitamins, minerals and essential amino acids (Mensah *et al.,* 2008). The nutrient content of different types of vegetables varies considerably and they are not considered to be a major source of carbohydrates, which form the bulk of food eaten but, contain vitamins, essential amino acids as well as minerals and antioxidants (Fasuyi, 2006). Cranberry has the highest total phenolic content followed by apple, red grape, strawberry, pineapple, banana, peach, lemon, orange, pear and grapefruit (Jie, 2002). Considerable attention has been focused on the vitamin C, vitamin E and β- carotene contents of fruits and among commercial fruit juices, grape juice has been demonstrated to have the highest antioxidant capacity followed by grapefruit juice, tomato juice, orange juice and apple juice (Wang *et al.*, 1996).

Current dietary habits characterized by refined diets and devoid of nutritionally-rich and functionally-healthy plant foods, are leading to emergence of obesity-linked epidemics such as type II diabetes, cardio-vascular disease, cancer and other chronic diseases (Johns and Eyzaguirre, 2006). In recent times, the scientists in the developed world have found that consuming a diet rich in high antioxidant rich fruits, vegetables and their processed products can raise blood antioxidants by 15-20 per cent, resulting in the reduction of the effects of aging. Fruits, vegetables and their processed products in combination have synergistic effects on the antioxidant activities leading to greater reduction in risk of chronic diseases (Won and Park, 2005). Antioxidant supplements are best taken in the form of combination products because multiple antioxidants appear to work together synergistically far more effectively than a single antioxidant irrespective of the dose (Heinonen *et al.*, 1989). Consumption of 100 per cent pure fruit juices is an effective approach to meet the current dietary recommendations for fruit intake as well as provide essential nutrients and functional components including antioxidants. Therefore, it can be a part of healthy active life style contrary to the synthetic beverages responsible for weight gain and chronic diseases in long run (Clemens and Dubost, 2008). The nutritional and therapeutic value of natural juices are far greater than that of synthetic drinks, which are at present being bottled and sold in large quantities throughout the country. If natural juices could be substituted for these synthetic preparations, it would be a great boon to the consumers (Kalra *et al.*, 1991). Therefore, immense demand for healthful fruit juices have been experienced in recent times by juice processing industry in India due to their antioxidant benefits. The functional food ingredients like vitamins, minerals, polyphenols, anthocyanins and other flavonoids present in large quantities in one or the other commercial or indigenous fruit or vegetable could not be optimally utilized into pure juice due to one or more reasons like structural properties, stability, aroma and extreme astringency or sourness or sweetness or bitterness etc. At the same time, vegetable juices are not common in India, despite the fact that many common vegetables like onion, leek, broccoli, parsley, celery, beetroot, red cabbage etc. have more anti-inflammatory, anti-histamine, antioxidant and anti-carcinogenic properties than fruits. Some of the vegetables like cucumber and bottlegourd are poor in antioxidant but rich in minerals while bittergourd is rich in antioxidants but bitter in taste.

None of the fruit or vegetable juice is complete nutritionally and/or functionally. Efforts are required to be made to develop juices, which could be advocated as functional foods. Blending of fruit and vegetable juices could be an economic requisite to utilize some fruits and vegetables profitably for processing which may not otherwise have favourable characters such as colour, aroma and mouth feel. Blending of juices with astringent and highly nutritious fruits like *aonla* and lemon can provide health beverages with high medicinal and therapeutic value (Sahota *et al*., 2009). Some of the fruits and most vegetables cannot be converted into free flowing pure juice thus the populations are devoid of their 100% natural juice. Further, acceptability of vegetable juices as pure juice is also poor due to their insipid taste and/or aroma. At the same time, individual fruit or vegetable juices are lacking in one or the other component. For example, apple juice contains negligible amount of carotenoids and vitamin C, pure bittergourd or bottlegourd juice is not palatable and Kinnow juice if not properly debittered during processing turns bitter and becomes unfit as pure juice. Blending of pulpy fruits and/or vegetables with the juicy one could be an effective approach to add variety in the category of healthy and functionally enriched fruit and vegetable juices in the market. Further, due to modern life style, health consciousness and rising living standard of middle class families, the customer demands for natural products with no chemical preservative, free from additives with assured safety and better shelf-life has increased significantly. Thus, fruit and vegetable based natural juice blends with bioactives having high antioxidant potential, without sacrifice to taste or convenience needs to be developed to replace the synthetic beverages as well as to make available a variety of natural fruit-vegetable juice choice at reasonable prices to the domestic consumers and export purpose. Apple and Kinnow are the main fruit crops of Himachal Pradesh and therefore, an attempt was made for their best utilization. Further, some of the other important fruits grown in Himachal Pradesh/North-Western states of India for example mango, sand pear, papaya, jamun, aonla, red grapes and vegetables like tomato, cabbage, carrot, bittergourd, bottlegourd, beetroot, pumpkin etc. have also been selected for the current study.

The present study was therefore conducted to investigate the possibility of blending a variety of fruits and vegetables juices/pulps to make available a great choice of antioxidant rich natural juice blends with the following objectives:

1. To develop natural juice blends from summer and winter fruits and vegetables.
2. To evaluate the quality and the antioxidant potential of the developed blends.
3. To investigate the shelf-life quality of the best blends under refrigerated and ambient storage temperatures.
4. To find out the cost: benefit ratio of the developed blends.

REVIEW OF LITERATURE

__Chapter-2__

REVIEW OF LITERATURE

There are epidemiological evidences linking a diet rich in fruits and vegetables with reduced incidences of many degenerative diseases. Fruits and vegetables contain several health-promoting factors including fibers and high concentrations of phenolic acids, flavonoids, vitamins and minerals. Phenolic acids and flavonoids although, not being essential for the survival but may protect us against a number of chronic diseases over the long term. Therefore, fruits and vegetables rich in bioactives could be investigated for the production of antioxidant rich foods. Fruits, vegetables and their processed products in combination, lead to the reduction in risk of chronic diseases as they provide multiple antioxidants in comparison to single ones which work together synergistically. Blending could be an effective way to utilize fruits and vegetables in combination for the preparation of health beverages with high medicinal and therapeutic value. Fruits and vegetables with unfavourable taste/aroma/mouthfeel can be utilized for preparation of functional beverages by working out the optimum proportion of each fruit or vegetable to be mixed. A brief review of the relevant literature on different aspects of present studies has been discussed herewith under the following headings and sub-headings:

2.1 Present status of fruits and vegetables in India

India is the second largest producer of fruits and vegetables in the world next only to China. The total area under fruits in India is 6, 329.2 thousands hectare with an annual production of 71, 515.5 thousands tones while vegetables are grown under the total area of 7, 984.8 thousand hectare with an annual production of 1, 33, 737.6 thousand tones. Fruits and vegetables contribute 31.74 and 58.93 per cent share of total horticulture crop production, respectively. Tomato covers an area of 634.4 thousand hectare with an annual production of 12, 433.2 thousand tones while cabbage is grown under the area of 331.0 thousand hectare with yearly production of 7, 281.4 thousand tones. Major vegetables grown in India are potato, tomato, onion, brinjal and cole crops, while major fruits are apple, citrus, grapes, mango and banana. The total annual production of mango is 15, 026.7 thousand tones followed by citrus (9, 638.0 thousand tones), papaya (3, 913.5 thousand tones), apples (1, 777.2 thousand tones) and grapes (880.7 thousand tones). In Himachal Pradesh, apple is grown under total area of 280.1 thousand hectare with an annual production of 999.6 thousand tones (Anonymous, 2010).

2.2 Antioxidants

Due to the increased prevalence of chronic degenerative diseases, people are becoming more aware of their food habits. Therefore, it is important to prevent the occurrence of the diseases with the consumption of right type of food so that the people lead quality life with increase in economic status. Many anti-nutritional factors are widely considered to be critical for human health. Among them, free radicals have been of concern as one of the factors contributing to chronic degenerative diseases (Bray, 2000). Free radicals can lead to a variety of biochemical and physiological lesions (Ames, 1998) and induce degenerative diseases such as coronary artery disease (CAD), diabetes, stroke, and cancer (Halliwell, 1994). In the body, free radicals derive from two sources i) endogenous sources e.g. nutrient metabolism and the ageing process and ii) exogenous sources e.g. air pollution (Elsayed, 2001; Lachance *et al*., 2001). Free radicals can attack various substrates in the body and contribute to chronic disease development. For example, oxidatively modified LDL has been hypothesised to be a causative agent in the development of cardiovascular disease (Touyz, 2004). Oxidatively modified DNA may also play an important role in human carcinogenesis (Lim *et al*., 2002). Usually the human body has mechanisms for eliminating the free radicals by some nutrients in the diet that have antioxidant activities. The Food and Nutrition Board of the United States of America has defined a dietary antioxidant as a substance present in commonly consumed foods that significantly decreases the adverse effects of chemically reactive species on normal physiological functions in humans (Anonymous, 2000).

The antioxidants are believed to play a major role in body defense system against reactive oxygen species (ROS), which are the harmful byproducts generated during normal metabolism and in pathological conditions (Gutteridge and Halliwell, 2000). Dietary antioxidants may help to control oxidative stress (Record *et al.,* 2000). Antioxidants can prevent oxidation of substrates when present at low concentrations compared with that of an oxidizable substrate (Halliwell, 1995). Antioxidant supplements or foods rich in medicinal plants are used to help the human body in reducing oxidative damage by free radicals and active oxygen. Currently, research interest has been focused on the role of antioxidants as well as antioxidant enzymes, in the treatment and prevention of many diseases. Antioxidants may guard against ROS toxicities by the prevention of ROS construction, by disruption of ROS attack, by scavenging reactive metabolites and converting them to less reactive molecules or by enhancing the resistance of sensitive biological target to ROS attack (Gutteridge and Halliwell, 2000).

2.3 Source of antioxidants in fruits and vegetables

Many researchers around the world have been studying antioxidant activity in various foods, especially in grains, vegetables and fruits (Ou *et al*., 2006; Sun *et al*., 2002; Karl and John, 2002). Fruits are more interesting because they are rich in antioxidants and can be consumed as fresh, dried, juice and other processed products on various occasions. Epidemiological studies have shown the importance of fruit and vegetable consumption in human diet for the prevention of coronary heart disease, cancer, diabetes and stroke (Wang *et al.,* 1996). The prevention of chronic diseases has been attributed to the presence of antioxidants present in fruits and vegetables (Steinberg, 1991). Antioxidant activities in many varieties of common western fruits such as blueberry, grape, banana, cranberry, prune, apple, plum, tomato and raspberry have been studied (Imeh and Khokhar, 2002; Sun *et al*., 2002; Connor *et al*., 2002).

Phytochemicals like carotenoids, tocopherols, ascorbates, lipoic acids and polyphenols are strong natural antioxidants with free radical scavenging activity. Endogenous antioxidant enzymes such as super oxide dismutase (SOD), catalase, glutathione peroxidase, glutathione reductase, minerals like Se, Mn, Cu, Zn and certain vitamins exert synergistic actions in scavenging free radicals (Escarpa and Gonzalez, 2001; Scalbert *et al*., 2005). Polyphenols act against allergies, ulcers, tumors, platelet aggregation, cardiovascular disease and can reduce the risk of cancer (Block *et al.*, 1992; Hertog *et al*., 1993; Bingham and Riboli, 2003; Prakash and Gupta, 2009). The most common antioxidants present in fruits, vegetables and cereals are vitamin C, vitamin E, carotenoids, flavonoids (anthocyanins, polyphenol and quercetin), related phenolics and thiol compounds (Ou *et al.*, 2006).

2.3.1 Vitamin C

Vitamin C is one of the most popular and least toxic antioxidant components of foods and has been most widely used as a dietary supplement to prevent oxidative stress mediated diseases (Gardener *et al.,* 2002). However, the contribution of the vitamin C to the antioxidant activity of fruits and vegetables is generally about 10 per cent (Slinkard and Singleton, 1977). Among common fruits, aonla, citrus, strawberries and raspberries are noted for their high vitamin C content (Kalt, 2005).

2.3.2 Polyphenols

Polyphenols are a variety of antioxidant compounds that have been used as dietary supplements for the prevention of pathological diseases and for the improvement of human health conditions (Weisburger, 1991; Zhang *et al.,* 2006). These are a class of phytonutrients or non-vitamin, non-mineral components of foods that have a significant health benefits. Chemically, polyphenols are a group of substances found in plants and characterized by the presence of more than one phenol unit per molecule. Phenolics are compounds possessing one or more aromatic rings with one or more hydroxyl groups and generally are categorized as phenolic acids, flavonoids, stilbenes, coumarins and tannins. Phenolics are the products of secondary metabolism in plants, providing essential functions in the reproduction and the growth of the plants, acting as defense mechanisms against pathogens (Sharma and Hashinaga, 2004), parasites, and predators, as well as contributing to the colour of plants. In addition to their roles in plants, phenolic compounds in our diet may provide health benefits associated with reduced risk of chronic diseases. The antioxidant properties of the phenolics are due to their redox properties which allows them to act as a reducing agent, hydrogen donators, singlet oxygen quenchers and metal scavengers (Rice-Evans *et al.*, 1997). Flavonoids terminate the radical chain reactions that occur during the oxidation of triglycerides (Das and Pereira, 1990). Protective effects of flavonoids against rubratoxin B toxicity in hepatocellular carcinoma cells have been reported by Sharma and Nagashima (2005).

Among the 11 common fruits consumed in the United States, cranberry has the highest total phenolic content followed by apple, red grape, strawberry, pineapple, banana, peach, lemon, orange, pear, and grapefruit (Sun *et al.*, 2002) while among the 10 common vegetables consumed, broccoli possesses the highest total phenolic content followed by spinach, yellow onion, red pepper, carrot, cabbage, potato, lettuce, celery, and cucumber (Chu *et al.*, 2002). It has been estimated that flavonoids account for approximately two thirds of the phenolics in our diet and the remaining one third are from phenolic acids. Some of the more notable groups of polyphenols include tannins, flavonoids and anthocyanins (Ohr, 2008). Common fruits and vegetables that are abundant in phenolic antioxidants include most berry crops, many tree fruit crops and onions (Hertog *et al.,* 1993).

2.3.3 Anthocyanins

Anthocyanins are natural components belonging to the flavonoid family. These are glycosides and acylglycosides of anthocyanidins. The chemical structure (position, number and types of substitutions) of the individual anthocyanin molecule also has a bearing on the degree to which anthocyanins exert their bioactive properties (Prior *et al*., 1998; Russo *et al*., 2000; Nagashima *et al*., 2004) and the structure function relationships also influence the intracellular localization of the pigments (Lazze *et al*., 2003). These are widely distributed among flowers, fruits (particularly in berries) and vegetables and are responsible for the bright colours such as orange, red and blue. Fruits like black currant, strawberry, plum, red grapes and vegetables like red cabbage, red onion etc have been found to be rich in anthocyanin content (Strack and Wray, 1989). In addition to their colourful characteristics, anthocyanins possess potent antioxidant properties. Some common anthocyanins are delphinidin, cyanidin, pelargonidin, malvidin and peonidin (Wang *et al.,* 1997). Anthocyanin isolates and anthocyanin-rich mixtures of bioflavonoids may provide protection from DNA cleavage, estrogenic activity (altering development of hormone-dependent disease symptoms), enzyme inhibition, boosting production of cytokines (thus regulating immune responses), anti-inflammatory activity, lipid peroxidation, decreasing capillary permeability and fragility and membrane strengthening (Ramirez-Tortosa *et al.*, 2001; Acquaviva *et al.*, 2003; Lazze *et al.,* 2003; Rossi *et al.*, 2003; Lefevre *et al.,* 2004). Anthocyanins have also been reported to possess protective action against rubratoxin B treated HL 60 cells (Nagashima *et al.,* 2004).

2.3.4 Betalains

Betalains are water-soluble pigments found in the vacuoles of plant cells. Betalains contains nitrogen in their structure (Robinson *et al*., 1963). They are aromatic indole derivatives synthesized from tyrosine and are not flavanoids (Raven, 2005). Each betalain is a glycoside consisting of a sugar and a coloured portion. Most studied betalain is betanin which is called as beetroot red. It is a glucoside and hydrolyzes into sugar glucose and betanidin (Robinson *et al*., 1963). It is used as a food colouring agent and the colour is sensitive to pH. These compounds have been reported to be natural antioxidants (Escribano *et al*., 1998) which may have positive effects in humans (Tesoriere *et al*., 2004). Betalains may exhibit anti-cancer activity. Betalains from prickly pear showed considerable free radical scavenging and antioxidant properties *in-vitro* to protect endothelium from cytokine induced redox state alteration through ICAM-1 inhibition (Gentile *et al*., 2004). Betalains are stable over a wide range of pH.

2.3.5 Carotenoids

Carotenoids are nature’s most widespread pigments and have also received substantial attention because of both their pro-vitamin and antioxidant roles. More than 600 different carotenoids have been identified in nature. They occur widely in plants, microorganisms and animals. Carotenoids have a 40-carbon skeleton of isoprene units. The structure may be cyclized at one or both ends, may have various hydrogenation levels or may possess oxygen-containing functional groups. Lycopene and β-carotene are examples of acyclized and cyclized carotenoids, respectively. Carotenoid compounds most commonly occur in nature in the *trans* form. The most characteristic feature of carotenoids is the long series of conjugated double bonds forming the central part of the molecule. This gives them their shape, chemical reactivity and light-absorbing properties. β-carotene, α-carotene, and β-cryptoxanthin are able to function as pro-vitamin A. Zeaxanthin and lutein are the major carotenoids in the macular region (yellow spot) of the retina in humans. Carotenoids are a group of pigments responsible for the colours varying from red to yellow. These are the precursors of pro-vitamin A. These are involved in enhancement of immune response and reduction of the risk of degenerative diseases such as cancer, cardiovascular disease, cataract, prostate cancer and macular degeneration. The principle carotenoids of fruits are α- and β-carotene, β-cryptoxanthine, lycopene, lutein and zeaxanthin. Orange vegetables and fruits, including carrots, sweet potatoes, winter squash, pumpkin, papaya, mango, and cantaloupe are rich sources of the carotenoid β-carotene. Tomatoes, watermelons, pink grapefruits, apricots and pink guavas are the most common sources of lycopene. In American diets, 85% of the lycopene intake comes from processed tomato products such as ketchup, paste, and soup (Liu, 2010). Dark leafy vegetables, carrot, pumpkin, tomato, orange, lettuce, mandarin etc are also a rich source of carotenoids (Ghodke and Chintapalli, 2009). Carotenoid pigments play important functions in photosynthesis and photoprotection in plant tissues. The photoprotection role of carotenoids originates from their ability to quench and to inactivate reactive oxygen species such as singlet oxygen formed from exposure of light and air. This photoprotection role is also associated with its antioxidant activity in human health. Carotenoids can react with free radicals and have ability to become stable radicals themselves. Their reactivity depends on the length of the chain of conjugated double bonds and the characteristics of the end groups. Carotenoid radicals are stable by virtue of the delocalization of the unpaired electron over the conjugated polyene chain of the molecules. This delocalization also allows addition reactions to occur at many sites on the radical (Britton, 1995). Carotenoids at sufficient concentrations can prevent lipid oxidation and related oxidative stress. Astaxanthin, zeaxanthin, and lutein are excellent lipid-soluble antioxidants that scavenge free radicals especially in a lipid-soluble environment.

2.4 Functional properties of fruits and vegetables

Regular consumption of fruits and vegetables containing natural antioxidants is correlated with the decreased risk of diseases like cancer, cardiovascular disease and so on. Fruits and vegetables both fresh and processed contribute significantly to improve the quality of our diet. In recent years, the interest in the exploration, development and evaluation of functional foods to the target population has increased considerably amongst the researcher and technologists (Dhiman *et al.*, 2009; Sharma *et al*, 2011; Sharma *et al.*, 2012). Karl and John (2002) reported that consumption of cruciferous vegetables protect against cancer more effectively than the total intake of fruits and vegetables. The nutrients and phytochemicals like lycopene of tomato and tomato products act together to modulate disease development and improve health. Fruits like black currant, strawberry, plum, red grapes and vegetables like red cabbage beetroot, carrot, tomato etc have been found to be rich in antioxidants. Highly coloured fruits that have a high level of anthocyanins such as black currants, elderberry and blueberry typically and possess a high antioxidant capacity. The most abundant types of antioxidants contained in fruits and vegetables include vitamin C, carotenoids and phenolics (Temple, 2000). Among common fruits citrus, strawberries, guava, aonla and grapes are known for their high vitamin C content. Spinach, carrot and tomatoes have a relatively higher carotenoid content (Thamburaj and Singh, 2004).

2.4.1 Apple

Apple (*Malus domestica* Borkh) is an important fruit of family Rosaceae and is liked throughout the world by all classes of the people due to its established nutritional and economical significance (Chaudhary, 1994). It is the premier table fruit of the temperate world. An old adage that an apple a day keeps the doctors away has its relevancy as shown by the human health research by the modern science. Apple contains 84.7% water, 0.8% fiber, 13.9% carbohydrate, 0.4% protein, 0.3% lipid, 0.3% ash, 8 mg/100 g vitamin C, 0.3 mg/100 g sodium, 145 mg/100 g potassium, 7 mg/100 g calcium, 6 mg/100 g magnesium, 480 μg/100 g iron, 12 mg/100 g phosphorus and 2 μg/100 g iodine (Hussain, 2001). Apple has been widely used as a food from the earliest times and is well known for its curative properties. It is rich in polyphenols (Paul and Southgate, 1978). Concentration of phenolic compounds in apple fruits varies (Podsedek *et al.*, 2000). In apple skin, quercetin glycosides and significant amounts of flavanols occur (Thielen *et al*., 2005). The highest concentration of phenolic acids is reported in cortex (Awad *et al.,* 2000; Russel *et al.* 2002). Five quercetins *viz*., hyperin, isoqyercitrin, reynoutrin, avicularin, quercitrin and two phloretins *viz*., phlorizin and phloretin xyloglucoside have been identified in the apple fruits (Oleszek *et al.,* 1988). Apple and its products are one of the major foods frequently consumed by people. Main antioxidants in apple are phenolics (Gardener *et al.,* 2002). Apple phenolics, as antioxidant source may provide major protection against free radical damage in human body (Ames *et al.,* 1993). In fresh apples, the total phenolics range from 72.9±9.9 to 98.0± 3.5 mg of gallic acid equivalents/100 g fresh weight. In the juice, the total phenolic concentrations are slightly lower as compared to fresh apples and range from 24.8±0.4 to 33.4±0.3 mg of gallic acid equivalents/100 mL (Zhang *et al.,* 2008a). Apple and apple juice have been reported to decrease the possibility of incidence of prostate cancer, anti-influenza viral activity and the risk of chronic diseases such as cardiovascular disease and cancer (Boyer and Liu, 2004; Hamauzu *et al.*, 2005). Apple has been used to treat infant intestinal disorders such as diarrhea and dysentery (Considine, 1982).

2.4.2 Mango

Mango (*Mangifera indica* L.) fruit is very aromatic and tends to be sweet. There is a high content of carotene, vitamin A, C and terpenes. From the nutritional point of view mango is a rich source of vitamin A (150 IU/100 g) almost as rich as butter. Also it has fair amount of vitamin C. Mango fruit contains amino acids, carbohydrates, fatty acids, minerals, organic acids, proteins and vitamins. It has been reported to contain 78.90-82.40% moisture, 0.36-0.40% protein and 0.30-0.53% fat (Majumdar and Sharma, 1990). Mango cv. Dashehari has been reported to possess, 14–19% total soluble solids, more than 5% reducing sugars and 30–40 mg/100 g vitamin C (Kalra *et al.*, 1991). However, 14 mg/ 100 g ascorbic acid and 19% reducing sugars have been reported by Jilani *et al*. (2010).

2.4.3 Pear

The oriental pear (*Pyrus cummunis* L) or sand pear 'Patharnakh' is grown wildly in temperate and semi-temperate regions of Himachal Pradesh, Jammu and Kashmir, Uttarakhand Punjab, Haryana and North Eastern regions of India. The fully mature sand pear fruit has high nutritional value. Edible portion of the fruit contains good amounts of carbohydrates, minerals, vitamins and polyphenols and the level of polyphenols in sand pear fruits is more than that of apple fruits (Kumar and Ghuman, 2007). Fruits of commercially cultivated pear are mostly used for table or processing purpose however, sand pear fruits, which are grown wildly, possess attributes like grittiness, higher acidity and astringent taste. Therefore, owing to presence of such attributes, these fruits are rarely used as fresh or in processing and hence, fetch low price to the grower. Even, the juice extracted from sand pear fruits being too acidic and astringent is not acceptable as such by the consumers (Raj *et al.,* 2011). The nutritive composition of European and Asian pear has been reported as vitamin C (3.8-4.2 mg/100 g), vitamin A (0-23 IU/100 g), calcium (4-9 mg/100 g), iron (0.0-0.17 mg/100 g), magnesium (7.0-8.0 mg/100 g), potassium (119-121 mg/100 g) and selenium (0.1 mg/100 g) (Anonymous, 2001).

Pears are a good source of phosphorous, potassium, vitamins B_1, B_2 and C, folic acid, pectin, dietary fibre, has no cholesterol and is low in calories therefore, it is traditionally used for treating the bladder problems, liver, constipation and prostate toxin elimination. The carbohydrates in a cup of pear juice are low on the glycemic index (GI) and have a low glycemic load (Powell *et al*., 2002). Pear contains phytochemicals including phenolics such as chlorogenic acid, arbutin, caffeic, *p*-coumaroyl, quinic and *p*-coumaric acids and a number of procyaninidins and flavonol glucosides (Ma, 2004; Tanrioven and Eksi, 2005). Fruits have a high oxygen radical absorbance capacity rating. Sand pear juice contains 10.50^{o}B total soluble solids, 0.374% acidity and 11.20 mg/100 mL ascorbic acid (Attri *et al*., 1998).

2.4.4 Aonla

Aonla or Indian gooseberry (*Emblica officinalis* Gaerth) belongs to family Euphorbiaceae and is one of the important fruits indigenous to India. Aonla fruits are highly nutritive and are the richest source of vitamin C among fruits except barbados cherry (Asenjo, 1953). Presence of astringency in the aonla fruit is due to the presence of polyphenols and leucoanthocyanins. These are recommended by Ayurvedic and Unani systems of medicines owing to its invaluable medicinal properties like acrid, cooling, diuretic and laxative effects. The fruit is useful in anemia, artherosclerosis, cough, diarrhea, dysentery, dyspepsia, haemorrhages, leucorrhea and jaundice as it is anabolic, antibacterial and resistance building and possesses anticarcinogenic, antiemetic, antioxidative, antipyretic, antitumour, antiviral, cardiotonic and expectorant activities. Therapeutic properties of the fruits are attributed to their high ascorbic acid content, about 1 g vitamin C per 100 mL of fresh juice (Kapoor, 1990). Because of the presence of tannins, the ascorbic acid does not oxidise even in dried fruit, thus maintaining its anti-scurvy property unchanged. The fruits contain fair amount of iron, calcium and lysine. Nevertheless, aonla is not popular as a table fruit due to its hard flesh and unpleasant astringent taste. Therefore, many value added products like beverages, pickles, jams, toffees etc have been developed to utilize fruit (Pathak, 1988).

2.4.5 Kinnow mandarin

Citrus fruits (lemon, lime, orange etc.) contain a number of different nutraceuticals which include a variety of phenolic compounds in the flavonoid subclass. The major flavonones in orange and grapefruit juices are hisperedin and naringenin, respectively (Patil and Sharma, 2009). Citrus fruits are considered to be the rich source of ascorbic acid, pectin, carotenes, citric acid, and minerals like calcium and phosphorous (Ahmed *et al.,* 2008). Mandarin (*Citrus reticulata*) is one of the most popular citrus fruit having attractive bright colour, appealing taste and flavour. The composition of Kinnow fruit juice is beneficial with respect to its mineral and ascorbic acid contents (Faladae *et al.,* 2003). There is a great potential to use this fruit in value added products such as diet drinks. These types of citrus drinks are probably the most recognized and globally accepted fruit drinks (Nchez-moreno *et al.,* 2003; Gorinstein *et al.,* 2004).

Kinnow mandarin is quite important as it has a great variety of beverage, industrial and medicinal uses due to its attractive colour, distinctive flavour and being rich source of vitamin C, vitamin B, β-carotene, calcium and phosphorous (Sogi and Singh, 2001). The single most hindrance in the popularity and processing of Kinnow mandarin juice is the development of bitterness due to enzymatic conversion of a non-bitter precursor limonoate A ring lactone (LARL) in to intensely bitter limonoid-limonin via limonoate-D-ring lactone hydrolase (Premi *et al.*, 1994), which makes the processing of this fruit limited. For improving the taste, aroma, palatability, nutritive value and reducing bitterness, Kinnow juice has been reported to be blended with some other highly nutritive fruit juices namely pomegranate and aonla juice with spice extracts like ginger for the preparation of refreshing juices with nutritional and medicinal properties (Bhardwaj and Mukherjee, 2011).

2.4.6 Jamun

In India, Jamun (*Syzygium cumini* Skeels) of the family Myrtaceae is commonly called as Indian blackberry or black plum and has been widely used to treat diabetes by the traditional practitioners over many centuries (Nadkani, 1954). Jamun fruits are edible and are reported to contain gallic acid, tannins, anthocyanins and other components (Benherlal and Arumughan, 2007). The juice of unripe fruits is used for preparing vinegar that is considered to be a stomachic, carminative and diuretic. The ripe fruits are used for making preserves, squashes and jellies. Jamun is a minor fruit crop, gaining popularity among the consumers due to its high neutro-clinical values in rural as well as in urban masses. In addition, the ripe berries are good source of vitamins, minerals, iron and pectin with fair amount of ascorbic acid. It is used as an effective therapeutic medicine against diabetes, heart and liver trouble (Garande and Joshi, 1995). The fruits are reported to contain vitamin C, gallic acid, tannins, anthocyanins such as cyanidin, petunidin, malvidin glucosides and other components. Jamun is very popular as a dessert because of its slight astringent but sweet sour taste and excellent colour. The untapped popularity of jamun fruits can be harnessed by processing into many products like ready-to-serve nectar, squash and syrup (Das, 2009). Jamun fruits are universally accepted to be very good for medicinal purposes especially for curing diabetes because of its effect on the pancreas. The fruit and its juice and the seed contain a biochemical called jamboline which is believed to check the pathological conversion of starch into sugar during increased production of glucose. Beside, the jamun fruit is an effective food remedy for bleeding piles and correcting liver disorders. Since, the fruit is a very rich source of anthocyanin, it imparts antioxidant properties too (Joshi *et al.,* 2001).

2.4.7 Grapes

Grapes have a long and abundant history. During the ancient Greek and Roman civilizations, grapes were revered for their use in wine making. Nowadays, there are three main species of grapes *viz*. European grapes (*Vitis vinifera*), North American grapes (*Vitis labrusca* and *Vitis rotundifolia*) and French hybrids. Grapes are classified as table grapes, wine grapes, raisin grapes etc. with edible seeds or seedless. Grape berries contain various nutrient elements, such as vitamins, minerals, carbohydrates, edible fibers and phytochemicals. Polyphenols are the most important phytochemicals in grape because they possess many biological activities and health-promoting benefits (Silva *et al.,* 1991; Shrikhande *et al.,* 2003). The phenolic compounds mainly include anthocyanins, flavanols, flavonols, resveratrol and phenolic acids (Dopico-Garcia *et al.,* 2008; Novaka *et al.,* 2008; Spacil *et al.,* 2008). Anthocyanins are pigments and mainly exist in grape skins. Flavonoids are widely distributed in grapes, especially in seeds and stems and principally contain (+)-catechins, (−)-epicatechin and procyanidin polymers. Anthocyanins are the main polyphenolics in red grapes, while flavan-3-ols are more abundant in white varieties (Bagchi *et al.,* 2000; Cantos *et al.,* 2002; Chacona *et al.,* 2009).

Red grapes are rich in anthocyanidins while yellow pigment of both white and red grapes is quercetin. The anthocyanin content in red grapes has been reported to possess about 2500 to 3000 mg/kg (Bose and Mitra, 1996). Among the commercial fruit and vegetable juices, grape juice had the highest antioxidant activity followed tomato juice, orange juice and apple juice (Wang *et al.,* 1996). Grapes contain high amount of vitamin K (22 µg), folate (2 µg), sodium (3.02

mg), potassium (191 mg), calcium (10 mg), magnesium (7 mg) and phosphorus (20 mg) per 100 g edible portion (Anonymous, 2009).

2.4.8 Papaya

Papaya (*Carica papaya* L.) is a common man's fruit, which is reasonably priced and has a high nutritive value. It is the fifth most important fruit crop in India. The fruits are excellent source of vitamin A (2020 IU/100 g) next to mango and also a rich source of vitamins like thiamine, riboflavin, nicotinic acid and ascorbic acids. Papaya contains 9% of dietary reference intake (DRI) for Cu, 6-8% of the DRI for Mg and less than 3% of the DRI for other minerals (Wall, 2006). It is low in calories and rich in natural vitamins and minerals. It contains 0.6% protein, 0.1% fat, 2740 µg total carotene and 888 µg β-carotene per 100 g of edible portion. It is antimicrobial, anti-helminthic, anti-fungal, anti-amoebic, diuretic and hepatoprotective (Krishna *et al.*, 2008).

2.4.9 Tomato

Tomato (*Lycopersicon esculentum*) is most important and remunerative vegetable crop in India. It has been estimated that about 25-30 per cent of tomatoes production in India are spoiled during post-harvest handling and glut in the markets (Anonymous, 2010). It is a rich source of minerals, vitamins and organic acids. Tomato fruit provide 15-30 mg/100 g ascorbic acid and 20-50 mg/100 g fruit weight of lycopene (Anonymous, 2001). It has been reported that all the vegetable juices have varying levels of antioxidant activities with tomato having 21.21±2.883 µg/100 g (Doss and Dhanabalan, 2009).

2.4.10 Carrot

Carrot (*Daucus carota* L.) juice is a rich source of carotene having 5.618 mg/100 g edible portion (Ghodke and Chintapalli, 2009). Orange coloured carrots are rich in carotene, a precursor of vitamin A and contain appreciable amount of thiamine and riboflavin (Anonymous, 2001). Total phenolic content of carrot has been reported to be 26.59±1.70 µg/g gallic acid equivalents (Doss and Dhanabalan, 2009). Thamburaj and Singh (2004) reported that carrot contains 11000 IU vitamin A. According to Massamba and Nguyen (2008) it possesses 4.9 mg/100 g vitamin C, 31.7 mg/ 100 g calcium and 320.7 mg/100 g phosphorous. Consumers like carrot juice because of high nutritious value, important source of fibre, carbohydrates and α-carotene and β-carotene content, colour, aromatic compounds and refreshing characteristics (Sahota *et al.,* 2009; Sharma *et al.*, 2012). The carotenoid levels are heterogeneous in different yellow, orange, red, and purple carrot cultivars with the level of β-carotene increasing gradually from the periderm toward the core, the levels of β-carotene and lutein being higher than those of β-carotene in younger cells and with lycopene accumulating throughout the whole secondary phloem in red cultivars (Sharma *et al.*, 2012).

2.4.11 Bottlegourd

Bottlegourd (*Legenaria siceraria* (Mol.) Standl.) is commonly grown vegetable in India. Fruit have cardiotonic and diuretic properties. Fruits have been reported to contain 0.2% protein and 11 mg of vitamin C per 100 g on fresh weight basis (Thamburaj and Singh, 2004). Its pulp is a very good source of fiber- free carbohydrates. It is grown for immature fruits, used for culinary purpose (Anonymous, 2001). It also cures pain, ulcers, fever, and used for pectoral cough, asthma and other bronchial disorders. Fruits contain 96.3% moisture, 0.2% protein, 2.9% carbohydrates, 0.5% mineral matter, 0.02% calcium and less than 0.01% phosphorus. Other mineral elements reported to be present are iron (0.7 mg/ 100 g), sodium (11.0 mg/100 g), potassium (86.0 mg/100 g) and iodine (4.5 µg/ Kg). Common amino acids present in bottlegourd are: leucine, phenylalanine, valine, tyrosine, alanine, threonine, glutamic acid, serine, aspartic acid, cystine, cysteine, arginine and proline. The fruit is a good source of B-complex vitamins and a fair source of ascorbic acid (Kubde *et al.*, 2010). Anti-hyperglycemic activity of bottlegourd has been reported by Deshpande *et al*. (2008). Erasto (2009) observed the antioxidant activity of bottlegourd and suggested it as a potential source of natural antioxidants.

2.4.12 Bittergourd

Bittergourd (*Momordica charantia*) is one of the most common vegetables of Indo-Pakistan subcontinent and cultivated during warm season. Fruits are of considerable importance due to its many medicinal applications. Bittergourd is considered anti-diabetic, stomachic, carminative, used in rheumatism, gout diseases of liver and spleen and also used as stimulant, blood purifier, anthelminthic, laxative and effective against leprosy, piles and jaundice. The fruits are rich in iron, vitamin A, B and C and are an inexpensive source of proteins and minerals (Thamburaj and Singh, 2004). Bittergourd fruit extracts have been reported to possess a wide medicinal use in the traditional medicinal systems, most often as hypoglycemic and anti-diabetic agents (Semiz and Sen, 2007). It has been reported to exhibit biological activities such as antioxidant, antimicrobial, antiviral, antihepatotoxic and antiulcerogenic activities, which are attributed to an array of biologically active plant chemicals including triterpenes, pisteins and steroids (Grover and Yadav, 2004). Bittergourd is bitter in taste and is not be relished by the masses therefore, needs to be processed and fortified to make it palatable and acceptable (Garg, 2010).

2.4.13 Pumpkin

Pumpkin (*Cucurbita moschata*) is defined as fruit botanically although commonly regarded as vegetable in consumer terms. Flesh and seeds of pumpkin are commonly used for culinary and medicinal purposes. Pumpkin is from genus Cucurbita of the family Cucurbitaceae. There are three common types of pumpkin world-wide, namely *Curcurbita pepo*, *Curcurbita maxima* and *C. moschata* (Thamburaj and Singh, 2004). Pumpkin can be found in many shapes, sizes and colours. *C. moschata* is most commonly used cucurbit in both Asia and the United States.

The yellow-orange characteristic colour of pumpkin is due to the presence of carotenoids. Carotenoids are natural pigments responsible for the yellow, orange and red colour of many foods. Pumpkin provides valuable source of carotenoids, provitamin A and ascorbic acid which have major roles in nutritional aspects as well as an antioxidant. The carotenoid content in Spanish pumpkin was reported to be higher than other pumpkins and even higher than carrots which contained α-carotene (Dhiman *et al.*, 2009). Similarly, Murkovic *et al*. (2002) reported that three species of pumpkin (*Cucurbita pepo*, *C. maxima* and *C. moschata*) consisted of beta-carotene (0.06-7.4 mg/100 g, alpha-carotene (0-7.5 mg/100 g) and lutein (0-17 mg/100 g). Pumpkin has also been reported as a rich source of vitamins, minerals, pectin and dietary fibre (Djutin, 1991).

Pumpkin seed has considerable nutritional value for human consumption due to its 37.8–45.4% oil and 25.2–37.0% protein. It has valuable dietetic and medicinal advantages besides being a source of edible oils, proteins and minerals of good quality (Yoshida *et al.,* 2004). The content of vitamin E in pumpkin seed is very high and the main available isomers are α- and γ-tocopherols (Idouraine *et al.*, 1996). Pumpkin can be consumed in a variety of ways such as a fresh or cooked vegetable, as well as being stored frozen or canned (Figueredo *et al.*, 2000).

2.4.14 Cabbage

Cabbage *(Brassica oleracea* var. *capitata*) is a rich source of vitamin A, B, C, minerals and antioxidants (Anonymous, 2001). According to Singh *et al.* (2009) total phenolic content and antioxidant activity of the cabbage is 18.7 mg/100 g gallic acid equivalent and 2.8 μmole Trolox equivalent, respectively. It has an anti-cancer property and it protects against bowel cancer due to the presence of indole-3-carbinol. Cabbage juice is used as a remedy against poisonous mushrooms and as a gargle against hoarseness (Thamburaj and Singh, 2004). It has been reported to possess 32.1 mg/100 g vitamin C, 39.0 mg/100 g calcium and 253.2 mg/100 g potassium (Massamba and Nguyen, 2008).

2.4.15 Beetroot

Red beetroot (*Beta vulgaris*) is considered to be a potential source of valuable water soluble nitrogenous pigments called betalains. These betalains are composed of two main groups i.e. the red betacyanins and the yellow betaxanthins (Pavlov *et al.,* 2002). Kohen and Shalhoub (1994) found that these betalains are cationized compounds and their affinity for membranes may improve their activity. According to Nilsson (1970), the betacyanin and betaxanthin contents of red beetroots vary within the ranges 0.04–0.21% and 0.02–0.14%, respectively, depending on the cultivar (Von Elbe, 1975) although, some new varieties produce higher betalain contents (Pszczola, 1998; Gaertner and Goldman, 2005). Gasztonyi *et al.* (2001) analysed five red beetroot varieties (Bone, Nero, Favorit, Rubin and Detroit) in terms of their pigment composition. The major red-violet pigments detected were betanin, isobetanin, betanidin and isobetanidin and the major yellow components were vulgaxanthin I and vulgaxanthin II. Moreover, an adverse earthy-like flavour because of geosmin and some pyrazines is undesirable when adding beetroot extracts to dairy products (Lu *et al*., 2003; Stintzing and Carle, 2004).

2.5 Antioxidant activity of fruit and vegetable juices

All vegetable juices exhibit increased antioxidant activity with increasing juice concentration in processed products (Doss and Dhanabalan, 2009). Fruit juices are valuable sources of vitamins and minerals which contribute to overall dietary quality and thus may reduce the risk of chronic diseases. In addition, they may be a major source of numerous polyphenols, particularly flavonoids in the diet. Researchers have found that fruit juice consumption can contribute significantly to adequate intakes of essential nutrients including vitamin C, folate, potassium and magnesium. Consumption of 100 per cent pure fruit juices is an effective approach to meet the current dietary recommendations for fruit intake as well as provide essential nutrients and functional components including antioxidants. Substantial evidences indicate that 100 per cent pure juice intake can be a part of healthy active life style (Clemens and Dubost, 2008).

In a study, the total antioxidant properties of 12 fruits and 5 commercial fruit juices were measured based on wet weight of fruits (edible portion), strawberry showed the highest ORAC activity followed by plum, orange, red grape, kiwi fruit, pink grapefruit, white grape, banana, apple, tomato, pear and honeydew melon. On the basis of dry weight of fruits, strawberry also had the highest ORAC followed by plum, orange, pink grape fruit, tomato, kiwi fruit, red grape, white grape, apple, honeydew melon, pear and banana. It has been reported that antioxidant capacities of fruit and vegetable juices may not always be similar to those measured in respective fresh fruits. The commercial grape juice and tomato juice has much higher ORAC than the fresh red grapes and fresh tomatoes, while the commercial orange juice had much lower ORAC than the fresh oranges (Wang *et al.*, 1996). The total phenolic content of grape, apple and tomato has been reported to be 29.57 mg/100 g, 27.47 mg/100 g and 15.33 mg/100 g on dry weight basis, respectively (Chen *et al.*, 2008). Kanner *et al.* (2001) emphasized on the strong antioxidant effects of betacyanins of beetroot in model systems of lipid peroxidation and suggested it as potent antioxidant against lipid peroxidation.

Kaur and Kapoor (2005) evaluated the antioxidant activity of 19 fruits and 5 fruit juices using three model reaction systems (FRAP assay, β-carotene lineolate assay and super-oxide anion scavenging activity). Aonla fruits had the highest phenol content (290 mg/100 g) and highest antioxidant activity as 56.8 mM by FRAP assay, 92% by β-carotene lineolate system and 85% by super-oxide anion scavenging activity. Appreciably high phenolic content was also recorded in anthocyanin rich fruits like red pomegranate (270 mg/100 g), plums (250 mg/100 g), jamun (215 mg/100 g) and black grapes (192 mg/100 g). Processing in the form of juices resulted in a significant increase in total phenols and antioxidant activity. Fruits like ber, phalsa, apple and strawberry also had moderate antioxidant activity ranging from 12-64 mM by FRAP assay. Anthocyanin and phenolics rich fruits like aonla, jamun and bael are good source of dietary antioxidants. Antioxidant activity of the apple, blackcurrant and blended juices of both were strongly correlated with phenolic content by Oszmianski and Wojdylo (2009). Highest level of antioxidant activity was recorded in blackcurrant juice which was attributed to its high anthocyanin content. Erasto (2009) established the antioxidant activity in bottlegourd fruits using DPPH assay and reported that percentage inhibition by concentration of 20, 40, 60 mg/mL ethanolic fruit extract were about 79.12%, 87.34% and 91.23%, respectively. Reducing power ability of the bottlegourd ethanolic extracts increased with their concentrations.

2.6 Medicinal properties of fruit and vegetable juices

This inverse association between fruit and vegetable intake and chronic diseases appears to hold true across different geographical locations and in populations that differ in lifestyle, gender and age – a paradigm prompting health authorities to recommend increased consumption of fruits and vegetables and to implement this public health directive in many countries. Many countries in the developed world have 5 plus-a-day programme during which 70 g each of fruits and vegetables per serving are to be consumed every day. Many pharmacological activities have been reported for aonla fruit extract *viz*., it inhibits micronuclei formation, sister chromatid exchanges, clastogenicity and mutagenicity induced by metals such as lead, aluminum, cadmium, nickel and caesium against radiations (Scartezzini and Speroni, 2000), possesses anti-diabetic activity (Sabu and Kuttan, 2002), inhibits clastogenicity of benzopyrene and cyclophosphamide (Sharma *et al*., 2000; Haque *et al*., 2001), possess gastroprotective (Al-Rehaily *et al*., 2002), cytoprotective, and immunomodulating properties (Ram *et al*., 2002). Further, new pharmacological activities have also been found for aonla i.e. it has cytoprotective activity against chromium (Ram *et al*., 2003), shows antivenom capacity (Alam and Gomes, 2003), ameliorates hyperthyroidism and hepatic lipid peroxidation (Panda and Kar, 2003), displays antiproliferative activity on MCF7 and MDA-MB-231 breast cancer cell lines (Lambertini *et al*., 2003), shows anti-tussive activity (Nosallova *et al*., 2003) and induces apoptosis in Dalton's Lymphoma Ascites and CeHa cell lines (Rajeshkumar *et al*., 2003). Similarly, high consumption of fruit and vegetables (considered together) has also been associated with reduced all-cause mortality in white and African American adults in 3 communities in the United States (Knoops *et al*., 2004). Furthermore, plasma concentrations of ascorbic acid were significantly and inversely associated with mortality in 2 British cohorts (Khaw *et al*., 2001; Fletcher *et al*., 2003). Plasma carotene was also associated with lower mortality in the elderly populations of several European countries (Buijsse *et al*., 2005). Spormann *et al.* (2011) studied the effect of anthocyanin/polyphenolic rich fruit juice on oxidative cell damage in patients on hemodialysis and reported a reduction in oxidative (cell) damage in hemodialysis patients especially due to the high anthocyanin/polyphenol content of the juice.

Kawashima *et al*. (2007) studied the effect of mixed fruit and vegetable juice concentrates supplementation on protective serum antioxidants, folate and plasma cystein in Japanese subjects. The study showed that supplementation with the fruit and vegetable juice concentrate capsules proved to be a highly bioavailable source of phytonutrients. Important antioxidants were elevated to desirable levels associated with decreased risk of disease while markers of oxidative stress were reduced and folate status improved with a concomitant decrease in homocysteine and these benefits occurred to a similar extent in smokers when compared to non-smokers. In a similar study by Kiefer *et al*. (2004) the effect of mixed fruit and vegetable juice concentrates on serum antioxidants and folate in healthy adults was observed. Significant increase in blood nutrient levels after active supplementation was observed for β-carotene, vitamin C, vitamin E, selenium and folate. Ranges measured after supplementation, often fell into those associated with a reduced risk for disease. These results showed a positive effect of supplementation with enriched dehydrated fruit and vegetable juice powder on blood levels of β-carotene, vitamin C, vitamin E, selenium and folate. Saoji (2009) studied the anti-hyperlipidemic effect of methanolic extract of bottlegourd fruits at different concentrations of 100, 200 and 300 mg/kg body weight of the rat. Doses were administered to the high fat-diet-induced hyperlipidemic rats for 30 days to evaluate its antihyperlipidemic activity. Atorvastatin (10 mg/kg per rat) was used as a standard drug. At the 30^{th} day, most significant reduction in lipid levels in the fruit extract treated rats as compared to the rats fed with high-fat diet was observed. Total cholesterol decreased from 290.14±18.42 mg/dl to 228.58±16.38 mg/dl, low density lipoprotein cholesterol decreased from 195.14±8.86 mg/dl to 120.57±8.11 mg/dl, triglyceride decreased from 232.41±15.22 mg/dl to 181.79±15.68 mg/dl and very low-density lipoprotein cholesterol decreased from 46.48±3.04 mg/dl to 36.35±3.13 mg/dl at 30^{th} day. Conversely, high-density lipoprotein cholesterol levels were significantly increased from 48.52±6.52 to 71.66±5.14 mg/dl. The increase in weight in rats administered with bottlegourd extract was less when compared to rats fed with high-fat diet.

The aqueous extract of Jamun (pulp) was investigated by Namasivayam *et al.* (2008) for its possible hypoglycemic and anti-oxidant potentials in streptozotocin (STZ) induced diabetic wistar female rats. Treatment with the aqueous extract of Jamun pulp at 100 mg/kg and 200 mg/kg body weight resulted in significant reduction in blood glucose levels. Body weights were significantly reduced in STZ Induced diabetic rats when compared to normal rats, while in diabetic rats jamun extract prevented significantly the decrease in body weight in a dose dependant manner. Goyal *et al*. (2010) used jamun extract to explore anti-tumor promoting activity in a stomach carcinogenesis model in mice. For this purpose, Swiss albino mice were administered with 1 mg of benzo-a-pyrene (BaP) in 100µl sesame oil by orally twice a week for 4 consecutive weeks. The animals were sacrificed 14 weeks after the last administration of BaP. Oral administration of the extract to pre-treated, post-treated and pre-post treated groups provided a significant reduction in tumor incidence, tumor burden and cumulative number of gastric carcinomas along with a significant elevation of phase II detoxifying enzymes, and inhibition of lipid per oxidation in the stomach. By administering blueberry extracts with significant anthocyanin content (but not purified pigments), it was noted that the blueberry-supplemented diets led to effective reversal of age-related deficits in various neural and behavioral parameters (memory and motor functions) (Joseph *et al.,* 2009). Further investigations of the study demonstrated that anthocyanins (in particular, cyanidin-3-sambubioside-5-glucoside and cyanidin- 3, 5-diglucoside) were highly bioavailable in endothelial cells, which was linked to their roles in prevention of atherosclerosis and neurodegenerative disorders (Youdim *et al.,* 2000; Youdim *et al.,* 2002). Anthocyanins exerted multiple protective effects against pleurisy in a rat model and were capable of attenuating inflammation. Deshpande *et al*. (2008) reported the anti-hyperglycemic activity of bottlegourd fruit extract and observed that administration of ethanolic extract of fruit extract (100 and 200 mg/kg body weight) effectively prevented these changes.

2.7 Blending of juices and pulps

The food market has stimulated the development of new products that present good sensory acceptance, contain high nutritional value and have functional activity. Nowadays, the nutrient content is an important factor that impacts on the consumers' choice of a particular food to be eaten. About 47% of consumers believe that fortified foods and beverages are able to supply their recommended daily vitamin intake (Sloan, 2003). Blending of juices and pulps could be an economic requisite to utilize profitably some fruits and vegetables for processing which may not otherwise have favourable characters such as colour, aroma and mouth feel (Kalra *et al.,* 1991). Two or more fruits juice/pulp may be blended in various proportions for the preparation of nectar, RTS beverages etc (Sandhu and

Sindhu, 1992; Saxena *et al.,* 1996; Attri *et al*., 1998; Langthasa, 1999; Deka, 2000; Deka and Sethi, 2001)). The blending of juice may also improve aroma, taste and nutrients of the beverages. Attempts have also been made to develop the fruit and vegetable juice blends like cucumber-litchi-lemon juice and ashgourd-pudina juice (Majumdar *et al.,* 2009a; Majumdar *et al.,* 2009b), carrot-black carrot, carrot-beetroot juice (Dhaliwal and Hira, 2001) and carrot-aonla beverage (Sahota *et al*., 2009), being good sources of vitamins and minerals with a good therapeutic value. Different fruit juice blends have also been prepared by Bhardwaj and Mukherjee (2011) using Kinnow, aonla and ginger juice in 100:0:0 and 95:5:0, 92:5:3 ratios and Kinnow, pomegranate and ginger juice in 90:10:0 and 87:10:3 ratio for improving flavour, palatability, nutritive and medicinal value. Similarly, suitability of blending sand pear juice with apple juice has been evaluated by Raj *et al*. (2011) who blended the apple and sand pear juice in different proportions and found that blending of sand pear juice with apple juice in the proportion of 50:50 to 60:40 gave better quality with higher sensory score among all the combinations. Hussain *et al*. (2011) blended the apple and apricot juices in different ratios and studied the effect of different preservatives on the quality parameters of juices during storage. They reported that apple-apricot juice blends in the ratio of 50:50 and 75:25 were judged as the best on the basis of sensory evaluation. Similarly, five types of juice blends with different proportions of juices were prepared by El-Sharouny (2006) in an attempt to maximize the potent antioxidants. He used locally produced fruits such as persimmon, papaya, guava and pomegranate and judged the acceptability of blends on the basis of their functional quality**.** Sharma *et al*. (2008) prepared ready-to-serve beverages from guava and papaya in different ratios and found that RTS beverages prepared from 15% pulp of guava and papaya blended in the ratio of 80:20 was the best. Chandel (2010) developed fruit leather by mixing apple, sand pear, persimmon and peach pulp which significantly resulted in a better overall rating for sensory properties without impairing nutritional and textural properties of product.

2.8 Effect of blending on the functional quality of the products

Blended non-alcoholic beverage development is an interesting way of improving the nutritional quality of traditional products. Mixing two or more kinds of fruits can result in a new product with more vitamins and minerals and with different sensory and flavour characteristics when compared to raw materials (Akinwale, 2000; Jain and Khurdiya, 2004). Blending of juices with astringent and highly nutritious fruits like aonla and lemon can provide health beverages with high medicinal and therapeutic value (Sahota *et al.*, 2009). El-Bastawesy *et al.* (2008) prepared nutraceutical vegetable juice blends and noticed that juice blends prepared by tomato, carrot and celery had the highest total phenols and total flavonoids being 16.65 and 31.25 mg/100 mL, respectively. Total carotenoids of all blends ranged from 7.69-12.09 mg/100 mL. They also reported that addition of green leafy vegetables (celery and parsley) to blends increased total chlorophyll content by more than two folds becoming greater than the other blends as well as control sample. The ascorbic acid content of the samples ranged from 8.45 to 20.22 mg/100 mL. Tomato, carrot, watermelon and rocket vegetables blend possessed the highest content of ascorbic acid while the blend devoid of tomato juice showed lowest ascorbic acid content. All the blends were found to be an adequate source of minerals to human nutrition. Further, a study have been conducted by El-Sharouny (2006) for the preparation of fruit juice blends with potent antioxidant effects by using persimmon, papaya, guava and pomegranate for the preparation of juice blends. Blends were prepared using different proportions of juices to maximize the required nutrients such as carotenoids, ascorbic acid and other nutrients. The best blend with highest ascorbic acid content (45.73 mg/100 g) contained 30% persimmon, 30% guava, 30% papaya and 10% pomegranate whereas blend containing 50% persimmon, 30% papaya, 30% guava and 10% pomegranate possessed highest carotenoids (33.58 mg/100 g). Selenium content of all the blends was almost same. Bhardwaj and Mukherjee (2011) prepared juice blends of Kinnow, aonla and ginger and Kinnow, pomegranate and ginger, respectively. Among Kinnow, aonla and ginger juice blends highest ascorbic acid content (45.70 mg/100 mL) was recorded in juice blend containing 95% Kinnow juice, 5% aonla juice and 0%

ginger juice however, among Kinnow, pomegranate and ginger juice blends highest ascorbic acid content (18.94 mg/100 mL) was recorded in blend having Kinnow, pomegranate and ginger in 90: 10: 0 ratio. Raj *et al*. (2011) studied the effect of blending on apple and sand pear blended juice and reported a gradual increase in the level of polyphenols with increase in the level of sand pear juice in the juice blends. Oszmianski and Wojdylo (2009) studied the effect of blackcurrant and apple mash blending on colour of juices and found that total anthocyanin content was 588.98-566.79 mg/L in apple juices made from Idared and Shampion cultivars and blended with blackcurrant. These anthocyanin amounts represented 18% of anthocyanins of blackcurrant juice.

2.9 Effect of processing on bioactive compounds of fruits and vegetables

Food processing such as pasteurization plays an important role in the destruction of bioactive compounds. Processing can alter and often damage fruit and vegetable antioxidants. Maceration, heating and various separation steps can result in oxidation, thermal degradation, leaching and other events that lead to lower level of antioxidants in processed foods compared with fresh. This is particularly true in case of vitamin C and phenolic antioxidants. It is well known that phenolic contents present in fruits and vegetables easily undergo enzymatic or chemical oxidation during processing and storage. During the processing of foods, various transformations of phenolics occur to produce yellowish to brownish pigments (Clifford, 2000). These chemical changes has been attributed to post-harvest treatments which could lead to the formation of various compounds having antioxidant and pro-oxidant properties and could exert complex effects on the antioxidant properties of phenolic compounds (Lee, 1999; Murakami *et al*., 2002).

Zhang *et al*. (2008) studied the effect of pressing treatment on bioactive compounds of fresh apples and reported that total phenolic concentration was significantly lower in juices as compared to fresh fruits and ranged from 24.8±0.4 to 33.4±0.3 mg gallic acid equivalents/100 mL. They also reported that levels of total phenols in juices prepared from straight pressing were about 60% lower than corresponding fresh apples. Similar findings have been reported by Van der sluis *et al*. (2005) in apple juice. Reduced phenolic content and antioxidant activities in juices compared to fruits have been attributed to squeezing process. It could also be due to the involvement of polyphenols in specific physico-chemical reactions with the solid part of fruits especially the cell wall material. The levels of total phenolic content have also been reported to reduce by 1-1.5 fold in centrifuged-treated juices as compared to corresponding crude juices (Zhang *et al.*, 2008). This difference was attributed to the removal of a small part of phenolic compounds because of their adsorption on cellular and cell-wall particles which were in suspension with crude juices (Vrhovsek *et al*., 2004). Gokmen *et al*. (2001) also reported that various clarification treatments caused a significant decrease in apple juice phenolics. Seok-moom *et al*. (2004) reported that heat treatment could liberate some low molecular weight phenolic compounds which usually present as covalently bound form.

In carotenoids, processing can lead to dissociation of antioxidants from plant matrix components, an increase in carotenoids, antioxidants and increased digestive absorption (Shi and Le Maguer, 2000). During processing the tissues such as peel and seeds are separated from the other components as in juice and wine production (Skrede *et al.,* 2000). Foods undergo numerous processing before consumption which may alter their nutritional profile (Goyal and Khetarpaul, 1994; Negi and Roy, 2001) including their antioxidants content (Mitchell *et al.,* 1990; Sato *et al.*, 2006; Turkmen *et al.*, 2006). Generally food processing procedures are recognized as one of the major factors on the destruction or changes of natural phytochemicals which may affect the natural antioxidant capacity in foods (Nicoli *et al.*, 1999). The oxidative loss of bioactive phenolic compounds in foods is attributed to enzymatic browning prior to inactivation of polyphenol oxidase (Lee, 1999). Hand cooking softens the cell wall and facilitates the extraction of carotenoids (Rodriguez-Amaya, 1999). Some studies have shown that the loss of vitamins in vegetables during cooking varies with the cooking treatment (Lin and Chang, 2005). Larger losses of vitamin C occur in processes that use water. Steam blanching is therefore more effective in retaining vitamin C before freezing than hot water blanching. Blanching inactivates enzymes such as ascorbate oxidase that are capable of breaking down vitamin C during frozen storage. In a study on effect of processing on the antioxidants in peas, carrots, spinach, potatoes and several *Brassica* group vegetables, it was noticed that losses of vitamin C during blanching and frozen storage ranged from 10 to 40 per cent (Puupponen *et al*., 2003). Further, they observed that the carotenoids appear to be less adversely affected by processing as compared to other major fruit and vegetable antioxidants. During blanching and refrigerated storage of carrot, spinach, potatoes and several *Brassica* group vegetables, there were essentially no losses in α-carotene and β-carotene, in fact, some increase was observed that was attributed to the dissociation of carotenoids from plant matrix material. Similarly, losses in total phenolics content after blanching and long term frozen storage ranged from 20 to 30 per cent. Like vitamin C, phenolic antioxidants are water soluble and can be leached from fruit and vegetable tissues by processing in water. When fresh spinach was boiled in water, approximately half of the flavonoids content was found to be dissolved in the cooking water and other half in the cooked tissue (Gill *et al.,* 1999). During processing of blueberries into juice, substantial losses of phenolics occur and the recovery of anthocyanins, procyanidins and chlorogenic acid have been reported to be 32, 43 and 53 per cent, respectively. Heat labile enzymes in blueberry fruits make a large contribution to the losses of anthocyanins. Approximately 20 per cent of anthocyanins in blueberries are retained in the press cake after juicing (Skrede *et al.,* 2000).

Azizah *et al.* (2009) evaluated the effect of various cooking methods on antioxidant content and radical scavenging activity of pumpkin. Pumpkin was boiled and stir-fried for 2, 4 and 6 min, respectively. The study showed an increase in both β-carotene (2 to 4 times) and lycopene (17 to 40 times) content of pumpkin after cooking for 2, 4 and 6 min. However, the treatment resulted in 18 to 54% losses of total phenolics content of the pumpkin. Nevertheless, the free radical scavenging activity exhibited by cooked pumpkins has been found to be high, in the range of 81.1% to 94.6% with IC_{50} of 1.41 to 1.62 mg/mL. Gahler *et al*. (2003) reported an improvement in the antioxidant activity of tomatoes after heat treatment due to the increased release of phytochemicals such as lycopene from the matrix. Boiling of several vegetables would attribute to the suppression of oxidation by antioxidants due to thermal inactivation of oxidative enzymes (Yamaguchi *et al*., 2001). Turkmen *et al.* (2006) reported that boiling, microwave cooking and steaming induced significant increases in total antioxidant activity of pepper, green beans, broccoli and spinach. Dewanto *et al*. (2002) observed that thermal processing elevated total antioxidants and bioaccessible lycopene content in tomatoes and produced no significant changes in total phenolics and total flavonoids content although some loss of ascorbic acid has been noticed. Re *et al*. (2002) also reported an improvement in the availability of individual antioxidants up on processing of fresh tomatoes into tomato sauce. These findings strongly supported the concept that thermal processing enhances the nutritional value of tomatoes by increasing bioaccessible lycopene content and total antioxidants. Anense *et al*. (1993) observed a decrease in antioxidant potential glucose-gycine aqueous solution after a short heat treatment (70 or 95^{o}C for up to 50 h). This decrease has been attributed to both degradation of natural antioxidant components and formation of early Maillard reaction products with pro-oxidant properties. However, prolonged heating showed a recovery of initial antioxidant properties and then an increase in overall antioxidant activity. This has been ascribed to formation of melanoidins which act as antioxidants during advance steps of Maillard reactions (Kaur *et al*., 2004). During fruit storage and processing polyphenol content as well as antioxidant activity decreases. However, at the same time there are some reports on an increase of polyphenol concentration as a result of thermal processing of raw material, e.g. in broccoli, peppers, spinach or beans (Turkmen *et al*., 2006).

2.10 Effect of storage on functional and quality characteristics of beverages

2.10.1 Total soluble solids (TSS)

Total soluble solids increases during storage due to solubilization of pulp constituents and degradation of starch into simple sugars due to hydrolysis of polysaccharides (Jawanda *et al*., 1978). The physico-chemical, microbiological safety and sensory characteristics of the bottlegourd-basil blended juice in glass bottle have been evaluated during 6 month at room temperature (28$\pm$2°C) and it was noticed that there were no remarkable changes in pH, total soluble solids, total acidity (as citric acid) and sensory scores of the juice during storage (Majumdar *et al*., 2011). Similar results have been reported by Deka and Sethi (2001) in fruit juice blends. Deka (2000) found an increasing trend in total soluble solids during storage at ambient and low temperature in lime-aonla and mango-pineapple spiced RTS beverages. Hussain *et al*. (2011) studied the effect of preservatives on apple-apricot juice blends and observed that TSS content of blends increased maximum in 100% apple juice (6.97%) and minimum in 50% apple + 50% apricot juice and potassium sorbate (4.25%). An increase in TSS in lime-ginger RTS/blended RTS, during storage has been recorded by Lanjhiyana *et al*. (2010) which could be attributed to the conversion of polysaccharides like pectin, cellulose, starch etc into simple sugars. Raj *et al*. (2011) studied the effect of storage on TSS of pear: apple juice blends and observed that TSS increased during initial stage up to 3 month and thereafter a decline in TSS was recorded at 6 month of storage. Increase in TSS was attributed to breakdown of the complex carbohydrates into simple soluble carbohydrates while the decline in the TSS of the beverage was related to the utilization of sugars in non-enzymatic reactions. Shah *et al.* (1975) studied the storage stability of guava drink and observed an increase in TSS in the product during the storage. They accredited this increase to the solubilization of fruit constituents during storage.

2.10.2 Titratable acidity

Acidity is considered as one of the biochemical properties, which affects both organoleptic and keeping qualities of a product (El Sheikha, 2004). Nunes *et al.* (1995) reported an increase in acidity of strawberry during storage and attributed it to the breakdown of pectin into pectinic acid (Riaz *et al.*, 1988). Lanjhiyana *et al*. (2010) reported a decrease in acidity of lime and ginger ready-to-serve (RTS) beverage during five month of storage and reported that this decrease was due to the chemical interaction between organic constituents of the juice by temperature and action of enzymes. Kannan and Thirumaran (2001) recorded a slight decrease in acidity of Kinnow juice during storage and attributed this loss in acidity to the chemical reactions taking place between organic acids and pigments by the action of enzymes. A gradual decrease in acidity of papaya nectar and pomegranate juice during storage has also been recorded by Saravana and Manimeglai (2005) and Ahire *et al.* (2010), respectively. They also observed that rate of decrease was higher at ambient storage. Deka *et al.* (2004) and Nath and Yadav (2005) have also reported similar findings in lime-aonla blended RTS beverage and ginger-Kinnow squash, respectively. A slight increase in acidity (0.25 to 0.27%) of jack fruit beverage during 6 month storage at room temperature has been reported by Krishnaveni *et al*. (2001). Similar changes in acidity have also been observed in Kinnow: aonla: ginger juice blends by Bhardwaj and Mukherjee (2011) which have been attributed to the conversion of sugars into acids and salts and by enzymes particularly, invertase (Kumar *et al*., 1992). Deka (2000) found that the acidity of the RTS beverage prepared from lime-aonla, mango-pineapple and guava-mango blends decreased with advancement of storage period up to six month under different storage conditions. However, changes were lesser at refrigerated storage as compared to ambient storage. Similar results have been reported by Tiwari (2000) in guava and papaya blended RTS and Dhaliwal and Hira (2001) in carrot juice blends. A gradual increase in acidity of pear-apple juice blends has been noticed by Raj *et al.* (2011) during storage period of 6 month. Titratable acidity of the blends has been found to increase from 0.29 to 0.32 per cent. Acidity of apple-apricot juice blends has also been reported to increase during storage and maximum increase in acidity was recorded for 100% apple juice i.e.46.87% while it was minimum for 75% apple + 25% apricot juice + potassium sorbate i.e.30.76% (Hussain *et al*., 2011).

2.10.3 Sugars

Sugars, the most important constituents of fruit products are essential factor for the flavour of the food products and also act as natural food preservative beyond 60% concentration. Significant increase in sugars during storage intervals have been reported by many workers. Krishnaveni *et al*. (2001) studied the effect of storage on quality of jack fruit beverage and found that total sugars content increased from 14.72 to 15.67% during six month of storage. Sethi (1992) recorded an increase in reducing sugars of lime-ginger cocktail during storage. A gradual increase in the total sugars content of carrot juice has been reported by Madan and Dhawan (2005). The rate of increase in total sugars of carrot juice was recorded to be higher at ambient storage as compared to low temperature conditions. Hussain *et al*. (2011) studied the effect of storage on apple-apricot blends and observed that the reducing sugars increased during storage while non-reducing sugars decreased. Maximum increase in reducing sugars has been recorded for 100% apricot juice i.e.8.82% and minimum for 25% apple + 75% apricot juice + 0.1% potassium sorbate i.e.3.72% while non-reducing sugars decreased maximum for 25% apple + 75% apricot juice i.e.33.92% and minimum for 100% apricot juice + 0.1% potassium sorbate i.e.22.00%. Sood *et al*. (2009) recorded a significant increase in total and reducing sugars content of mango squash during storage and concluded that hydrolysis of non-reducing sugars into reducing sugars resulted in increaseed reducing sugars during storage. Similar results have been reported by Lanjhiyana *et al*. (2010) in lime-ginger blended squash. They related this variation in the different fractions of sugar to the hydrolysis of complex polysaccharides like starch and pectin into monosaccharides. Ruiz-Nieto *et al.* (1997) suggested that sucrose content of the strawberry juice converted to glucose and fructose during the storage resulting in changes in total sugars content of juice during storage. Attri *et al.*, (1998) reported that total sugars in sand pear juice blends increased with increase in storage period. Similarly, Shreshtha and Bhatiya (1987) reported a significant increase in total sugars content of apple juice blends and accredited this increase to the hydrolysis of complex sugars like pectin, starch etc to sucrose and monosaccharide sugars.

2.10.4 Ascorbic acid

Ascorbic acid is the least stable of all the vitamins. It is highly sensitive to oxidation and leach into water-soluble media during processing, storage and cooking of fresh, frozen and canned fruits and vegetables (Franke *et al*., 2004). It has been found to decrease in the processed products during the storage (Hussain *et al*., 2011). Viberg *et al.* (1999) reported a decrease in ascorbic acid during storage. They recorded that ascorbic acid content in strawberry pulp was affected by treatments *viz*., freezing, heating and accelerated storage. Higher losses of vitamin C in vegetables due to blanching in water have been reported by many workers (Murcia *et al*., 2000; Sikora *et al*., 2008). Albrecht *et al.* (1991) reported that vitamin C losses ranged from 2% to 48% for six different broccoli cultivars stored at $2^{o}C$ for 21 days. Similarly, Howard *et al*. (1999) observed vitamin C losses of 13% and 48%, respectively, after 3 weeks of storage of broccoli at $4^{o}C$. Majumdar *et al.* (2011) studied the effect of storage quality of bottlegourd-basil leaves juice. They noticed that vitamin C lost 74% after 6 month of storage. Majumdar *et al*. (2009a) also found remarkable loss of vitamin C (74%) during 6 months storage of cucumber-litchi-lemon juice at room temperature ($28\pm2^{o}C$). However, Tiwari (2000) reported 26.47% loss of vitamin C during 6 month storage of guava and papaya beverage at room temperature. Losses in vitamin C content of apple juice and pineapple juice stored for 12 month in the warehouse under ambient conditions (33°C) were 45.8 and 49.8%, respectively (Ewaidah, 1992). Cortes *et al.* (2005) reported 4.1% loss of vitamin C during 132 days storage of orange-carrot juice at -40°C and noticed lower losses of vitamin C at low temperature storage. Losses of ascorbic acid and β-carotene during cooking and storage of tomato, aonla and carrot products have also been reported (Nagra and Khan, 1988; Aggarwal *et al.,* 1995).

Storage of carrot-black carrot and carrot-beetroot juices resulted in significant losses of ascorbic acid and β-carotene after 3 month of storage. By the end of 6 month of storage period, 74.7-83.9% and 52.0-68.35% of ascorbic acids and β-carotene, respectively, have been reported to be lost (Dhaliwal and Hira, 2001). Burdulu *et al.* (2006) observed vitamin C losses ranging from 27.3 to 45.3% for orange juices during 2 month of storage at $28^{o}C$. Storage stability of a stimulant coconut water-cashew apple juice beverage has been studied by Carvalho *et al*. (2007) who reported that vitamin C content decreased from 19.13 mg/100 mL to 7.87 mg/100 mL during the storage period of 6 month. Total vitamin C loss during the storage period (6 month) was about 58.9 per cent. Similar results have also been observed for cashew apple juice (Costa *et al.* 2003). Deka *et al.* (2004) reported that the loss in ascorbic acid might be due to the oxidation of irreversible conversion of L-ascorbic acid into dehydroascorbic acid oxidase caused by trapped or residual oxygen in the glass bottles. Fruit handling can also affect vitamin content in fruits and fruits juices (Prochaska *et al.* 2000). Hussain *et al*. (2011) studied the effect of preservatives on apple-apricot juice blends and observed that ascorbic acid decreased during storage. Minimum ascorbic acid content decreased in 100% apple juice + 0.1% potassium sorbate i.e. 46.42%, while maximum in 25% apple + 75% apricot juice i.e.78.26 per cent. DeMan (1980) reported that out of four important enzymes (ascorbic acid oxidase, phenolase, cytochrome oxidase and peroxidase) catalyzing the decomposition of ascorbic acid, only ascorbic acid oxidase involves a direct reaction between enzyme, substrate and molecular oxygen while other enzymes oxidize the vitamins indirectly. Bender (1958) reported very little loss of ascorbic acid in processed products after six months, about 80% retention in 12 month, 50% retention in 18 month and 40% retention in two year of storage study. Retention of ascorbic acid in lemon squash after seven months storage at ambient conditions has been reported about 35% (Palaniswamy and Mathukrishnan, 1974). Data collected on the stability of ascorbic acid in fortified foods by DeRitter (1976) indicated that retention of this vitamin after 12 month of storage at 23^{o}C was 58-76% in apple juice 78-83% in craneberry juice, 73-86% in grapefruit juice, 74-82% in pineapple juice, 64-93% in tomato juice, 66-69% in vegetable juices, 65-94% in grape drink, 75-83% in orange drink and 54-64% in carbonated beverages. This variation and disagreement in the results reported by various workers was attributed to type and quantity of preservative used (Martin, 1961) container type (Bisset and Berry, 1975), exposure to light (Ahmed *et al.*, 1976), storage temperature and exposure of drinks to air in partially filled bottles (Bender, 1958).

2.10.5 Total phenolics

Processing significantly alters the physical and bio-chemical composition and functionality (Patras *et al.*, 2009; Zhang and Hamauzu, 2004b) and may play a vital role in non-uniform behaviour of phenols towards different processing treatments. Patras *et al.* (2011) observed an increase in total phenolic content of unblanched broccoli at a much higher rate during storage than that of blanched samples and attributed this increase to the developmental changes and wound-like response due to freezing. Dixon and Paiva (1995) reported that plants respond to wounding with increase of phenolic compounds involved in the repair of wound damage and in defense against microbial invasion. Increase in tannic acid content of aonla juice (Tripathi *et al.*, 1988) during storage of more than 4 month. Zhang *et al*. (2008a) recorded no significant changes in total phenolics content of apple juice at 5 days of storage which later on decreased significantly during storage at ambient temperature. At low temperature storage (4^oC) total phenolics content increased by 8% of the initial values. Miller *et al*. (1995) also reported the same findings for apple juice stored at 4^oC over 10 days. Raj *et al*. (2011) reported a significant decrease in the phenolic content of sand pear and apple juice blends during six month of storage.

2.10.6 Total carotenoids

Krishnaveni *et al*. (2001) reported a remarkable loss of β-carotene (50%) during six month storage of jack fruit beverage at room temperature while losses of β-carotene were 56% during 6 month storage of guava-papaya beverage (Tiwari, 2000). Srivastava (1998) recorded a slight decrease in total carotenoids of mango RTS beverage during six month of storage. The total carotenoids content has been found to decrease over a period of six months in peach nectar by Deka *et al.* (2005). They observed 87.53 to 90.24% retention of total carotenoids after six month of storage whereas Lavelli *et al*. (2009) observed no changes in β-carotene content of mango products. Koca and Karadeniz (2008) reported that cold storage (6 month, 0^oC) did not affect α-carotene, β-carotene and total carotenoids of carrots as well as pro-vitamin A activity whereas, the level of lutein, a minor component in carrot, decreased by 38 per cent. Similarly, Kopas-Lane and Warthesen (1995) reported that carrot carotenoids are rather stable compounds during storage as no differences were seen in the content of α- and β-carotene during 4 month of refrigerated storage (1^oC, 98% RH). There are many previous investigations which reported no or only a minor degradation of carrot carotenoids during cold storage (Howard *et al*., 1999).

The influence of minimal processing and storage on carotenoids content of fresh cut fruits have been evaluated in comparison to whole fruits stored for the same duration but prepared on the day of sampling by Gil *et al.* (2006). During storage at 5^oC, the total carotenoids content of cubes from whole pineapple has been reported stable during storage, and no significant changes observed after 9 days. However, after 3 days a decrease in total carotenoids of fresh-cut samples was noticed resulting in a 25% reduction as compared to the whole fruit. The total carotenoids content of whole Ataulfo mangoes has been quite stable during storage and no significant changes observed when compared with the initial contents. Fresh-cut mango cubes had slightly lower total carotenoids content than did cubes obtained from the whole stored fruit. The slicing and storage has shown its effect only after 9 days of storage, when a 25% reduction in total carotenoid content of fresh-cut mango with respect to the initial values was observed. The total carotenoid content in both fresh-cut and whole San Joaquin Gold cantaloupe cubes decreases after cutting. There was no significant change in the total carotenoids content of fresh-cut slices and sliced strawberry fruit over the time of storage with the exception of day 9, where lower and higher contents of total carotenoids have been reported for fresh-cut slices and sliced fruit, respectively. The carotenoid content of kiwifruits did not change significantly in slices from either fresh-cut or whole stored fruit over the storage period (Gil *et al.*, 2006). Fresh-cut papaya cubes and slices stored at $5^{o}C$ did not present any change in β-carotene content during 10 days of storage. No changes were observed in β-carotene content after 6 days of storage at $10^{o}C$ however, after 14 days of storage, there was a depletion of 62% for cubes and 63.4% for papaya slices. Fresh-cut papaya cubes and slices stored at $20^{o}C$ showed the maximum loss in β-carotene after 6 days of storage where β-carotene content of cubes and slices was decreased by 57.4% and 60.63%, respectively.

2.10.7 Total anthocyanins

Processing and storage conditions (time, temperature, light, pH, clarification, level of oxygen etc), as well as the level of sugars and ascorbic acid, other phenolics and highly reactive compounds present in juice may affect the colour stability. Colour and colour stability of juices is important quality factor for their production and marketing (Will and Dietrich, 2006). Anthocyanins are responsible for the colour of most of the fruits and some vegetables *viz.*, jamun, red grapes, plum, black carrot etc. Anthocyanins are efficient free radical scavengers, due to their ability to inactivate free radicals, but are highly susceptible to degradation. Temperature is the main factor in the degradation of anthocyanins. However, pH, presence of enzymes, light or presence of complex compounds also plays an important role in the stability of anthocyanins (Eiro and Heinomen, 2002). Quinones play an important role in enzymatic degradation of anthocyanins. First enzymes oxidize other phenolic compounds in the media to their corresponding quinones, which then react with anthocyanins resulting in anthocyanin degradation and formation of brown condensation products (Skrede *et al.*, 2000; Kader *et al.*, 2002).

Will and Dietrich (2006) studied the effect of storage and temperature on the stability of the anthocyanins in plum juice and noticed that degradation of anthocyanins was less at lower temperature. They found that loss of anthocyanins was about 77-88% at 90 days as compared to freshly prepared juice which increased up to 90-95% at 180 days at ambient temperature. Contrary to this, losses were only 41-58% even during 300 days of interval at low temperature. Strong reduction in anthocyanins content has also been reported in blood orange juice (Kirca *et al.*, 2003), strawberry juice and concentrate (Gorzan and Wrolstad, 2002) and black currant juices (Eder, 1996) during storage. Spayd *et al*. (1984) determined the stability of anthocyanins in apple and pear juices blended with juices containing anthocyanins and reported that the reduction of anthocyanins in juices after three month of storage at 25^{o}C was 20% in black raspberry blend, 26% in Bing cherry blend, 31% in Concord grape blend and 42% in red raspberry blend. The anthocyanins losses in the blend of apple juice after 4 month of storage at room temperature have been found to be 46-69% with black currant juice and 50-56% with red currant juice (Nani *et al*., 1993). Oszmianski and Wojdylo (2009) studied the effect of storage on anthocyanins content of blackcurrant and apple mash blends. The losses in the anthocyanins content has been reported to be 40% and 96% in blackcurrant juice after six month of storage at 4^{o}C and 30^{o}C, respectively. In apple-blackcurrant juice, losses in anthocyanins content were found to be 33% and 99% at 4^{o}C and 30^{o}C, respectively for the Shampion cultivar while 60% and 99.5% 4^{o}C and 30^{o}C, respectively for Idared cultivar. The higher stability of anthocyanins in blended juice of Shampion cultivar was attributed to co-pigmentation with the high amount of flavan-3-ols in Shampion cultivar. They also reported that rate of anthocyanin degradation increased during storage with rise in the storage temperature.

Anthocyanins are highly sensitive to pH. The temperature rise at the pH value equal to 4 induces loss of the glycosyl moieties of the anthocyanins by hydrolysis of the glycosidic bond. This leads to a further loss of anthocyanin colour since, aglycones are less stable than their glycosidic forms. It is postulated that the formation of chalcone is the first step in thermal degradation of anthocyanins (Adams, 1973). Eventually, thermal degradation leads to brown products especially in the presence of oxygen. Thermal degradation of anthocyanins follows the first order kinetics (Ahmed *et al.*, 2004). Temperature is the most important factor on betalain stability during food processing and storage. Some studies reported increasing betalain degradation rates resulting from increasing temperatures (Saguy *et al.*, 1978). Thermal betacyanin degradation in betanin solutions as well as in red beet and purple pitaya juices was reported to follow first-order reaction kinetics (von Elbe *et al*., 1974; Saguy *et al*., 1978). During heat processing, betanin may be degraded by isomerisation, decarboxylation or cleavage (by heat or acid), resulting in a gradual reduction of red colour, and eventually the appearance of a light brown colour (Huang and von Elbe, 1985; Drdak and Vallova, 1990). Dehydrogenation of betanin leads to neobetanin formation, bringing about a yellow shift. Cleavage of betanin and isobetanin, which can also be induced by bases (Schwartz and von Elbe, 1983; Schliemann *et al*., 1999), generates the bright yellow betalamic acid and the colourless cyclo-Dopa-5-O-glycoside.

2.10.8 Antioxidants

Antioxidant activity of food products depend upon many factors like phenolic content, ascorbic acid, carotenoids and other phytochemicals. Therefore, it has been found to decrease with the reduction in all these compounds. Patthamakanokporn *et al*. (2008) investigated the antioxidant activity and total phenolic compounds in various fruits like mangoes (ripe and unripe), guava, papaya, mangosteen, banana, makiang and maluod. Guava, makiang (*Cleistocalyx nervosum* var *paniala*) and maluod (*Elaeagnus iatifolia*, Linn) were used to determine the changes in antioxidant activity (AO) and total phenolic compounds (TP) during storage at −20 °C for 3 month and at 5°C for 10 days. The oxygen radical absorbance capacity (ORAC) during storage at −20 °C for

2 weeks decreased significantly in homogenized guava (23%) and in whole fruits of maluod (62%), whereas that of makiang remained constant. At 5°C, a decrease in the ORAC-AO in the whole fruits of makiang (14%) and maloud (70%) was found after 3-days storage, whereas a gradual increase in the activity (120–190%) was found in the whole fruit of guava throughout the storage period. Arena *et al*. (2001) reported that total antioxidant activities of orange juice remain unchanged up to 60 days at 20^{o}C of storage temperature. They also reported that ferric reducing antioxidant power (FRAP) and 2, 2-diphenyl-1-picrylhydrazyl (DPPH) scavenging activity of apple juice did not change significantly in the first five days of storage at 20^{o}C but increased rapidly thereafter. Oszmianski and Wojdylo (2009) observed a higher decrease in antioxidant activity of juice on six month storage at 4^{o}C than 30^{o}C. This variation was attributed to the degradation products formed during storage at higher temperature.

2.10.9 Non-enzymatic browning (NEB)

Browning reactions are of prime importance because of their adverse effect on the appearance, flavour and nutritive value of the processed products. Various factors such as temperature, pH, moisture, organic acids, water activity, oxygen and sugars affect the non-enzymatic browning (Sahni and Kumar, 1998; Siddiqi and Cash, 2000). Non-enzymatic browning of the beverages increases with increase in storage period. This increase in non-enzymatic browning during storage might be due to non-enzymatic reaction of organic acid with sugars or oxidation of phenols, which leads to the formation of brown pigments. A linear increase in non-enzymatic browning has been observed in Kinnow: aonla: ginger juice blends during 6 month of storage irrespective of type of juice blend (Bhardwaj and Mukherjee, 2011). Such increase in NEB during storage of processed products has also been reported Sagar and Kumar (2009). Khurdiya and Anand (1981) have also reported a gradual increase in browning due to formulation of hydroxy methylfurfural (dark pigment) in stored phalsa beverage. Similar results have been reported by Jain *et al*. (2003) in aonla juice. Non-enzymatic browning in citrus products has been related to ascorbic acid degradation by Henshall (1982).

2.10.10 Organoleptic attributes

Organoleptic properties of processed products have been found to decrease with storage due to many metabolic changes like loss of aroma and flavour, pigment degradation etc. Bhardwaj and Mukherjee (2011) reported a decrease in sensory quality of Kinnow juice blends with the advancement of storage period. The colour, flavour and organoleptic taste of the blended juices have been reported to be superior as compared to juices prepared from individual fruit. The blend of Kinnow juice (87%) + pomegranate juice (10%) + ginger juice (3%) recorded higher score for colour (7.27), flavour (7.43) and organoleptic taste (7.71) as compared to other blends at the end of storage. This was explained as ginger juice checks microbial and enzymatic activities in stored juice, which produce off flavour and change in natural colour and taste. Tandon *et al*. (2007) reported that addition of papaya pulp to bael pulp has been found to be very effective in checking the browning and improving the appearance of the beverage. They also observed that the beverage prepared from 2:3 blend of bael: papaya pulp scored maximum (7.4 out of 10.0) after six month of storage. Similar results have also been reported by Murari and Verma (1989) in guava nectar and by Gowda (1995) in mango and papaya blends. Increased acceptability in sensory score of blended beverage of apple, pear and grape juices on storage has been reported by Siler and Morris (1993) and Saxena *et al*. (1996). According to Sistrunk and Morris (1985) the blend of apple and grape juices were highly acceptable in quality and retained acceptable flavour and colour during storage at 24°C for 12 month. The loss of flavour and taste may be due to the degradation of ascorbic acid into furfural during storage (Shimoda and Osajima, 1981). Balaswamy *et al*. (2011) reported that a minimal loss of visual colour was found in blended beverages with phalsa, but scored well in terms of overall acceptability after 4 month storage period.

2.10.11 Microbial count

The juice blend ratio of Kinnow: Aonla: Ginger juice (92:5:3) was reported to contain a population of bacteria (4.0×10^3), moulds (1.5×10^3) and yeasts (2.1×10^3) at end of storage (six month) and was found acceptable after six months of storage at room temperature (Bhardwaj and Mukherjee, 2011). Deka (2000) reported negligible growth of moulds and yeasts in lime-aonla and mango-pineapple spiced RTS beverages, which got further reduced during storage due to inhibitory effect and antioxidative properties of spices. Deka and Sethi (2001) reported that no bacterial growth was observed in the spiced mixed fruit juice, RTS beverages. These results were supported by Ejechi *et al*. (1998) in spiced mixed fruit juices and Dhaliwal and Hira (2001) in mixed vegetable juice. Bhardwaj and Mukherjee (2011) observed that Kinnow: Aonla: Ginger blend samples were contaminated with a large variety of bacterial, fungal and moulds species but within the acceptable limit. No apparent microbial growth has been reported by Lakhanpal (2010) in honey based mango nectar and Dhaigude (2010) in wild pomegranate drinks.

MATERIALS AND METHODS

Chapter-3

MATERIALS AND METHODS

The present investigation entitled "**Seasonal fruit and vegetable juice blends with high antioxidant potential**" was conducted under different experiments in the Department of Food Science and Technology, Dr. Y.S. Parmar University of Horticulture and Forestry, Nauni, Solan, Himachal Pradesh during the year 2009-2011. The materials used, details of the experiment and techniques employed in the investigation have been furnished in this chapter under the following headings:

3.1 Procurement of raw materials

3.1.1 Fruits

Apple (*Malus domestica* Borkh.) fruits cv. Spartan were procured from the Regional Horticultural Research Station, Seobagh (Kullu). Mango (*Mangifera indica* L.) fruits cv. Dashehari, Kinnow fruits (*Citrus nobilis* x *Citrus deliciosa* L.), red grapes fruits (*Vitis vinifera* L.) and jamun (*Sizygium cumini* Skeels) fruits were procured from the Solan Market. Aonla (*Emblica officinalis* Gaerth.) fruits cv. NA-7 were procured from the Central Soil and Water Conservation Research Farm, Panchkula. Papaya (*Carica papaya* L.) fruits cv. Coorg Honey Dew were purchased from fruit shop at Nauni and sand pear (*Pyrus communis* L.) fruits were purchased from local farmers of Nauni (Solan).

3.1.2 Vegetables

Vegetables like bottlegourd (*Legenaria siceraria* Standl.) var. Pusa Summer Prolofic Long, bittergourd (*Memordica charantia* L.) var. Solan Hara, pumpkin (*Cucurbita moschata* Duch.) var. Solan Badami, tomato (*Solanum lycopersicon* Mill.) var. Naveen 2000^{+}, carrot (*Daucus carota* L.) var. Solan Rachna and cabbage (*Brassica oleracea* var. *capitata* L.) var. Pride of India were purchased from the local market at Nauni. Beet root (*Beta vulgaris* L.) var. Detriot Dark Red was purchased from vegetable market, Solan.

3.2 Juice preparation

The juice of the fruits *viz*., apple and pear was extracted by grating the fruits in fruit mill followed by extraction of juice using hydraulic press. Kinnow juice was extracted by passing the fruits through screw type juice extractor. Juice of vegetables *viz*., bottlegourd, tomato and bittergourd was extracted by using juicer while carrot and beetroot juice was extracted using carrot-type juice extractor. Red grapes were crushed and boiled for 2 min in pressure cooker to extract pigments. Boiled grapes were then squeezed to extract juice. The juice after extraction was filtered, heated to boil and filled into pre-sterilized glass bottles followed by processing ($90 \pm 2^{o}C$, 20 min).

3.3 Pulp preparation

For pulp preparation, fruits and vegetables were sorted, washed and peeled. Peeled fruits were cut into small pieces and the seeds/stones were removed from them manually. After the removal of the seeds/stone, pulp of the fruits *viz*., Mango and papaya and vegetables *viz*., cabbage and pumpkin was prepared by hot method (Lal and Sharma, 1989), by adding 100 mL water per kg of fruit followed by cooking for 15-20 min and passing through a pulper (BSB, New Delhi). In Jamun, whole fruits were first boiled for 5 min and then passed through a pulper. Pulp was homogenized, heated to boil and filled into pre-sterilized glass bottles followed by processing ($90 \pm 2^{o}C$, 25 min).

3.4 Preparation of juice blends

3.4.1 Development of natural blends from summer fruits and vegetables

Juice blends were prepared from the summer fruits and vegetables in the following proportions:

Apple cv. Spartan

Jamun (wild)

Sand pear cv. Patthar Nakh

Papaya cv. Coorg Honey Dew

Red grapes cv. Beauty Seedless

Aonla cv. NA 7

Kinnow

Mango cv. Dashehari

Plate 3.1 Fruits used for the preparation of blends

Tomato cv. Naveen 2000+

Carrot cv. Solan Rachna

Pumpkin cv. Solan Badami

Bootlegourd cv. Pusa Summer Prolific Long

Bittergourd cv. Solan Hara

Beetroot cv. Detriot Dark Red

Cabbage cv. Pride of India

Plate 3.2 Vegetables used for preparation of blends

3.4.1.1 Two fruit juice blends

Proportion of juices/pulps in different blends was standardized by mixing the juices/pulps in ten different combinations (Table 3.1). Prepared blends were hot filled in pre-sterilized glass bottles and subjected to sensory evaluation.

Table 3.1 Standardization of proportion of two fruit juice blends from summer season fruits*

Blend	Proportion of fruit juice/pulp mixed									
Apple : Pear	10:0	9.5:0.5	9:1	8.5:1.5	8:2	7.5:2.5	7:3	6.5:3.5	6:4	5.5:4.5
Apple : Jamun	10:0	9.5:0.5	9:1	8.5:1.5	8:2	7.5:2.5	7:3	6.5:3.5	6:4	5.5:4.5
Apple : Mango	10:0	9.5:0.5	9:1	8.5:1.5	8:2	7.5:2.5	7:3	6.5:3.5	6:4	5.5:4.5

***Best blend in each combination was selected by sensory evaluation**

3.4.1.2 Three fruit juice blends

Three fruit juice blends were prepared from the best combinations selected by sensory evaluation from Table 3.1. Further, the proportion of the third fruit juice/pulp to be mixed was worked out after presentation of the samples to the sensory panel as per the details given in Table 3.2.

Table 3.2 Standardization of proportion of three fruit juice blends from summer season fruits*

Blend	Proportion of fruit juice/pulp to be mixed									
Apple : Pear : Mango	10:0	9.5:0.5	9:1	8.5:1.5	8:2	7.5:2.5	7:3	6.5:3.5	6:4	5.5:4.5
Apple : Jamun : Pear	10:0	9.5:0.5	9:1	8.5:1.5	8:2	7.5:2.5	7:3	6.5:3.5	6:4	5.5:4.5
Apple : Mango : Jamun	10:0	9.5:0.5	9:1	8.5:1.5	8:2	7.5:2.5	7:3	6.5:3.5	6:4	5.5:4.5

***Best blend in each combination was selected on the basis of sensory evaluation**

3.4.1.3 Two fruits and one vegetable juice blends

The best blends selected by sensory evaluation from Table 3.1 were further mixed with bottlegourd, bittergourd, pumpkin and tomato juice/pulp separately in the following proportions (Table 3.3).

Table 3.3 Standardization of proportion of two fruits and one vegetable juice blends from summer season fruits and vegetables*

Blend	Proportion of fruit juice/pulp to be mixed									
Apple : Pear : Bottlegourd	10:0	9.5:0.5	9:1	8.5:1.5	8:2	7.5:2.5	7:3	6.5:3.5	6:4	5.5:4.5
Apple : Jamun : Bottlegourd	10:0	9.5:0.5	9:1	8.5:1.5	8:2	7.5:2.5	7:3	6.5:3.5	6:4	5.5:4.5
Apple:Mango: Bottlegourd	10:0	9.5:0.5	9:1	8.5:1.5	8:2	7.5:2.5	7:3	6.5:3.5	6:4	5.5:4.5
Apple : Pear : Pumpkin	10:0	9.5:0.5	9:1	8.5:1.5	8:2	7.5:2.5	7:3	6.5:3.5	6:4	5.5:4.5
Apple : Jamun : Pumpkin	10:0	9.5:0.5	9:1	8.5:1.5	8:2	7.5:2.5	7:3	6.5:3.5	6:4	5.5:4.5
Apple : Mango : Pumpkin	10:0	9.5:0.5	9:1	8.5:1.5	8:2	7.5:2.5	7:3	6.5:3.5	6:4	5.5:4.5
Apple : Pear : Tomato	10:0	9.5:0.5	9:1	8.5:1.5	8:2	7.5:2.5	7:3	6.5:3.5	6:4	5.5:4.5
Apple : Jamun : Tomato	10:0	9.5:0.5	9:1	8.5:1.5	8:2	7.5:2.5	7:3	6.5:3.5	6:4	5.5:4.5
Apple : Mango : Tomato	10:0	9.5:0.5	9:1	8.5:1.5	8:2	7.5:2.5	7:3	6.5:3.5	6:4	5.5:4.5
Apple : Pear : Bittergourd	10:0	9.5:0.5	9:1	8.5:1.5	8:2	7.5:2.5	7:3	6.5:3.5	6:4	5.5:4.5
Apple:Jamun : Bittergourd	10:0	9.5:0.5	9:1	8.5:1.5	8:2	7.5:2.5	7:3	6.5:3.5	6:4	5.5:4.5
Apple:Mango: Bittergourd	10:0	9.5:0.5	9:1	8.5:1.5	8:2	7.5:2.5	7:3	6.5:3.5	6:4	5.5:4.5

***Best blend in each combination was selected on the basis of sensory evaluation**

3.4.1.4 Three fruits and one vegetable juice blends

The best blends selected from Table 3.2 on the basis of sensory evaluation were further blended with bottlegourd, bittergourd, pumpkin and tomato juice/pulp in the following proportions (Table 3.4).

Table 3.4 Standardization of proportion of three fruits and one vegetable juice blends from summer season fruits*

Blend	Proportion of fruit juice/pulp to be mixed									
Apple:Pear:Mango:Bottlegourd	10:0	9.5:0.5	9:1	8.5:1.5	8:2	7.5:2.5	7:3	6.5:3.5	6:4	5.5:4.5
Apple:Jamun:Pear:Bottlegourd	10:0	9.5:0.5	9:1	8.5:1.5	8:2	7.5:2.5	7:3	6.5:3.5	6:4	5.5:4.5
Apple:Mango:Jamun:Bottlegourd	10:0	9.5:0.5	9:1	8.5:1.5	8:2	7.5:2.5	7:3	6.5:3.5	6:4	5.5:4.5
Apple:Pear:Mango:Pumpkin	10:0	9.5:0.5	9:1	8.5:1.5	8:2	7.5:2.5	7:3	6.5:3.5	6:4	5.5:4.5
Apple:Jamun:Pear:Pumpkin	10:0	9.5:0.5	9:1	8.5:1.5	8:2	7.5:2.5	7:3	6.5:3.5	6:4	5.5:4.5
Apple: Mango:Jamun:Pumpkin	10:0	9.5:0.5	9:1	8.5:1.5	8:2	7.5:2.5	7:3	6.5:3.5	6:4	5.5:4.5
Apple: Pear: Mango: Tomato	10:0	9.5:0.5	9:1	8.5:1.5	8:2	7.5:2.5	7:3	6.5:3.5	6:4	5.5:4.5
Apple:Jamun: Pear: Tomato	10:0	9.5:0.5	9:1	8.5:1.5	8:2	7.5:2.5	7:3	6.5:3.5	6:4	5.5:4.5
Apple: Mango: Jamun: Tomato	10:0	9.5:0.5	9:1	8.5:1.5	8:2	7.5:2.5	7:3	6.5:3.5	6:4	5.5:4.5
Apple: Pear: Mango: Bittergourd	10:0	9.5:0.5	9:1	8.5:1.5	8:2	7.5:2.5	7:3	6.5:3.5	6:4	5.5:4.5
Apple: Jamun: Pear: Bittergourd	10:0	9.5:0.5	9:1	8.5:1.5	8:2	7.5:2.5	7:3	6.5:3.5	6:4	5.5:4.5
Apple:Mango:Jamun: Bittergourd	10:0	9.5:0.5	9:1	8.5:1.5	8:2	7.5:2.5	7:3	6.5:3.5	6:4	5.5:4.5

***Best blends were selected on the basis of sensory evaluation**

3.4.2 Development of natural blends from winter fruits and vegetables

Juice blends were prepared from the winter fruits and vegetables in the following proportions:

3.4.2.1 Two fruit juice blends

Ten proportions of juice blends were prepared to standardize the best proportion of juices in each type of blend (Table 3.5). Blends were hot filled in pre-sterilized glass bottles and subjected to sensory evaluation.

Table 3.5 Standardization of proportion treatment of two fruit juice blends from winter season fruits*

Blend	Proportion of fruit juice/pulp to be mixed									
Kinnow : Papaya	10:0	9.5:0.5	9:1	8.5:1.5	8:2	7.5:2.5	7:3	6.5:3.5	6:4	5.5:4.5
Kinnow : Aonla	10:0	9.5:0.5	9:1	8.5:1.5	8:2	7.5:2.5	7:3	6.5:3.5	6:4	5.5:4.5
Kinnow : Red grapes	10:0	9.5:0.5	9:1	8.5:1.5	8:2	7.5:2.5	7:3	6.5:3.5	6:4	5.5:4.5

***Best blend in each combination was selected by sensory evaluation**

3.4.2.2 Three fruit juice blends

Three fruit juice blends were prepared from the best proportions selected in each fruit juice blend by sensory evaluation from Table 3.5. Three fruit juices were mixed in the following proportions.

Table 3.6 Standardization of proportions of three fruit juice blends from winter season fruits*

Blend	Proportion of fruit juice/pulp to be mixed									
Kinnow: Papaya : Aonla	10:0	9.5:0.5	9:1	8.5:1.5	8:2	7.5:2.5	7:3	6.5:3.5	6:4	5.5:4.5
Kinnow: Aonla : Red grapes	10:0	9.5:0.5	9:1	8.5:1.5	8:2	7.5:2.5	7:3	6.5:3.5	6:4	5.5:4.5
Kinnow:Red grapes: Papaya	10:0	9.5:0.5	9:1	8.5:1.5	8:2	7.5:2.5	7:3	6.5:3.5	6:4	5.5:4.5

***Best blend in each combination was selected on the basis of sensory evaluation**

3.4.2.3 Two fruits and one vegetable juice blends

The best blends selected by sensory evaluation from Table 3.5 were further mixed separately with carrot, beetroot, cabbage and tomato juice/pulp in the following proportions.

Table 3.7 Standardization of proportions of two fruits and one vegetable juice blends from winter season fruits and vegetables*

Blend	Proportion of fruit juice/pulp to be mixed									
Kinnow : Papaya : Tomato	10:0	9.5:0.5	9:1	8.5:1.5	8:2	7.5:2.5	7:3	6.5:3.5	6:4	5.5:4.5
Kinnow : Aonla : Tomato	10:0	9.5:0.5	9:1	8.5:1.5	8:2	7.5:2.5	7:3	6.5:3.5	6:4	5.5:4.5
Kinnow:Red grape: Tomato	10:0	9.5:0.5	9:1	8.5:1.5	8:2	7.5:2.5	7:3	6.5:3.5	6:4	5.5:4.5
Kinnow : Papaya : Carrot	10:0	9.5:0.5	9:1	8.5:1.5	8:2	7.5:2.5	7:3	6.5:3.5	6:4	5.5:4.5
Kinnow : Aonla : Carrot	10:0	9.5:0.5	9:1	8.5:1.5	8:2	7.5:2.5	7:3	6.5:3.5	6:4	5.5:4.5
Kinnow: Red grape: Carrot	10:0	9.5:0.5	9:1	8.5:1.5	8:2	7.5:2.5	7:3	6.5:3.5	6:4	5.5:4.5
Kinnow : Papaya : Cabbage	10:0	9.5:0.5	9:1	8.5:1.5	8:2	7.5:2.5	7:3	6.5:3.5	6:4	5.5:4.5
Kinnow : Aonla: Cabbage	10:0	9.5:0.5	9:1	8.5:1.5	8:2	7.5:2.5	7:3	6.5:3.5	6:4	5.5:4.5
Kinnow:Red grape: Cabbage	10:0	9.5:0.5	9:1	8.5:1.5	8:2	7.5:2.5	7:3	6.5:3.5	6:4	5.5:4.5
Kinnow: Papaya: Beetroot	10:0	9.5:0.5	9:1	8.5:1.5	8:2	7.5:2.5	7:3	6.5:3.5	6:4	5.5:4.5
Kinnow: Aonla: Beetroot	10:0	9.5:0.5	9:1	8.5:1.5	8:2	7.5:2.5	7:3	6.5:3.5	6:4	5.5:4.5
Kinnow: Red grape: Beetroot	10:0	9.5:0.5	9:1	8.5:1.5	8:2	7.5:2.5	7:3	6.5:3.5	6:4	5.5:4.5

***Best blend in each combination was selected on the basis of sensory evaluation**

3.4.2.4 Three fruits and one vegetable juice blends

The best blends selected from Table 3.6 on the basis of sensory evaluation were further blended with carrot, beetroot, cabbage and tomato juice/pulp in the following proportions.

Table 3.8 Standardization of proportions of three fruits and one vegetable juice blends from winter season fruits and vegetables *

Blends	Proportion of fruit juice/pulp to be mixed									
Kinnow: Papaya: Aonla: Tomato	10:0	9.5:0.5	9:1	8.5:1.5	8:2	7.5:2.5	7:3	6.5:3.5	6:4	5.5:4.5
Kinnow: Aonla: Red grape : Tomato	10:0	9.5:0.5	9:1	8.5:1.5	8:2	7.5:2.5	7:3	6.5:3.5	6:4	5.5:4.5
Kinnow : Red grape :Papaya : Tomato	10:0	9.5:0.5	9:1	8.5:1.5	8:2	7.5:2.5	7:3	6.5:3.5	6:4	5.5:4.5
Kinnow : Papaya : Aonla : Carrot	10:0	9.5:0.5	9:1	8.5:1.5	8:2	7.5:2.5	7:3	6.5:3.5	6:4	5.5:4.5
Kinnow : Aonla : Red grape : Carrot	10:0	9.5:0.5	9:1	8.5:1.5	8:2	7.5:2.5	7:3	6.5:3.5	6:4	5.5:4.5
Kinnow : Red grape : Papaya : Carrot	10:0	9.5:0.5	9:1	8.5:1.5	8:2	7.5:2.5	7:3	6.5:3.5	6:4	5.5:4.5
Kinnow : Papaya : Aonla : Cabbage	10:0	9.5:0.5	9:1	8.5:1.5	8:2	7.5:2.5	7:3	6.5:3.5	6:4	5.5:4.5
Kinnow : Aonla : Red grape : Cabbage	10:0	9.5:0.5	9:1	8.5:1.5	8:2	7.5:2.5	7:3	6.5:3.5	6:4	5.5:4.5
Kinnow : Red grape : Papaya : Cabbage	10:0	9.5:0.5	9:1	8.5:1.5	8:2	7.5:2.5	7:3	6.5:3.5	6:4	5.5:4.5
Kinnow :Papaya :Aonla :Beetroot	10:0	9.5:0.5	9:1	8.5:1.5	8:2	7.5:2.5	7:3	6.5:3.5	6:4	5.5:4.5
Kinnow: Aonla: Red grape: Beetroot	10:0	9.5:0.5	9:1	8.5:1.5	8:2	7.5:2.5	7:3	6.5:3.5	6:4	5.5:4.5
Kinnow : Red grape: Papaya :Beetroot	10:0	9.5:0.5	9:1	8.5:1.5	8:2	7.5:2.5	7:3	6.5:3.5	6:4	5.5:4.5

***Best blend in each combination was selected on the basis of sensory evaluation**

3.5 Physico-chemical analysis of fruits, vegetables and juice blends

3.5.1 Physical characteristics

The randomly selected 10 number each of the fruits and vegetables were analyzed for the following characteristics:

3.5.1.1 Size

The size of randomly selected fruits and vegetables was determined by measuring the length and diameter of the fruits with the help of vernier calliper. The average fruit size (length and diameter) was expressed in millimeter (mm)**.**

3.5.1.2 Weight

The weight of fruits and vegetables was measured on top pan balance individually and an average weight was calculated and expressed in gram (g).

3.5.2 Chemical characteristics

3.5.2.1 Total soluble solids (TSS)

TSS was determined with the help of hand refractometer of range 0-32^{o}B (Model ERMA). Fruits and vegetables were crushed with pestle and mortar and their extract was taken for observation. The TSS was recorded by placing 1-2 drops of extract on the prism of a hand refractrometer. The results were expressed as ^{o} Brix (Ranganna, 2007).

3.5.2.2 Titratable acidity

Titratable acidity was estimated by titrating a known volume of the sample against standard 0.1 N NaOH solution by using phenolphthalein as an indicator up to the end point (pink colour). The titratable acidity was expressed as per cent malic/citric acid (AOAC, 2004).

$$\text{Titratable acidity (\%)} = \frac{\text{Titre} \times \underset{\text{alkali}}{\text{Normality of}} \times \underset{\text{made up}}{\text{volume}} \times \underset{\text{of acid}}{\text{equivalent weight}}}{\underset{\text{taken}}{\text{Volume of sample}} \times \underset{\text{taken}}{\text{volume of aliquot}} \times 1000} \times 100$$

3.5.2.3 Ascorbic acid

Ascorbic acid content was determined as per AOAC (2004) method using 2, 6- dichlorophenol indophenol dye. A known volume of the sample extracted in 3% m-phosphoric acid was titrated with dye to pink colour end point. Results were expressed as mg per 100 g of sample and calculated by using the following formula:

$$\text{Ascorbic acid (mg/100 g)} = \frac{\text{Titre} \times \text{Dye factor} \times \text{Volume made up}}{\text{Aliquot of extract taken} \times \text{Weight of sample taken}} \times 100$$

3.5.2.4 Sugars

3.5.2.4.1 Estimation of sugars in fruits and juice blends

A known weight of sample (25 g) was taken in a 250 mL volumetric flask and 100 mL water was added to it. Solution was neutralized with 1 N NaOH and 2 mL of 45% lead acetate was added to it and kept for 10 min. Excess of lead acetate was removed from the sample by using 2 mL of 22% potassium oxalate in 250 mL volumetric flask. After diluting it up to the mark, the solution was filtered and clear filtrate was taken to estimate reducing sugars by titrating against a known quantity of Fehling's A and Fehling's B solution using methylene blue as an indicator (Lane and Eynon, 1923). Reducing sugars were estimated as per cent and calculated as given below:

$$\text{Reducing sugars (\%)} = \frac{\text{Factor} \times \text{Dilution}}{\text{Titre value} \times \text{Weight of sample taken}} \times 100$$

Total sugars were estimated by adding 5 g of citric acid to 50 mL calibrated sample solution and heating it for 10 min. For complete inversion of sugars, neutralizing with NaOH and making volume 250 mL in volumetric flask was done. The total sugars were estimated as per cent and calculated as given as under:

$$\text{Total sugars as invert sugars (\%)} = \frac{\text{Factor} \times \text{Dilution}}{\text{Titre} \times \text{Weight of sample taken}} \times 100$$

% Sucrose = (% total invert sugars - % reducing sugars) x 0.95

% Total sugars = (% reducing sugars + % sucrose)

3.5.2.4.2 Estimation of sugars in vegetables

Total sugars in vegetables were estimated by Phenol-Sulphuric acid method (Sadasivam and Manickam, 1991). A known weight of sample was extracted by grinding with hot 80% ethanol followed by centrifugation and collecting the supernatant. A known volume of aliquot (0.1 and 0.2 mL) was taken in separate test tubes and volume was made up to 100 mL with distilled water. One mL of 5% phenol was added to each test tube. After 10 min 5 mL H_2SO_4 was added to each test tube. Optical density of the sample was recorded at 490 nm with the help of UV-Vis spectrophotometer (Model Shimadzu, Japan). The standard curve was prepared using different concentrations of glucose and results were expressed as per cent and calculated as given below:

$$\text{Total sugars (\%)} = \frac{\text{Sugar value from standard curve } (\mu g) \times \text{Total volume of extract}}{\text{Aliquot of sample used} \times \text{Weight of sample taken}} \times 100$$

Reducing sugars were estimated by Nelson-Somoygyi method (Sadasivam and Manickam, 1991). For the estimation of reducing sugars, 0.1 and 0.2 mL aliquots of the sample (prepared above for total sugars) were taken into separate test tubes and volume was made up to 2 mL with distilled water. One mL alkaline copper tartrate reagent was added to each test tube followed by boiling on water bath for 10 min. After cooling, 1 mL arsenomolybdate reagent was added to each test tube. Final volume was made up to 25 mL and optical density of the samples was measured at 620 nm. Standard curve was prepared by using different concentrations of glucose and results were expressed into per cent using the formula discussed above for total sugars.

3.5.2.5 Total phenolics

The amount of total phenolics in the fruits, vegetables and juice blends was determined with the Folin-Ciocalteu reagent according to the method of Bray and Thorpe (1954) using catechol as a standard. One gram of sample was taken and grinded with 10 mL of 80 per cent ethanol in pestle and mortar, and centrifuged for 20 min at 1000 rpm and filtered. Filtrate was evaporated in oven up to dryness and dried extract was dissolved in 5 mL distilled water. 0.2-2.0 mL aliquot was taken in separate test tubes and volume was made up to 3 mL. Then 0.5 mL Folin-Ciocalteu reagent was added. After 3 min 2 mL of Na_2CO_3 (20%) was added and mixed. Test tubes were placed in boiling water bath for one min and then cooled. Optical density of the sample was recorded at 650 nm with the help of UV-Vis spectrophotometer (Model Shimadzu, Japan). The concentration was determined as per the standard procedure from the standard curve. The standard curve was prepared using different concentrations (8-32 µg/mL) of catechol and results were expressed as mg per 100 g on fresh weight basis.

3.5.2.6 Total carotenoids

A known weight of sample was macerated with acetone in pestle and mortar and extract was decanted into a conical flask. Extraction was continued till the residue became colourless. All extracts were combined and transferred into a separating funnel. 10-15 mL of petroleum ether was added to transfer the red pigments into the petroleum ether and 5% sodium sulphate was added to it. Again petroleum ether was added to transfer all colour into it and then separated out from separating funnel into 50 mL volumetric flask and volume was made up to 25 mL by petroleum ether. The colour intensity (optical density) was measured in a UV-Vis spectrophotometer (Model Shimadzu, Japan) at 452 nm using 3% acetone in petroleum ether as blank. The results were expressed in terms of β-carotene as mg/100 g of the sample (Ranganna, 2007).

$$\beta\text{-carotene (mg/100 g)} = \frac{\mu\text{g of carotene per mL as read from curve} \times \text{dilution}}{\text{Weight of sample} \times 1000} \times 100$$

3.5.2.7 Total anthocyanins

Total anthocyanins present in the samples were determined by the method given by Ranganna (2007). The procedure involved extraction of the anthocyanins with ethanolic-HCl and measurement of colour at the wavelength of 535 nm against blank of ethanolic-HCl using a UV-Vis spectrophotometer (Model Shimadzu, Japan). The anthocyanins were calculated and expressed as mg per 100 mL using the formula given below:

$$\text{Total OD/100 mL} = \frac{\underset{\text{(OD)}}{\text{Optical Density}} \times \underset{\text{measurement}}{\underset{\text{extracts used for colour}}{\text{Volume made up of the}}} \times \text{Total volume}}{\text{Volume of extract used} \times \text{Volume of sample taken}} \text{X100}$$

$$\text{Total anthocyanins content (mg/100 mL)} = \frac{X}{E}$$

where, X = Total OD/100 mL

E = Extinction coefficient (98.2)

3.5.2.8 Antioxidant activity

Antioxidant activity (Free radical scavenging activity) was measured as per the method of Brand-Williams *et al*. (1995). DPPH (2, 2-diphenyl-1-picrylhydrazyl) was used as a source of free radical. A quantity of 3.9 mL of $6 \text{x} 10^{-5}$ mol/L DPPH in methanol was put into a cuvette with 0.1 mL of sample extract and the decrease in absorbance was measured at 515 nm for 30 min or until the absorbance become steady. Methanol was used as blank. The remaining DPPH concentration was calculated using the following equation:

$$\text{Antioxidant activity (\%)} = \frac{Ab_{(B)} - Ab_{(S)}}{Ab_{(B)}} \times 100$$

Where,

$Ab_{(B)}$ = Absorbance of blank

$Ab_{(S)}$ = Absorbance of sample

3.5.2.9 Non-enzymatic browning (NEB)

Non-enzymatic browning in juice blends was recorded by measuring of optical density of alcoholic extracts of centrifuged samples (2000 rpm) at 440 nm in UV-Vis spectrophotometer (Model Shimadzu, Japan) using 60 per cent ethanol as blank (Ranganna, 2007).

3.6 Sensory evaluation

Nine point Hedonic scale method as given by Amerine *et al.* (1965) was followed for conducting the sensory evaluation of juice blends. The panel of 7 judges comprising of faculty members and post-graduate students of the department of Food Science and Technology, Dr. Y.S. Parmar University of Horticulture and Forestry, Nauni, Solan was selected with care to evaluate the blends for sensory parameters such as colour, consistency, taste and overall acceptability. Efforts were made to keep the same panel for sensory evaluation throughout the entire period of study. The samples were presented to judges and plain water was given to them to rinse their mouth in between the evaluation of samples. No discussion during evaluation was allowed.

3.7 Microbial evaluation

Total plate count using nutrient agar, potato dextrose agar and yeast malt extract agar media was done. Total plate count was carried out by aseptically inoculating 0.1 g of serially diluted samples in standard plate count agar medium prepared according to Ranganna (1997). An aliquot (0.1 mL) of the sample after serial dilution (10^{-2}, 10^{-4}, 10^{-6} and 10^{-8}) was aseptically inoculated in pre-sterilized plates followed by pouring total plate count agar (10-15 mL) under sterilized environment of laminar air flow. The plates were then incubated at 37^{o}C for 72 h prior to counting of microbes (Bacteria, yeasts and moulds). The results of the total plate count (TPC) were expressed as x 10^{2} CFU/g of sample.

3.8 Statistical analysis

Data pertaining to the sensory evaluation of fruit juice blends and fruit-vegetable juice blends were analyzed by using randomized block design (RBD) factorial as described by Mahony (1985). However, data on physico-chemical characteristics before and during storage were analyzed by completely randomized design (CRD) factorial. Various experiments conducted in this study were replicated thrice.

3.9 Cost of production

Cost incurred for the purchase of raw materials like fruits, vegetables, bottles, crown corks etc. was taken into account. An over head charge @ 20% of expenditure as manufacturing cost on machinery and equipment, building etc. was included for juice blends. A margin of 20% on the total cost was added as project margin on the actual sale price.

RESULTS

Chapter-4

EXPERIMENTAL RESULTS

Present investigation entitled **"Seasonal fruit and vegetable juice blends with high antioxidant potential"** was carried out in the Department of Food Science and Technology, Dr. YS Parmar University of Horticulture and Forestry, Nauni, Solan during the year 2009-11. The results recorded in the different experiments have been described under the following heads:

4.1 Physico-chemical analysis of fruits

4.2 Physico-chemical analysis of vegetables

4.3 Development of juice blends from summer season fruits and vegetables

4.4 Effect of storage on quality characteristics of summer season juice blends

4.5 Development of juice blends from winter season fruits and vegetables

4.6 Effect of storage on quality characteristics of winter season juice blends

4.7 Effect of storage on microbial quality of juice blends

4.8 Cost of production of developed juice blends

4.1 Physico-chemical analysis of fruits

Data pertaining to physico-chemical characteristics of fruits *viz.*, apple, sand pear, mango, jamun, Kinnow, papaya, red grapes and aonla are presented in Table 4.1.

4.1.1 Apple

Perusal of data mentioned in the Table 4.1 showed that the average length, diameter and weight of apple fruits were recorded as 46.05 mm, 64.47 mm and 90.70 g, respectively. The fruit contained 11.23^{o}B total soluble solids, 0.32% titratable acidity (as % malic acid), 6.11 mg/100 g ascorbic acid, 10.44% total sugars and 6.96% reducing sugars. Total phenolic content and antioxidant activity was recorded as 365.67 mg/100 g and 74.79 per cent, respectively.

4.1.2 Mango

Average length, diameter and weight of mango fruits were recorded as 88.64 mm, 55.72 mm and 139.14 g, respectively (Table 4.1). The fruit contained 18.47^{o}B total soluble solids, 0.26% titratable acidity (as % citric acid), 30.38 mg/100 g ascorbic acid, 15.13% total sugars and 9.58% reducing sugars. Total phenolic content and antioxidant activity was recorded as 84.26 mg/100 g and 63.69 per cent, respectively. Total carotenoids content in mango was recorded as 6.32 mg/100 g.

4.1.3 Jamun

Average length, diameter and weight of Jamun fruits were recorded as 26.81 mm, 20.35 mm and 7.36 g, respectively (Table 4.1). The fruit contained 16.55^{o}B total soluble solids, 0.96% titratable acidity (as % citric acid), 22.74 mg/100 g ascorbic acid, 14.00% total sugars and 6.81% reducing sugars. Total phenolic content and antioxidant activity was recorded as 415.49 mg/100 g and 76.47 per cent, respectively. Total anthocyanins content of jamun fruits was recorded as 157.99 mg/100 g.

4.1.4 Sand pear

Average length, diameter and weight of fruits were recorded as 54.54 mm, 52.80 mm and 86.68 g, respectively. The fruit contained 9.06^{o}B total soluble solids, 0.49% titratable acidity (as % malic acid), 5.20 mg/100 g ascorbic acid, 3.88% total sugars and 2.96% reducing sugars. Total phenolic content and antioxidant activity was recorded as 369.60 mg/100 g and 65.25 per cent, respectively.

4.1.5 Kinnow

Average length, diameter and weight of Kinnow fruits was recorded as 53.47 mm, 65.41 mm and 144.78 g, respectively. The fruit contained 10.08^{o}B total soluble solids, 1.07% titratable acidity (as % citric acid), 25.50 mg/100 g ascorbic acid, 7.66% total sugars and 4.55% reducing sugars. Total phenolic content and antioxidant activity was recorded as 18.36 mg/100 g and 22.32 per cent, respectively.

4.1.6 Papaya

Average length, diameter and weight of papaya fruits was recorded as 288.82 mm, 232.48 mm and 1005.04 g, respectively. The fruit contained 11.21^{o}B total soluble solids, 0.003% titratable acidity (as % citric acid), 109.22 mg/100 g ascorbic acid, 7.73% total sugars and 6.16% reducing sugars. Total phenolics content was recorded as 55.97 mg/100 g while antioxidant activity was recorded as 64.71 per cent. Papaya contained 5.03 mg/100 g total carotenoids.

4.1.7 Aonla

Aonla fruits showed 38.20 mm average length, 36.35 mm average diameter and 37.71 g average weight. The fruit contained 10.38^{o}B total soluble solids, 2.26% titratable acidity (as % citric acid), 448.4 mg/100 g ascorbic acid, 4.42% total sugars and 3.22% reducing sugars. Total phenolic content and antioxidant activity was recorded as 293.12 mg/100 g and 82.75 per cent, respectively.

4.1.8 Red grapes

Average length, diameter and weight of grape berries were recorded as 21.51 mm, 19.07 mm and 2.84 g, respectively. Average total soluble solids, titratable acidity, ascorbic acid, total sugars and reducing sugars of berries were recorded as 16.23^{o}B, 0.84% (as % tartaric acid), 11.95 mg/100 g, 11.86% and 9.89%, respectively. Total phenolics content and antioxidant activity of the fruits was recorded as 196.14 mg/100 g and 69.56 per cent, respectively. Average total anthocyanins content was recorded as 79.40 mg/100 g.

Table 4.1 Physico-chemical characteristics of fresh fruits

Parameter	Mean ± Standard deviation							
	Apple	**Mango**	**Jamun**	**Sand pear**	**Kinnow**	**Aonla**	**Papaya**	**Red grapes**
Physical								
a) Length (mm)	46.05±4.59	88.64±4.26	26.81±2.29	54.54±21.07	53.47±18.21	38.20±1.16	288.82±11.27	21.51±1.44
b) Diameter (mm)	64.47±3.18	55.72±1.64	20.35±1.41	52.80±20.08	65.41±21.21	36.35±0.66	232.48±2.69	19.07±1.23
Weight (g)	90.70±12.31	139.14±10.45	7.36±0.89	86.68±28.08	144.78±49.21	37.71±1.85	1005.04±113.32	2.84±0.079
Biochemical								
Total soluble solids (^{0}B)	11.23±0.37	18.47±0.28	16.55±0.48	9.06±2.87	10.08±3.19	10.38±0.28	11.21±0.17	16.23±0.19
Titratable acidity (%)	0.32±0.046	0.26±0.044	0.96±0.18	0.49±0.16	1.07±0.36	2.26±0.38	0.003±0.0005	0.84±0.02
Total sugars (%)	10.44±0.34	15.13±0.82	14.00±1.23	3.88±1.24	7.66±2.43	4.42±0.25	7.73±0.18	11.86±0.14
Reducing sugars (%)	6.96±0.30	9.58±0.36	6.81±0.33	2.96±1.06	4.55±1.44	3.22±0.17	6.16±0.18	9.89±0.05
Ascorbic acid (mg/100 g)	6.11±0.61	30.38±3.40	22.74±1.86	5.20±2.094	25.50±8.05	448.40±13.19	109.22±13.8	11.95±0.92
Total carotenoids (mg/100 g)	-	6.32±0.34	-	-	2.39±0.85	-	5.03±0.33	-
Total anthocyanins (mg/100g)	-	-	157.99±9.20	-	-	-	-	79.40±4.63
Total phenolics (mg/100 g)	365.67±3.45	84.26±11.38	415.49±19.59	369.60±8.03	18.36±3.52	293.12±19.73	55.97±1.86	196.14±12.64
Antioxidant activity (%)	74.79±1.74	63.69±3.19	76.47±0.99	65.25±11.31	22.32±7.43	82.75±2.43	64.71±3.07	69.56±3.57

Table 4.2 Physico-chemical characteristics of fresh vegetables

Parameter	Mean ± Standard deviation						
	Tomato	**Bottlegourd**	**Bittergourd**	**Pumpkin**	**Carrot**	**Cabbage**	**Beetroot**
Physical							
a) Length (mm)	52.88±1.69	276.29±13.9	117.34±5.73	104.04±12.15	82.51±22.84	93.86±3.21	60.01±6.15
b) Diameter (mm)	47.63±2.95	82.50±2.79	43.61±3.19	353.50±14.72	22.53±21.84	108.57±6.48	59.05±6.91
Weight (g)	58.49±1.19	790.00±181.50	52.17±0.166	2566.00±505.68	49.35±1.77	286.07±44.33	89.79±19.46
Biochemical							
Total soluble solids (^{0}B)	6.07±0.22	1.71±0.038	2.89±0.02	6.32±0.57	8.18±0.22	3.03±0.35	13.57±0.16
Titratable acidity (%)	0.59±0.034	0.003±0.005	0.05±0.02	0.013±0.023	0.01±0.0015	0.001±0.0001	0.001±0.001
Total sugars (%)	2.74±0.08	1.45±0.18	1.10±0.068	3.26±0.10	6.58±0.14	1.86±0.027	8.82±0.35
Reducing sugars (%)	2.38±0.041	1.32±0.14	0.56±0.06	2.17±0.139	2.84±0.06	1.35±0.06	7.52±0.20
Ascorbic acid (mg/100 g)	21.55±1.19	16.43±0.137	88.83±2.24	13.52±0.29	4.47±0.13	11.60±0.18	9.74±0.12
Total carotenoids (mg/100 g)	4.25±0.54	-	-	1.35±0.13	8.93±0.37	-	-
Total phenolics (mg/100 g)	31.71±3.84	13.85±8.50	82.90±19.00	2.63±1.26	12.66±0.56	70.41±12.10	212.31±5.32
Antioxidant activity (%)	52.46±1.72	72.13±2.31	58.55±2.80	70.81±1.44	61.71±0.51	44.03±0.82	82.55±0.88

4.2 Physico-chemical analysis of vegetables

Results obtained for the physico-chemical characteristics of different vegetables used for the study are depicted in Table 4.2.

4.2.1 Tomato

Tomato fruits contained average fruit length, diameter and weight as 52.88 mm, 47.63 mm and 58.49 g, respectively. Total soluble solids content was recorded as 6.07^{o}B while titratable acidity was recorded as 0.59 per cent. Fruits contained 21.55 mg/100 g ascorbic acid, 2.74% total sugars, 2.38% reducing sugars, 31.71 mg/100 g total phenols and 52.46% antioxidant activity. Total carotenoids were recorded as 4.25 mg/100 g.

4.2.2 Bottlegourd

Average length, diameter and weight of fruits were recorded as 276.29 mm, 82.50 mm and 790.00 g, respectively. Average total soluble solids content, titratable acidity (as % citric acid), ascorbic acid content, total sugars, reducing sugars, total phenolics content and antioxidant activity was recorded as 1.71^{o}B, 0.003%, 16.43 mg/100 g, 1.45%, 1.32%, 13.85 mg/100 g and 72.13 per cent, respectively.

4.2.3 Bittergourd

Bittergourd fruits showed 117.34 mm average length, 43.61 mm average diameter and 52.17 g average weight. The fruit contained 2.89^{o}B total soluble solids, 0.05% titratable acidity (as % citric acid), 88.83 mg/100 g ascorbic acid, 1.10% total sugars and 0.56% reducing sugars. Total phenolic content and antioxidant activity was recorded as 82.90 mg/100 g and 58.55 per cent, respectively.

4.2.4 Pumpkin

Pumpkin fruits contained average weight as 2566.00 g while average length and average diameter was recorded as 104.04 mm and 353.50 mm, respectively. Average total soluble solids, titratable acidity (as % citric acid), ascorbic acid, total sugars and reducing sugars were recorded as 6.32^{o}B, 0.013%, 13.52 mg/100 g, 3.26% and 2.17 per cent, respectively. Total phenolics content and antioxidant activity was recorded as 2.63 mg/100 g and 70.81 per cent, respectively.

4.2.5 Carrot

Carrot contained 8.18^{o}B total soluble solids, 0.01% titratable acidity (as % citric acid), 4.47 mg/100 g ascorbic acid, 6.58% total sugars and 2.84% reducing sugars. Total phenolics content was recorded as 12.66 mg/100 g and antioxidant activity was recorded as 61.71 per cent, respectively. Total carotenoids content was recorded as 8.93 mg/100 g. Average root length of carrot was recorded as 82.51 mm while diameter was recorded as 22.53 mm. Average weight of carrot was recorded as 49.35 g.

4.2.6 Cabbage

Average weight of cabbage heads was recorded as 286.07 g. Average length and diameter was recorded as 93.86 mm and 108.57 mm, respectively. Average total soluble solids content was recorded as 3.03^{o}B while titratable acidity was recorded as 0.001% (as % citric acid). Ascorbic acid content in cabbage was recorded as 11.60 mg/100 g while total sugars and reducing sugars content was recorded as 1.86% and 1.35 per cent, respectively. Total phenolics content and antioxidant activity was recorded as 70.41 mg/100 g and 44.03 per cent, respectively.

4.2.7 Beetroot

Beetroot contained 89.79 g average weight while average length and diameter were recorded as 60.01 mm and 59.05 mm, respectively. Average total soluble solids, titratable acidity (as % citric acid), ascorbic acid, total sugars and reducing sugars were recorded as 13.57^{o}B, 0.001%, 9.74 mg/100 g, 8.82% and 7.52 per cent, respectively. It contained 212.31 mg/100 g total phenolics content and 82.55 per cent antioxidant activity.

4.3 Development of fruit juice blends from summer season fruits and vegetables

4.3.1 Development of apple based (two fruit) juice blends

Sensory score for the proportions of fruit juices/pulps used for the preparation of apple based (two fruit) juice blends are presented in Table 4.3. A significant difference was observed among the sensory scores of all the blends. On the basis of overall acceptability 8: 2, 9: 1 and 8: 2 proportions were found best for apple: pear, apple: jamun and apple: mango juice/pulp blends, respectively. Apple: pear blend (8: 2) achieved the colour, flavour, body and overall acceptability score as 7.25, 8.15, 8.25 and 8.25, respectively which was significantly higher than other proportions including control for which scores for respective parameters were recorded as 6.60, 8.00, 7.20 and 6.45, respectively. Apple and mango juice/pulp mixed in proportions of 8: 2 exhibited maximum sensory score for colour, flavour, body, and overall acceptability as 8.00, 8.50, 8.50 and 8.50, respectively. Apple: jamun blend (9: 1) ranked best among all the proportions with colour, flavour, body and overall acceptability score of 7.35, 7.20, 6.90 and 7.45 against 6.80, 6.70, 6.50 and 6.87, respectively for control. The best juice blend in each category standardized as above were further prepared and stored at ambient and low temperature for detailed shelf-life study as well as for the preparation of three fruits/vegetable juice/pulp blends.

4.3.2 Development of apple based (three fruit) juice blends

Sensory score for the standardization of proportion of three fruits juice/pulp blends are presented in Table 4.4a – 4.4c. Apple: pear blend (8: 2) selected best as above in 4.3.1 was further blended with mango pulp in different proportions as mentioned in Table 4.4a and a blend of apple, pear and mango in the proportion of 6.4, 1.6 and 2, respectively had maximum acceptability on the basis of colour (8.00), flavour (8.50), body (7.95) and overall acceptability (8.20). Similarly, the blend of apple, jamun and pear in the 7.2: 0.8: 2 proportion was adjudged best with colour score of 7.55, flavour score of 7.30, body score of 7.68 and overall acceptability score of 7.65 (Table 4.4b). However, three fruit juice blend of apple, mango and jamun blended in the proportion of 6.8, 1.7 and 1.5, respectively was ranked as the best with a highest sensory score for colour (7.90), flavour (8.30), body (8.45) and overall acceptability (8.45) (Table 4.4c). The best juice blend in each category standardized as above were further prepared and stored at ambient and low temperature for detailed shelf-life study as well as for the preparation of vegetable juice/pulp blends.

4.3.3 Development of Apple: Pear and vegetable juice blends

Apple: pear blend (8:2) as standardized from previous experiment (Table 4.3) was further blended with juice/pulp of vegetables *viz*. bottlegourd, bittergourd, pumpkin and tomato in different proportions and data obtained for sensory evaluation are presented in Table 4.5. Apple: pear blend mixed with bottlegourd juice in the proportion of 9: 1 (actual proportion 7.2: 1.8: 1.0) was rated best among all the proportions. Maximum mean overall acceptability score was recorded as 7.70 for 9.5: 0.5 which was at par with 9: 1 (7.65). Therefore, on the basis of nutritional quality 9: 1 was taken for the preparation of respective blend. The sensory score for other parameters like colour, flavour and body were recorded as 7.60, 7.33 and 7.50, respectively. Further, the other blends like apple: pear: bittergourd, apple: pear: pumpkin and apple: pear: tomato blends containing apple: pear and respective vegetable juice/pulp in proportions of 9.5: 0.5 (actual proportion 7.6: 1.9: 0.5) achieved highest acceptability with colour score of 7.60, 7.40 and 7.95, respectively while flavour score for the respective blends were recorded as 7.00, 7.55 and 7.65, respectively. The overall acceptability score of apple: pear: bittergourd, apple: pear: pumpkin and apple: pear: tomato blend was recorded as 7.65, 7.45 and 7.60, respectively. Acceptability of blends was found to decrease with increase in the concentration of vegetable juice/pulp. Blends were prepared in standardized proportions for the storage study.

4.3.4 Development of Apple: Jamun and vegetable juice blends

Apple: jamun blends containing bottlegourd, bittergourd, pumpkin and tomato in proportions of 9: 1, 9.5: 0.5, 9.5: 0.5 and 9.5: 0.5, respectively, were rated best among each type of blends with mean overall acceptability score of 7.60, 7.43, 7.57 and 7.43, respectively (Table 4.6). Apple: jamun: bottlegourd blend (actual proportion 8.1: 0.9: 1) achieved sensory score of 7.85 for colour, 7.70 for flavour and 7.57 for body against 7.25, 7.53 and 7.31 for respective characters in control while apple: jamun: bittergourd (actual proportion 8.5: 1: 0.5) scored 7.60 for colour, 6.50 for flavour and 7.71 for body. Colour, flavour and body score for apple: jamun: pumpkin (8.5: 1: 0.5) were recorded as 7.59, 7.21 and 7.62, respectively whereas for apple: jamun: tomato (8.5: 1: 0.5) these were recorded as 7.65, 7.22 and 7.38, respectively. Those blends scoring highest score were selected for further study.

4.3.5 Development of Apple: Mango and vegetable juice blends

Data presented in Table 4.7 shows the sensory scores recorded for the different proportions used for blending apple: mango blend with different vegetable juice/pulp. apple: mango blend (8: 2) was mixed with vegetable juice/pulp in different proportions to standardize the best proportion of each vegetable in blend. For apple: mango: bottlegourd blend, a proportion of 6.4: 1.6: 2 was found as the best with an average overall acceptability score of 8.70. Blends containing apple: mango blend and bittergourd juice in proportion of 9: 1 (actual proportion of 7.2: 1.8: 1) was found as most acceptable among all the proportions used with an average score of 7.20 for overall acceptability, 8.65 for colour, 5.35 for flavour and 7.83 for body. Among different proportions used, 9.5: 0.5 (Actual proportion of 7.6: 1.9: 0.5) was found acceptable for both apple: mango: pumpkin and apple: mango: tomato blends with a mean acceptability score of 8.32 and 8.40, colour score of 8.65 and 8.60, flavour score of 8.30 and 8.40 and body score of 8.20 and 8.25, respectively.

4.3.6 Development of Apple: Pear: Mango and vegetable juice blends

Effect of blending on the acceptability of apple: pear: mango and vegetable juice/pulp in different proportions have been presented in Table 4.8. Data showed that apple: pear: mango blends further blended with bottlegourd, bittergourd, pumpkin and tomato juice/pulp in the proportion of 8.5: 1.5, 9: 1, 9.5: 0.5 and 9.5: 0.5, respectively, were found to be most acceptable with a mean overall acceptability score of 8.40, 7.15, 8.50 and 8.50 for the respective blends. Colour, flavour and body score for the apple: pear: mango: bottlegourd blend was recorded as 8.25, 8.27 and 8.30, respectively. Similarly, for apple: pear: mango: bittergourd, the colour score was recorded as 8.60 while flavour and body score was recorded as 8.20 and 8.60, respectively. The actual proportion of the best blends were calculated as 5.4: 1.4: 1.7: 1.5 and 5.8: 1.4: 1.8: 1 for apple: pear: mango: bottlegourd and apple: pear: mango: bittergourd, respectively while 6.1: 1.5: 1.9: 0.5 for both apple: pear: mango: pumpkin and apple: pear: mango: tomato.

4.3.7 Development of Apple: Jamun: Pear and vegetable juice blends

Apple: jamun: pear blends were prepared in standardized proportion (6.4: 1.6: 2) and were further blended with bottlegourd, bittergourd, pumpkin and tomato juice/pulp in different proportions to find out the best one for each type of blend (Table 4.9). Among different proportions used for apple: jamun: pear: bottlegourd blend, the proportion of 5.4: 0.6: 1.5: 2.5 was found best with maximum mean overall acceptability score of 8.17, colour score of 8.20, flavour score of 8.00 and body score of 8.10. Whereas, proportion of 6.8: 0.8: 1.9: 0.5 was found acceptable in each of apple: jamun: pear: bittergourd, apple: jamun: pear: pumpkin and apple: jamun: pear: tomato blends with an average overall acceptability score of 7.85, 8.30 and 7.93, colour score of 8.30, 7.93 and 8.47, flavour score of 7.70, 8.60 and 8.28 and body score of 8.10, 8.05 and 8.07, respectively.

4.3.8 Development of Apple: Mango: Jamun and vegetable juice blends

Table 4.10 shows the average sensory score recorded for different proportions used for blending of apple: mango: jamun and vegetable juice/pulp. Best proportions for blending of apple: mango: jamun blend with vegetable juice/pulp were found as 9: 1, 9.5: 0.5, 9: 1 and 9.5: 0.5 for apple: mango: jamun: bottlegourd, apple: mango: jamun: bittergourd, apple: mango: jamun: pumpkin and apple: mango: jamun: tomato blends and their actual proportions were calculated as 6.1: 1.5: 1.4: 1, 6.5: 1.6: 1.4: 0.5, 6.1: 1.5: 1.4: 1 and 6.5: 1.6: 1.4: 0.5, respectively. Colour, flavour, body and overall acceptability score for apple: mango: jamun: bottlegourd was recorded as 7.65, 7.82, 8.29 and 7.83, respectively while for apple: mango: jamun: Bittergourd these were recorded as 7.45, 7.35, 8.33 and 7.55, respectively. Standardized Apple: Mango: Jamun: Pumpkin achieved a sensory score of 7.50 for colour, 7.70 for flavour, 8.25 for body and 7.80 for overall acceptability while apple: mango: jamun: tomato (9.5: 0.5) blend achieved a sensory score of 7.73, 7.97, 8.30 and 8.10 for colour, flavour, body and overall acceptability, respectively. All the blends were prepared in standardized proportions for the further study.

Table 4.3 Development of apple based (two fruit) juice blends

Juice blend	Parameter	Proportion/Sensory score										$CD_{(0.05)}$
		10: 0	9.5: 0.5	9: 1	8.5: 1.5	8: 2	7.5: 2.5	7: 3	6.5: 3.5	6: 4	5.5: 4.5	
Apple: Pear	Colour	6.60	6.90	7.10	7.05	7.25	7.00	6.85	6.55	6.70	6.20	0.10
	Flavour	8.00	8.05	8.07	8.10	8.15	7.70	7.55	7.20	6.95	6.50	0.29
	Body	7.20	7.35	7.50	7.85	8.25	8.00	7.75	7.60	7.45	7.40	0.01
	Overall acceptability	6.45	6.85	7.50	8.00	8.25	7.80	7.50	7.00	6.50	6.25	0.41
Apple: Jamun	Colour	6.80	7.10	7.35	7.00	6.80	6.55	6.20	6.05	5.90	5.70	0.48
	Flavour	6.70	7.00	7.20	6.95	6.75	6.50	6.25	6.10	5.90	5.75	0.20
	Body	6.50	7.00	6.90	6.50	6.25	6.15	6.00	5.75	5.42	5.40	0.13
	Overall acceptability	6.87	7.20	7.45	7.25	7.20	7.10	7.05	6.85	6.75	6.60	0.13
Apple: Mango	Colour	6.65	7.00	7.50	7.80	8.00	7.80	7.60	7.50	7.35	7.10	0.12
	Flavour	6.00	7.10	7.50	8.10	8.50	8.35	8.20	8.00	7.60	7.35	0.16
	Body	7.33	7.45	7.80	8.20	8.50	8.10	7.85	7.10	7.15	7.00	0.09
	Overall acceptability	6.80	7.50	7.75	8.20	8.50	8.00	7.50	7.25	7.05	7.00	0.12

Table 4.4a Development of Apple: Pear: Mango juice blend

Parameter	Proportion*/Sensory score										CD$_{(0.05)}$
	10: 0 (8:2:0)	9.5: 0.5 (7.6:1.9:0.5)	9: 1 (7.2:1.8:1)	8.5: 1.5 (6.8:1.7:1.5)	8: 2 (6.4:1.6:2)	7.5: 2.5 (6:1.5:2.5)	7: 3 (5.6:1.4:3)	6.5: 3.5 (5.2:1.3:3.5)	6: 4 (4.8:1.2: 4)	5.5: 4.5 (4.4:1.1: 4.5)	
Colour	7.15	7.50	7.73	7.85	8.00	8.05	8.10	8.10	8.05	7.90	0.08
Flavour	7.25	7.70	7.80	8.00	8.50	8.55	8.40	8.30	8.25	8.20	0.08
Body	7.80	7.90	8.00	8.00	7.95	7.80	7.70	7.60	7.50	7.40	0.14
Overall acceptability	7.55	7.80	7.90	8.00	8.20	8.10	7.95	7.83	7.67	7.58	0.03

*Figures given in parenthesis represent the actual proportion of three fruits in the blend

Table 4.4b Development of Apple: Jamun: Pear juice blend

Parameter	Proportion*/Sensory score										CD$_{(0.05)}$
	10: 0 (9:1: 0)	9.5: 0.5 (8.5:1:0.5)	9: 1 (8.1:0.9:1)	8.5: 1.5 (7.6:0.9:1.5)	8: 2 (7.2: 0.8: 2)	7.5: 2.5 (6.7:0.8: 2.5)	7: 3 (6.3:0.7:3)	6.5: 3.5 (5.8:0.7: 3.5)	6: 4 (5.4:0.6: 4)	5.5: 4.5 (4.9:0.6:4.5)	
Colour	7.35	7.45	7.50	7.58	7.55	7.35	7.22	7.15	7.10	7.00	0.09
Flavour	7.40	7.40	7.37	7.35	7.30	7.25	7.20	7.15	7.00	6.80	0.13
Body	7.52	7.60	7.65	7.70	7.68	7.63	7.55	7.40	7.35	7.25	0.09
Overall acceptability	7.50	7.53	7.60	7.65	7.65	7.50	7.40	7.30	7.20	7.00	0.05

*Figures given in parenthesis represent the actual proportion of three fruits in the blend

Table 4.4c Development of Apple: Mango: Jamun juice blend

Parameter	Proportion*/Sensory score										CD$_{(0.05)}$
	10: 0 (8:2:0)	9.5: 0.5 (7.6:1.9:0.5)	9: 1 (7.2:1.8:1)	8.5: 1.5 (6.8:1.7:1.5)	8: 2 (6.4:1.6:2)	7.5: 2.5 (6:1.5:2.5)	7: 3 (5.6:1.4:3)	6.5: 3.5 (5.2:1.3:3.5)	6: 4 (4.8:1.2:4)	5.5: 4.5 (4.4:1.1:4.5)	
Colour	8.80	8.40	8.15	7.90	7.70	7.55	7.40	7.35	7.40	7.30	0.06
Flavour	8.70	8.50	8.40	8.30	8.15	8.00	7.80	7.60	7.40	7.10	0.17
Body	8.5	8.50	8.40	8.45	8.30	8.15	8.00	7.80	7.60	7.50	0.12
Overall acceptability	8.50	8.50	8.40	8.45	8.30	8.10	7.95	7.75	7.50	7.30	0.05

*Figures given in parenthesis represent the actual proportion of three fruits in the blend

Table 4.5 Development of apple, sand pear and vegetable juice blends

Juice blend	Parameter	Proportion*/Sensory score										$CD_{(0.05)}$
		10: 0 (8:2:0)	9.5: 0.5 (7.6:1.9:0.5)	9: 1 (7.2:1.8:1)	8.5: 1.5 (6.8:1.7:1.5)	8: 2 (6.4:1.6:2)	7.5: 2.5 (6:1.5:2.5)	7: 3 (5.6:1.4:3)	6.5: 3.5 (5.2:1.3:3.5)	6: 4 (4.8:1.2:4)	5.5: 4.5 (4.4:1.1:4.5)	
Apple: Pear: Bottlegourd	Colour	7.80	7.75	7.60	7.53	7.45	74.30	7.23	7.15	7.05	7.00	0.06
	Flavour	7.65	7.50	7.33	7.20	7.13	7.05	7.00	6.90	6.73	6.60	0.07
	Body	7.75	7.63	7.50	7.35	7.25	7.10	7.03	6.90	6.80	6.75	0.04
	Overall acceptability	7.70	7.70	7.65	7.50	7.40	7.30	7.20	7.07	7.00	7.00	0.06
Apple: Pear: Bittergourd	Colour	7.67	7.60	7.50	7.37	7.25	7.17	7.07	7.00	6.90	6.83	0.06
	Flavour	7.88	7.00	6.35	6.00	5.75	5.35	5.15	5.00	4.50	4.30	0.03
	Body	7.93	7.85	7.60	7.53	7.45	7.30	7.15	7.00	6.80	6.65	0.05
	Overall acceptability	7.73	7.65	7.35	7.27	7.15	7.03	6.93	6.85	6.80	6.77	0.10
Apple: Pear: Pumpkin	Colour	7.55	7.40	7.25	7.10	7.03	6.90	6.73	6.60	6.53	6.45	0.09
	Flavour	7.70	7.55	7.30	7.13	7.05	6.97	6.83	6.70	6.60	6.47	0.04
	Body	7.85	7.73	7.50	7.40	7.25	7.15	7.00	6.83	6.65	6.53	0.03
	Overall acceptability	7.82	7.45	7.15	7.00	6.83	6.65	6.57	6.35	6.15	6.00	0.04
Apple: Pear: Tomato	Colour	7.85	7.95	7.70	7.55	7.45	7.30	7.27	7.10	7.00	6.93	0.08
	Flavour	7.80	7.65	7.30	7.20	7.03	6.83	6.70	6.65	6.50	6.37	0.07
	Body	7.83	7.70	7.50	7.35	7.15	7.00	6.90	6.73	6.55	6.40	0.17
	Overall acceptability	7.85	7.60	7.40	7.25	7.00	6.82	6.70	6.60	6.45	6.30	0.06

*Figures given in parenthesis represent the actual proportion of two fruits and one vegetable in the blend

Table 4.6 Development of apple, jamun and vegetable juice blends

Juice blend	Parameter	Proportion*/Sensory score										$CD_{(0.05)}$
		10: 0 (9:1: 0)	9.5: 0.5 (8.5:1:0.5)	9: 1 (8.1:0.9:1)	8.5: 1.5 (7.6:0.9:1.5)	8: 2 (7.2:0.8:2)	7.5: 2.5 (6.7:0.8:2.5)	7: 3 (6.3:0.7:3)	6.5: 3.5 (5.8:0.7:3.5)	6: 4 (5.4:0.6:4)	5.5: 4.5 (4.9:0.6:4.5)	
Apple: Jamun: Bottlegourd	Colour	7.25	7.63	7.85	7.70	7.60	7.60	7.57	7.50	7.40	7.27	0.09
	Flavour	7.53	7.60	7.70	7.50	7.43	7.43	7.39	7.33	7.27	7.21	0.08
	Body	7.31	7.42	7.57	7.23	7.07	7.07	6.91	6.83	6.57	6.35	0.13
	Overall acceptability	7.45	7.65	7.60	7.45	7.22	7.22	7.17	7.09	6.87	6.53	0.08
Apple: Jamun: Bittergourd	Colour	7.75	7.60	7.20	6.85	6.67	6.67	6.60	6.50	6.41	6.25	0.08
	Flavour	7.83	6.50	5.50	5.35	5.15	5.15	5.07	5.03	4.95	4.80	0.03
	Body	7.65	7.71	7.45	7.35	7.03	7.03	6.97	6.73	6.65	6.53	0.05
	Overall acceptability	7.75	7.43	6.90	6.43	6.11	6.11	5.85	5.63	5.41	5.25	0.13
Apple: Jamun: Pumpkin	Colour	7.68	7.59	7.50	7.45	7.25	7.25	7.18	7.10	7.05	6.90	0.09
	Flavour	7.54	7.21	7.00	6.85	6.65	6.65	6.57	6.51	6.45	6.30	0.14
	Body	7.73	7.62	7.34	7.20	7.09	7.09	6.85	6.67	6.51	6.44	0.09
	Overall acceptability	7.65	7.57	7.30	7.15	6.94	6.94	6.80	6.69	6.55	6.43	0.16
Apple: Jamun: Tomato	Colour	7.63	7.65	7.60	7.56	7.37	7.37	7.30	7.28	7.20	7.15	0.10
	Flavour	7.35	7.22	7.01	7.00	6.78	6.78	6.60	6.43	6.21	6.04	0.13
	Body	7.53	7.38	7.19	7.07	6.77	6.77	6.63	6.50	6.37	6.19	0.14
	Overall acceptability	7.50	7.43	7.15	7.03	6.73	6.73	6.52	6.33	6.17	6.03	0.11

*Figures given in parenthesis represent the actual proportion of two fruits and one vegetable in the blends.

Table 4.7 Development of apple, mango and vegetable juice blends

Juice blend	Parameter	Proportion*/Sensory score										$CD_{(0.05)}$
		10: 0 (8:2:0)	9.5: 0.5 (7.6:1.9: 0.5)	9: 1 (7.2:1.8:1)	8.5: 1.5 (6.8:1.7:1. 5)	8: 2 (6.4:1.6:2)	7.5: 2.5 (6:1.5: 2.5)	7: 3 (5.6:1.4:3)	6.5: 3.5 (5.2:1.3:3. 5)	6: 4 (4.8:1.2:4)	5.5: 4.5 (4.4:1.1:4. 5)	
Apple: Mango: Bottlegourd	Colour	8.80	8.85	8.87	8.80	8.85	8.20	8.00	7.95	7.75	7.50	0.62
	Flavour	8.50	8.70	8.65	8.50	8.55	8.10	7.90	7.80	7.50	7.20	0.10
	Body	8.00	8.20	8.55	8.70	8.80	8.65	8.50	8.25	8.00	7.90	0.08
	Overall acceptability	8.50	8.60	8.55	8.65	8.70	8.20	8.00	7.90	7.70	7.50	0.10
Apple: Mango: Bittergourd	Colour	8.90	8.70	8.65	8.50	8.43	8.28	8.15	8.05	7.80	7.73	0.18
	Flavour	8.80	6.50	5.35	5.20	5.15	5.08	5.00	4.92	4.85	4.70	0.16
	Body	8.20	8.00	7.83	7.71	7.60	7.47	7.50	7.27	7.20	7.15	0.07
	Overall acceptability	8.65	7.50	7.20	7.05	6.92	6.83	6.70	6.55	6.30	6.15	0.04
Apple: Mango: Pumpkin	Colour	8.72	8.65	8.50	8.43	8.37	8.30	8.21	8.15	8.00	7.80	0.11
	Flavour	8.55	8.30	8.00	7.80	7.65	7.53	7.40	7.27	7.18	7.00	0.07
	Body	8.35	8.20	7.97	7.90	7.80	7.69	7.55	7.45	7.30	7.20	0.03
	Overall acceptability	8.55	8.32	8.10	7.85	7.60	7.53	7.37	7.23	7.15	7.05	0.05
Apple: Mango: Tomato	Colour	8.75	8.60	8.43	8.37	8.27	8.20	8.15	8.00	7.80	7.73	0.16
	Flavour	8.69	8.40	8.13	7.97	7.82	7.70	7.57	7.43	7.32	7.25	0.06
	Body	8.40	8.25	8.00	7.90	7.83	7.65	7.60	7.50	7.35	7.30	0.04
	Overall acceptability	8.60	8.40	8.23	8.11	8.07	7.85	7.60	7.45	7.33	7.03	0.04

*Figures given in parenthesis represent the actual proportion of two fruits and one vegetable in the blend

Table 4.8 Development of apple, sand pear, mango and vegetables juice blends

Juice blend	Parameter	Proportion*/Sensory score										CD$_{(0.05)}$
		10: 0 (6.4:1.6 :2:0)	9.5: 0.5 (6.1:1.5: 1.9:0.5)	9: 1 (5.8:1.4: 1.8:1)	8.5: 1.5 (5.4:.1.4 :1.7:1.5)	8: 2 (5.1:1.3: 1.6:2)	7.5: 2.5 (4.8:1.2: 1.5:2.5)	7: 3 (4.5:1.1: 1.4:3)	6.5: 3.5 (4.2:1:1. 3:3.5)	6: 4 (3.8:1: 1.2:4)	5.5: 4.5 (3.5:0.9:1 .1:4.5)	
Apple: Pear: Mango : Bottlegourd	Colour	8.50	8.47	8.40	8.25	8.17	8.05	7.90	7.83	7.70	7.55	0.12
	Flavour	8.55	8.50	8.40	8.27	8.15	8.10	7.97	7.90	7.80	7.70	0.07
	Body	8.45	8.45	8.40	8.30	8.25	8.14	8.08	8.00	7.90	7.80	0.10
	Overall acceptability	8.50	8.47	8.40	8.40	8.10	8.03	7.92	7.80	7.65	7.57	0.12
Apple: Pear: Mango : Bittergourd	Colour	8.77	8.75	8.60	8.50	8.35	8.30	8.21	8.15	8.07	7.90	0.16
	Flavour	8.85	8.45	8.20	8.00	7.73	7.55	7.20	7.00	6.75	6.47	0.12
	Body	8.75	8.70	8.60	8.55	8.40	8.30	8.23	8.15	8.10	8.05	0.10
	Overall acceptability	8.75	7.21	7.15	6.95	6.57	6.30	6.17	5.90	5.65	5.55	0.08
Apple: Pear: Mango : Pumpkin	Colour	8.65	8.60	8.47	8.30	8.17	8.09	7.90	7.83	7.70	7.60	0.12
	Flavour	8.60	8.53	8.45	8.33	8.20	8.10	8.00	7.93	7.75	7.67	0.10
	Body	8.60	8.55	8.50	8.45	8.40	8.30	8.27	8.20	8.15	8.10	0.13
	Overall acceptability	8.60	8.50	8.35	8.20	8.10	7.97	7.85	7.70	7.66	7.50	0.09
Apple: Pear: Mango : Tomato	Colour	8.5	8.45	8.30	8.25	8.17	8.11	8.05	7.95	7.87	7.80	0.09
	Flavour	8.55	8.47	8.30	8.20	8.10	7.95	7.83	7.70	7.71	7.47	0.15
	Body	8.40	8.42	8.35	8.30	8.20	8.20	8.15	8.13	8.10	8.05	0.11
	Overall acceptability	8.55	8.50	8.30	8.22	8.13	8.03	7.90	7.80	7.70	7.55	0.06

*Figures given in parenthesis represent the actual proportion of three fruits and one vegetable in the blend

Table 4.9 Development of apple, jamun, sand pear and vegetable juice blends

Juice blend	Parameter	Proportion*/Sensory score										CD$_{(0.05)}$
		10: 0 (7.2:0.8:2: 0)	9.5: 0.5 (6.8:0.8 :1.9: 0.5)	9: 1 (6.5:0.7 :1.8:1)	8.5: 1.5 (6.1:0.7: 1.7:1.5)	8: 2 (5.8:0.6 :1.6:2)	7.5: 2.5 (5.4:0.6: 1.5:2.5)	7: 3 (5:0.6: 1.4:3)	6.5: 3.5 (4.7:0.5:1. 3:3.5)	6: 4 (4.3:0.5: 1.2:4)	5.5: 4.5 (4:0.4: 1.1:4.5)	
Apple: Jamun: Pear: Bottlegourd	Colour	7.90	7.95	8.00	8.10	8.25	8.20	8.03	7.85	7.70	7.63	0.18
	Flavour	7.70	7.75	7.80	7.83	7.95	8.00	7.85	7.70	7.66	7.40	0.05
	Body	8.00	8.05	8.10	8.25	8.17	8.10	7.90	7.80	7.65	7.47	0.05
	Overall acceptability	7.95	8.03	8.10	8.15	8.2	8.17	8.00	7.93	7.85	7.77	0.05
Apple: Jamun: Pear: Bittergourd	Colour	8.20	8.30	8.15	8.05	7.90	7.77	765	7.50	7.43	7.30	0.06
	Flavour	8.50	7.70	7.35	7.10	6.90	6.65	6.40	6.20	6.05	5.90	0.04
	Body	8.20	8.10	8.05	7.93	7.87	7.75	7.60	7.53	7.37	7.25	0.06
	Overall acceptability	8.40	7.85	7.50	7.25	7.10	6.85	6.60	6.35	6.17	6.03	0.08
Apple: Jamun: Pear: Pumpkin	Colour	8.00	7.93	7.85	7.70	7.65	7.53	7.40	7.30	7.17	7.05	0.13
	Flavour	8.70	8.60	8.45	8.30	8.20	8.07	7.90	7.77	7.55	7.40	0.03
	Body	8.15	8.05	7.90	7.81	7.70	7.57	7.40	7.25	7.10	7.09	0.07
	Overall acceptability	8.35	8.30	8.10	8.03	7.90	7.75	7.60	7.50	7.37	7.23	0.09
Apple: Jamun: Pear: Tomato	Colour	8.50	8.47	8.35	8.25	8.17	8.05	7.90	7.75	7.60	7.50	0.04
	Flavour	8.35	8.28	8.10	8.00	7.85	7.70	7.65	7.53	7.47	7.35	0.14
	Body	8.13	8.07	8.00	7.97	7.80	7.71	7.63	7.57	7.40	7.27	0.03
	Overall acceptability	8.00	7.93	7.80	7.75	7.60	7.53	7.45	7.39	7.25	7.17	0.05

*Figures given in parenthesis represent the actual proportion of three fruits and one vegetable in the blend

Table 4. 10 Development of apple, mango, jamun and vegetable juice blends

Juice blend	Parameter	Proportion*/Sensory score										$CD_{(0.05)}$
		10: 0	9.5: 0.5	9: 1	8.5: 1.5	8: 2	7.5: 2.5	7: 3	6.5: 3.5	6: 4	5.5: 4.5	
		(6.8:1.7: 1.5: 0)	(6.5:1.6: 1.4:0.5)	(6.1:1.5: 1.4:1)	(5.8:1.4: 1.3: 1.5)	(5.4:1.4: 1.2:2)	(5.1:1.3: 1.1:2.5)	(4.8:1.2: 1.1:3)	(4.4:1.1: 2:3.5)	(4.1:1: 0.9:4)	(3.8:0.9: 0.8:4.5)	
Apple: Mango: Jamun: Bottlegourd	Colour	7.53	7.60	7.65	7.55	7.50	7.47	7.40	7.33	7.25	7.20	0.11
	Flavour	7.90	7.87	7.82	7.65	7.60	7.53	7.45	7.39	7.27	7.13	0.07
	Body	8.45	8.35	8.29	8.13	7.90	7.75	7.67	7.54	7.33	7.15	0.07
	Overall acceptability	7.95	7.87	7.83	7.65	6.53	7.40	7.33	7.17	7.05	7.00	0.04
Apple: Mango: Jamun: Bittergourd	Colour	7.85	7.45	7.30	7.20	7.15	7.00	6.85	6.70	6.55	6.40	0.16
	Flavour	8.00	7.35	7.07	6.85	6.40	6.25	6.10	5.90	5.65	5.44	0.12
	Body	8.40	8.33	8.20	8.11	8.03	7.95	7.80	7.71	7.57	7.43	0.12
	Overall acceptability	8.20	7.55	7.20	6.95	6.77	6.53	6.37	6.45	6.30	6.15	0.08
Apple: Mango: Jamun: Pumpkin	Colour	7.65	7.60	7.50	7.43	7.35	7.20	7.17	7.10	7.05	6.95	0.06
	Flavour	7.85	7.80	7.70	7.55	7.37	7.25	7.10	6.87	6.63	6.47	0.03
	Body	8.55	8.40	8.25	8.14	8.00	7.85	7.45	7.23	7.15	7.05	0.77
	Overall acceptability	8.00	7.97	7.80	7.69	7.47	7.33	7.21	7.17	7.05	6.95	0.06
Apple: Mango: Jamun: Tomato	Colour	7.70	7.73	7.70	7.63	7.55	7.47	7.35	7.29	7.15	7.03	0.06
	Flavour	8.05	7.97	7.73	7.51	7.35	7.20	7.13	7.02	6.90	6.77	0.07
	Body	8.45	8.30	8.15	8.07	7.93	7.85	7.70	7.60	7.45	7.30	0.11
	Overall acceptability	8.15	8.10	8.00	7.77	7.67	7.50	7.37	7.25	7.13	7.05	0.13

*Figures given in parenthesis represent the actual proportion of three fruits and one vegetable in the blend

4.4 Effect of storage on quality characteristics of summer season juice blends

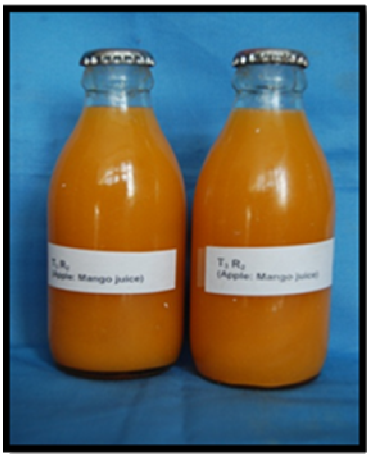
4.4.1 Apple based (two fruit) juice blends

4.4.1.1 Total soluble solids (TSS)

Perusal of the data in Table 4.11 revealed that the total soluble solids in blends ranged from 10.90 to 12.74^{o}B. Significant difference was recorded in TSS content of all blends. Maximum TSS was recorded in apple: mango juice blend (12.74^{o}B) while minimum value was 10.68^{o}B in apple: pear blend. A gradual increase in TSS was recorded with the advancement of storage period which increased from average initial value of 11.46 to 11.76^{o}B after six month irrespective of all the factors however, changes were non-significant. Juice blends stored at ambient temperature showed more increase in TSS (from an initial value of 11.46 to 11.64^{o}B) while those stored at refrigerated temperature resulted in a minimum change (from an initial value of 11.46 to 11.50^{o}B) during storage. The interaction of various factors revealed the non-significant results for change in TSS during storage at both the temperatures.

4.4.1.2 Titratable acidity

Results obtained for the changes in titratable acidity of the apple based (two fruit) blends during storage are presented in Table 4.12. A significant difference was recorded in the titratable acidity of all the treatments. The maximum mean titratable acidity (0.40%) was recorded in apple: jamun juice blend of 9: 1 while minimum was recorded as 0.28% in the apple: mango blend of 8: 2. A gradual increase in titratable acidity was recorded from an initial mean value of 0.33 to 0.35 after six month of storage however, changes were not significant. Changes were more at ambient storage with an increase from mean initial value of 0.33 to 0.35% as compared to refrigerated storage where the increase was from a mean initial value of 0.33 to 0.34 per cent. Data showed that there was an increasing trend of titratable acidity in all the blends during the storage irrespective of storage conditions.

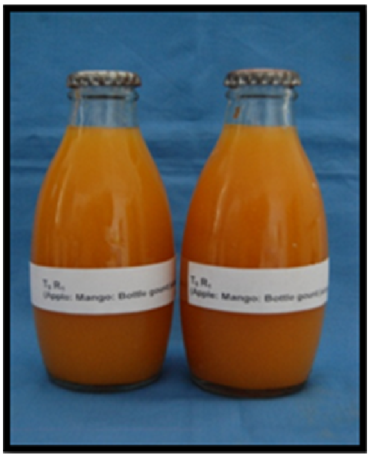


Apple: Mango

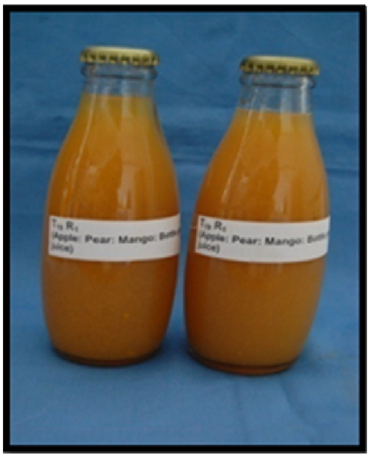
Apple: Pear: Mango

Apple: Pear: Bottlegourd

Apple: Jamun: Bottlegourd



Apple: Mango: Bottlegourd



Apple: Pear: Mango: Bottlegourd

Plate 4.1 Best fruit and vegetable juice pulp blends of summer season

Table 4.11 Effect of storage on total soluble solids (°B) of apple based (two fruit) juice blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Apple (Control)	10.90	11.13	10.93	11.21	11.16	10.90	11.64
Apple: Pear (8: 2)	10.68	10.81	10.72	10.95	10.81	10.78	11.50
Apple: Jamun (9: 1)	11.50	11.76	11.69	11.89	11.78	11.69	
Apple: Mango (8: 2)	12.74	12.94	12.84	13.18	13.10	12.92	
Mean	11.46	11.66	11.55	11.81	11.71		
Grand Mean (I)	11.46	11.50		11.76			
$CD_{(0.05)}$ Juice (J)=1.06 Storage conditions (C)= NS Storage intervals (I)= NS J x I= NS J x C= NS C x I=NS J x C x I= NS							

AT= Ambient temperature (13-27°C) RT= Refrigerated temperature (0-4°C)

Table 4.12 Effect of storage on titratable acidity (%) of apple based (two fruit) juice blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Apple (Control)	0.30	0.31	0.31	0.33	0.31	0.31	0.35
Apple: Pear (8: 2)	0.36	0.37	0.36	0.39	0.37	0.37	0.34
Apple: Jamun (9: 1)	0.40	0.41	0.40	0.42	0.41	0.41	
Apple: Mango (8: 2)	0.28	0.29	0.28	0.31	0.29	0.29	
Mean	0.33	0.34	0.34	0.36	0.34		
Grand Mean (I)	0.33	0.34		0.35			
$CD_{(0.05)}$ Juice (J)= 0.04 Storage conditions (C)= 0.03 Storage intervals (I)= NS J x I=NS J x C= NS C x I= NS J x C x I= NS							

AT= Ambient temperature (13-27°C) RT=Refrigerated temperature (0-4°C)

Table 4.13 Effect of storage on reducing sugars (%) of apple based (two fruit) juice blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Apple (Control)	6.86	6.90	6.89	6.96	6.93	6.90	7.65
Apple: Pear (8: 2)	6.89	6.94	6.90	7.04	6.95	6.94	7.63
Apple: Jamun (9: 1)	7.77	7.83	7.80	7.87	7.84	7.81	
Apple: Mango (8: 2)	8.84	8.92	8.90	8.97	8.95	8.91	
Mean	7.59	7.65	7.62	7.71	7.67		
Grand Mean (I)	7.59	7.64		7.69			
$CD_{(0.05)}$ Juice (J)= 1.51 Storage conditions (C)= NS Storage intervals (I) = NS J x I= NS J x C= NS C x I= NS J x C x I= NS							

AT= Ambient temperature (13-27°C) RT= Refrigerated temperature (0-4°C)

4.4.1.3 Reducing sugars

The data presented in Table 4.13 reveals that reducing sugars content ranged from 6.86% to 8.84% in different apple based two fruit juice/pulp blends. Apple: mango blend contained maximum reducing sugars content as 8.84% followed by apple: jamun juice/pulp blend (7.77%). It was minimum in apple juice (6.86%) followed by apple: pear juice blend which contained 6.89% reducing sugars. No significant variation was recorded in reducing sugars content of all the treatments. An increasing trend of reducing sugars was noticed in all the blends during the storage irrespective of storage conditions. A gradual increase from an initial value of 7.59 (0 day) to 7.64 (3 month) and finally to 7.69% (6 month) was recorded during the storage. Storage conditions also did not affect the reducing sugars content as the increase was recorded from an average initial value of 7.59 to 7.65% in ambient storage as against 7.63 in refrigerated storage.

4.4.1.4 Total sugars

It is evident from the Table 4.14 that blending of juice resulted in decrease of total sugars in all the blends except apple: mango juice blend. The mean maximum total sugars content was recorded in apple: mango juice blends as 11.91% whereas it was minimum in apple: pear juice blend (9.11%). An increasing trend was recorded in total sugars content of all the blends during storage. It was recorded to increase from an average initial value of 10.29 to 10.34% during six month of storage. Temperature did not show any significant effect on the total sugars of different blends however, it resulted in an increase from average initial value of 10.29 to 10.32 at ambient temperature as against 10.31% at refrigerated conditions. Besides, interaction of various factors revealed the non-significant results for change in total sugars.

4.4.1.5 Ascorbic acid

The perusal of data in Table 4.15 indicates that ascorbic acid in apple: jamun blend and apple: mango blend improved significantly by blending of apple juice with jamun and mango juice/pulp however, apple (control) and apple: pear juice blend were found to be statistically non-significant. Average ascorbic acid content was recorded to be in the range of 4.25-10.59 mg/100 mL. The maximum ascorbic acid content was recorded in apple: jamun juice blend (10.59 mg/100 mL) while it was minimum in apple: pear juice blend (4.25 mg/100 mL).

Table 4.14 Effect of storage on total sugars (%) of apple based (two fruit) juice blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Apple (Control)	10.27	10.30	10.27	10.31	10.28	10.28	10.32
Apple: Pear (8: 2)	9.11	9.13	9.12	9.15	9.13	9.13	10.31
Apple: Jamun (9: 1)	9.87	9.91	9.89	9.96	9.93	9.91	
Apple: Mango (8: 2)	11.91	11.96	11.93	12.01	11.97	11.95	
Mean	10.29	10.33	10.30	10.36	10.33		
Grand Mean (I)	10.29	10.31		10.34			
$CD_{(0.05)}$ Juice (J)= 1.28 Storage conditions (C)= NS Storage intervals (I)= NS J x I=NS J x C= NS C x I= NS J x C x I= NS							

AT= Ambient temperature (13-27^{o}C) RT= Refrigerated temperature (0-4^{o}C)

Table 4.15 Effect of storage on ascorbic acid (mg/100 mL) of apple based (two fruit) juice blends

Juice	Storage interval (month)					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Apple (Control)	4.81	3.08	3.68	1.85	2.73	3.49	5.24
Apple: Pear (8: 2)	4.25	3.05	4.160	2.22	3.85	3.63	6.38
Apple: Jamun (9: 1)	10.59	9.25	10.35	5.14	9.92	9.31	
Apple: Mango (8: 2)	7.86	6.41	7.25	4.36	7.11	6.81	
Mean	6.88	5.45	6.36	3.39	5.90		
Grand Mean (I)	6.88	5.90		4.65			
$CD_{(0.05)}$ Juice (J)= 1.31 Storage conditions (C)= 0.95 Storage intervals (I)= 1.14 J x I= NS J x C= NS C x I= NS J x C x I= NS							

AT= Ambient temperature (13-27^{o}C) RT= Refrigerated temperature (0-4^{o}C)

Table 4.16 Effect of storage on total phenolics (mg/100 mL) of apple based (two fruit) juice blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Apple (Control)	198.25	173.85	185.67	131.59	178.51	177.69	171.87
Apple: Pear (8: 2)	199.68	171.25	196.62	168.91	185.55	186.95	195.13
Apple: Jamun (9: 1)	238.45	189.59	228.36	137.62	198.64	204.19	
Apple: Mango (8: 2)	186.64	151.57	181.62	118.09	166.59	165.19	
Mean	205.01	171.57	198.07	139.05	182.32		
Grand Mean (I)	205.01	184.82		160.69			
$CD_{(0.05)}$ Juice (J)= 7.24 Storage conditions (C)= 5.12 Storage intervals (I)= 6.27 J x I= 12.53 J x C= NS C x I= 8.86 J x C x I= NS							

AT= Ambient temperature (13-27^{o}C) RT= Refrigerated temperature (0-4^{o}C)

A decreasing trend was recorded for ascorbic acid content of all the blends during the storage irrespective of storage conditions. Average ascorbic acid content was recorded to decrease significantly from an initial value of 6.88 to 4.65 mg/ 100 mL after six month of storage, irrespective of storage conditions. The decrease was higher at ambient storage where the decrease was from 6.88 to 5.24 as against 6.38 mg/100 mL at refrigerated storage.

4.4.1.6 Total phenolics

Data showing the effect of storage interval and storage condition on the apple based two fruit juice/pulp blends are presented in Table 4.16. Total phenolic content (TPC) was found to be in the range from 186.64 to 238.45 mg/100 mL. A significant difference in the mean TPC was recorded in all the blends. It was highest in apple: jamun juice/pulp blend (238.45 mg/100 mL) while lowest in apple: mango blend (186.64 mg/100 mL). A gradual decrease in the TPC was recorded from a mean initial value of 205.01 to 160.69 with the advancement of storage. TPC was found to be affected significantly by storage condition. It decreased from an average initial value of 205.01 to 171.87 at ambient storage against 195.13 at refrigerated conditions. Maximum decrease in TPC (41.69%) was recorded in apple: jamun juice blend under ambient condition at six month of storage which was comparatively lower (15.83%) at refrigerated storage condition.

4.4.1.7 Antioxidant activity

Data on the effect of storage on the antioxidant activity (AA) of apple based two fruit juice/pulp blends are presented in Table 4.17. The antioxidant activity ranged from 72.15 to 75.15% in different blends. No significant differences were observed in the AA of different juice/pulp blends. Storage intervals imposed a significant effect on the antioxidant activity of all the blends. The AA was observed to decrease from an average mean value of 74.34 (0 day) to 70.54 (6 month) during storage. Changes were lower at ambient temperature as compared to refrigerated temperature in case of all blends where AA reduced from 73.34 to 72.33

at ambient temperature and from 73.34 to 71.52 at refrigerated temperature. Similar trends were recorded in all the juice blends. Besides this, interaction of various factors revealed the non-significant results for change in antioxidant activity.

Table 4.17 Effect of storage on antioxidant activity (%) of apple based (two fruit) juice blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Apple (Control)	72.15	71.78	70.47	70.56	68.34	70.66	72.33
Apple: Pear (8: 2)	72.89	71.97	70.93	70.12	69.02	70.99	71.52
Apple: Jamun (9: 1)	75.15	73.73	72.85	72.87	72.28	73.28	
Apple: Mango (8: 2)	73.17	72.25	71.21	71.33	69.80	71.55	
Mean	73.34	72.43	71.37	71.22	69.86		
Grand Mean (I)	73.34	71.90		70.54			
$CD_{(0.05)}$ Juice (J)= NS Storage conditions (C)= NS Storage intervals (I)= 1.95 J x I= NS J x C= NS C x I= NS J x C x I= NS							

AT= Ambient temperature (13-27^{o}C) RT= Refrigerated temperature (0-4^{o}C)

Table 4.18 Effect of storage on non-enzymatic browning of apple based (two fruit) juice blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Apple (Control)	0.371	0.386	0.379	0.393	0.382	0.380	0.809
Apple: Pear (8: 2)	0.362	0.389	0.374	0.396	0.376	0.377	0.823
Apple: Jamun (9: 1)	1.453	1.321	1.417	1.215	1.389	1.375	
Apple: Mango (8: 2)	1.119	1.142	1.121	1.158	1.136	1.133	
Mean	0.826	0.810	0.823	0.791	0.821		
Grand Mean (I)	0.826	0.8161		0.8056			
$CD_{(0.05)}$ Juice (J)= 0.07 Storage conditions (C)= NS Storage intervals (I)= NS J x I= NS J x C= NS C x I= NS J x C x I= NS							

AT= Ambient temperature (13-27^{o}C) RT= Refrigerated temperature (0-4^{o}C)

Table 4.19 Effect of storage on colour of apple based (two fruit) juice blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Apple (Control)	6.00	5.90	5.90	5.80	5.90	5.92	7.18
Apple: Pear (8: 2)	7.50	7.30	7.40	7.05	7.20	7.33	7.24
Apple: Jamun (9: 1)	7.20	7.00	7.10	6.85	6.95	7.05	
Apple: Mango (8: 2)	8.70	8.50	8.60	8.30	8.4	8.53	
Mean	7.35	7.18	7.25	7.00	7.11		
Grand Mean (I)	7.35	7.21		7.06			
$CD_{(0.05)}$ Juice (J)= 1.15 Storage conditions (C)= NS Storage intervals (I)= NS J x I= NS J x C= NS C x I= NS J x C x I= NS							

AT= Ambient temperature (13-27^{o}C) RT= Refrigerated temperature (0-4^{o}C)

4.4.1.8 Non-enzymatic browning

It is clear from the data given in Table 4.18 that the non-enzymatic browning (NEB) increased with the advancement of storage period in all the blends except apple: jamun blend where the value of NEB was recorded to decrease with the storage. The NEB of all the blends varied significantly with highest value for apple: jamun blend (1.453) and the lowest for apple: pear (0.362). No significant effect of storage period and storage conditions was recorded on NEB of juices. Besides this, interaction of various factors did not impose significant changes in NEB.

4.4.1.9 Sensory quality

The colour rating was found to increase by blending of juices. It was highest (8.70) in apple: mango (8: 2) juice blend while lowest colour rating was recorded for pure apple juice. The colour rating of two fruit blends prepared using apple, pear, Jamun and mango juices/pulps showed slight decrease during storage. It was found to decrease from an initial value of 7.35 to 7.06 at six month of storage however, changes were not significant. Blends stored at refrigerated temperature had better liking than those stored at ambient temperature. It decreased from an initial value of 7.35 to 7.18 and 7.24 at ambient and refrigerated storage conditions, respectively. The colour rating was not significantly affected by various interaction factors.

Data showing the effect of storage on the flavour rating of apple based two fruit juice blends are presented in the Table 4.20. During storage the blends suffered losses in flavour score. However blends stored at low temperature were better than those stored at ambient temperature. During storage, the flavour rating was observed to decrease non-significantly from mean initial value of 7.63 to 7.39. Highest flavour rating was recorded as 9.00 (apple: mango blend) while it was lowest for apple and apple: pear (7.00). Various interaction factors did not affect the flavour during the storage irrespective of storage conditions.

Table 4.20 Effect of storage on flavour of apple based (two fruit) juice blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Apple (Control)	7.00	6.80	6.90	6.60	6.90	6.87	7.43
Apple: Pear (8: 2)	7.00	6.80	6.90	6.70	6.90	6.88	7.57
Apple: Jamun (9: 1)	7.50	7.30	7.50	7.200	7.400	7.40	
Apple: Mango (8: 2)	9.00	8.70	8.90	8.50	8.90	8.83	
Mean	7.63	7.40	7.55	7.25	7.53		
Grand Mean (I)	7.63	7.48		7.39			
$CD_{(0.05)}$ Juice (J)= 0.55 Storage conditions (C)= NS Storage intervals (I)= NS J x I= NS J x C= NS C x I= NS J x C x I= NS							

AT= Ambient temperature (13-27^{o}C) RT= Refrigerated temperature (0-4^{o}C)

Table 4.21 Effect of storage on body of apple based (two fruit) juice blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Apple (Control)	6.00	5.80	6.00	5.70	5.90	5.90	6.77
Apple: Pear (8: 2)	8.00	7.90	7.90	7.700	7.85	7.89	6.92
Apple: Jamun (9: 1)	6.00	5.50	5.80	5.25	5.75	5.72	
Apple: Mango (8: 2)	8.00	7.00	7.90	7.60	7.90	7.87	
Mean	7.00	6.55	6.90	6.56	6.85		
Grand Mean (I)	7.00	6.83		6.71			
$CD_{(0.05)}$ Juice (J)= 1.12 Storage conditions (C)= NS Storage intervals (I)= NS J x I= NS J x C= NS C x I= NS J x C x I= NS							

AT= Ambient temperature (13-27^{o}C) RT= Refrigerated temperature (0-4^{o}C)

Table 4.22 Effect of storage on overall acceptability of apple based (two fruit) juice blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Apple (Control)	6.00	5.90	5.90	5.80	5.90	5.92	7.25
Apple: Pear (8: 2)	7.10	6.90	7.10	6.80	7.00	7.00	7.36
Apple: Jamun (9: 1)	8.00	7.80	8.00	7.70	7.8	7.88	
Apple: Mango (8: 2)	8.50	8.30	8.50	8.20	8.50	8.42	
Mean	7.40	7.23	7.38	7.13	7.30		
Grand Mean (I)	7.40	7.30		7.21			
$CD_{(0.05)}$ Juice (J)= 0.53 Storage conditions (C)= NS Storage intervals (I)= NS J x I= NS J x C= NS C x I= NS J x C x I= NS							

AT= Ambient temperature (13-27^{o}C) RT= Refrigerated temperature (0-4^{o}C)

Perusal of the data presented in Table 4.21 indicated perceivable decrease in the body score of all the blends. The body score was recorded to increase with the blending however, it decreased in apple: jamun juice/pulp blend. The maximum body score was recorded for apple:

mango and apple: pear juice blends as 8.00 while it was minimum in apple: jamun blend (6.00) except control. During storage, the body score was recorded to decrease from 7.00 at 0 day to 6.71 at 6 month. Storage conditions also affected the body score of blends as more decrease was recorded at ambient storage conditions. Besides this, changes were non-significant irrespective of various interaction factors.

The overall acceptability (OAA) score of blends exhibited a gradual decrease with the advancement of storage conditions (Table 4.22). Blending exhibited a significant increase in OAA rating of different blends. Blend containing apple and mango in proportion of 8: 2 obtained superior rating (8.50) for OAA while that containing apple and sand pear in the proportion of 8: 2 obtained lowest score on Hedonic scale (7.10) for OAA except control. The storage temperature also influenced the OAA score as it was lower at ambient temperature as compared to low temperature storage. OAA rating was found to decrease from an average initial value of 7.40 to 7.21 during six month of storage however, changes were non-significant.

4.4.2 Apple based (three fruit) juice blends

4.4.2.1 Total soluble solids (TSS)

Data pertaining to the effect of storage on TSS of apple based three fruit blends are presented in Table 4.23. The maximum TSS was recorded in apple: mango: jmun blend (12.93 ^{o}B) followed by apple: pear: mango juice/pulp blend (12.49^{o}B). A gradual increase was recorded in the TSS content of all the blends during six month of storage. The TSS increased from an initial value of 11.91^{o}B to 12.27^{o}B. Storage conditions also affected the TSS content however, the increase was non-significant. No significant effect was recorded by interaction of various factors.

Table 4.23 Effect of storage on total soluble solids (°B) of apple based (three fruit) juice blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Apple (Control)	10.90	11.13	10.93	11.21	11.16	10.90	12.13
Apple: Pear: Mango (6.4: 1.6: 2)	12.49	12.67	12.58	12.88	12.74	12.64	11.98
Apple: Jamun: Pear (6.8: 1.2: 2)	11.31	11.55	11.47	11.69	11.58	11.19	
Apple: Mango: Jamun (6.8: 1.7: 1.5)	12.93	13.29	13.15	13.51	13.38	13.20	
Mean	11.91	12.16	12.03	12.32	12.22		
Grand Mean (I)	11.91	11.99		12.27			
$CD_{(0.05)}$ Juice (J)= 1.08 Storage conditions (C)= NS Storage intervals (I)= NS J X I= NS J x C= NS C x I= NS J x C x I= NS							

AT= Ambient temperature (13-27^{o}C) RT= Refrigerated temperature (0-4^{o}C)

Table 4.24 Effect of storage on titratable acidity (%) of apple based (three fruit) juice blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Apple (Control)	0.30	0.31	0.31	0.33	0.31	0.31	0.38
Apple: Pear: Mango (6.4: 1.6: 2)	0.33	0.35	0.33	0.36	0.34	0.34	0.37
Apple: Jamun: Pear (6.8: 1.2: 2)	0.41	0.42	0.42	0.43	0.42	0.42	
Apple: Mango: Jamun (6.8: 1.7: 1.5)	0.43	0.45	0.44	0.46	0.45	0.44	
Mean	0.37	0.38	0.38	0.40	0.38		
Grand Mean (I)	0.37	0.38		0.39			
$CD_{(0.05)}$ Juice (J)= 0.04 Storage conditions (C)= NS Storage intervals (I)= NS J X I= NS J x C= NS C x I= NS J x C x I= NS							

AT= Ambient temperature (13-27^{o}C) RT= Refrigerated temperature (0-4^{o}C)

Table 4.25 Effect of storage on reducing sugars (%) of apple based (three fruit) juice blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Apple (Control)	6.86	6.90	6.89	6.96	6.93	6.90	6.46
Apple: Pear: Mango (6.4: 1.6: 2)	6.24	6.29	6.27	6.33	6.30	6.28	6.45
Apple: Jamun: Pear (6.8: 1.2: 2)	6.13	6.18	6.16	6.22	6.19	6.17	
Apple: Mango: Jamun (6.8: 1.7: 1.5)	6.43	6.48	6.46	6.51	6.49	6.47	
Mean	6.42	6.46	6.45	6.51	6.48		
Grand Mean (I)	6.42	6.45		6.49			
$CD_{(0.05)}$ Juice (J)= NS Storage conditions (C)= NS Storage intervals (I)= NS J X I= NS J x C= NS C x I= NS J x C x I= NS							

AT = Ambient temperature (13-27^{o}C) RT = Refrigerated temperature (0-4^{o}C)

4.4.2.2 Titratable acidity

Data presented in Table 4.24 shows a significant difference in the titratable acidity of all the juice blends. The titratable acidity of apple juice (control) and apple: pear: mango was at par with a mean value of 0.30 and 0.33 per cent, respectively. The acidity was found to increase by the effect of blending and was recorded maximum in apple: mango: jmun blend. The titratable acidity increased marginally in various blends during storage of six month. It increased from an average initial value of 0.37 to 0.39 at six month. Increase was higher at ambient storage as compared to refrigerated storage with a mean value of 0.38 and 0.37 per cent, respectively. Interaction of various factors did not impose any significant effect on acidity of blends during storage.

4.4.2.3 Reducing sugars

Data on the **c**hange in reducing sugars content of apple based (three fruit) juice blends during storage are presented in Table 4.25. It is clear from the data that blending resulted in a gradual increase in reducing sugars content. Maximum mean reducing sugars content was recorded as 6.43% in apple: mango: jamun except apple juice (control). A slight increase was recorded in reducing sugars content of all the blends. Increase was higher at ambient storage (from initial value of 6.42% to 6.46%) as compared to refrigerated storage (from initial value of 6.41 to 6.45%). No significant effect was noticed by interaction of various factors. Maximum increase in reducing sugars content was recorded during six month storage at ambient temperature where it increased from a mean initial value of 6.42 to 6.51 per cent.

4.4.2.4 Total sugars

Total sugars content of the blends varied from 8.69 to 11.48% (Table 4.26). It is evident from the data that blending of fruit juices resulted in significant increase in total sugars content of all the blends except apple: jamun: pear blend. Highest total sugars content was recorded in apple: mango: jamun blends (11.48%) followed by apple: pear: mango blend (10.38%). A marginal increase in total sugars content of juice blends was observed depending upon storage period and conditions however, changes were not significant. Mean total sugars content of blends after six month of storage was recorded as 10.25 which increased from its initial value of 10.21 per cent.

4.4.2.5 Ascorbic acid

Effect of blending resulted in significant increase in ascorbic acid content of juice blends (Table 4.27). Ascorbic acid content varied from 4.81 to 22.15 mg/100 mL. A significant decrease in ascorbic acid content was recorded during storage which varied from an initial value of 11.59 to 10.18 mg/100 mL after six month. Reduction was more at ambient storage as compared to refrigerated storage after six month. Reduction was more at ambient storage (from 11.59 to 10.58 mg/100 mL) as compared to refrigerated storage (from 11.59 to 11.06 mg/100 mL). Maximum reduction in ascorbic acid content was recorded after six month of storage. The Interaction of factors did not show any significant effect on ascorbic acid content.

4.4.2.6 Total phenolics

Blending of apple, jamun, sand pear and mango juice/pulps resulted in significant increase in the total phenolic content of all the blends as compared to control (Table 4.28). Total phenolics content was maximum in apple: jamun: pear blend (282.18 mg/100 mL) while it was minimum in control (pure apple juice). A significant reduction was recorded in total phenolics content of all the blends however, losses were more in apple: pear: mango blend (42.10%) followed by control (33.62%) after six month of storage at ambient temperature.

4.4.2.7 Antioxidant activity

Antioxidant activity of juice blends was recorded in a range of 72.15 to 82.28 per cent (Table 4.29). Antioxidant activity of blends was increased significantly by the effect of blending. A significant decrease in the antioxidant activity of blends was observed after six month of storage from an initial value of 76.93 to 72.08%, irrespective of other interaction factors. Reduction was more during refrigerated storage as compared to ambient storage however, it was not significant.

Table 4.26 Effect of storage on total sugars (%) of apple based (three fruit) juice blends

Juice	Storage intervals (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Apple (Control)	10.27	10.30	10.27	10.31	10.27	10.28	10.24
Apple: Pear: Mango (6.4: 1.6: 2)	10.38	10.41	10.40	10.44	10.41	10.41	10.22
Apple: Jamun: Pear (6.8: 1.2: 2)	8.69	8.730	8.71	8.77	8.74	8.73	
Apple: Mango: Jamun (6.8: 1.7: 1.5)	11.48	11.52	11.51	11.56	11.53	11.52	
Mean	10.21	10.24	10.22	10.27	10.24		
Grand Mean (I)	10.21	10.23		10.25			

$CD_{(0.05)}$ Juice (J)= 0.99 Storage conditions (C)= NS Storage intervals (I)= NS J X I= NS
J x C= NS C x I= NS J x C x I= NS

AT= Ambient temperature (13-27^{o}C) RT= Refrigerated temperature (0-4^{o}C)

Table 4.27 Effect of storage on ascorbic acid (mg/100 mL) of apple based (three fruit) juice blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Apple (Control)	4.81	3.08	3.68	1.85	2.73	3.49	10.58
Apple: Pear: Mango (6.4: 1.6: 2)	9.85	9.12	9.47	8.87	9.29	9.41	11.06
Apple: Jamun: Pear (6.8: 1.2: 2)	9.53	8.86	9.24	8.59	9.08	9.14	
Apple: Mango: Jamun (6.8: 1.7: 1.5)	22.15	20.49	21.63	19.76	21.23	21.24	
Mean	11.59	10.39	11.01	9.77	10.58		
Grand Mean (I)	11.59	10.70		10.18			

$CD_{(0.05)}$ Juice (J)= 1.26 Storage conditions (C)= 0.50 Storage intervals (I)= 1.09 J X I= NS
J x C= NS C x I= NS J x C x I= NS

AT= Ambient temperature (13-27^{o}C) RT= Refrigerated temperature (0-4^{o}C)

Table 4.28 Effect of storage on total phenolics (mg/ 100 mL) of apple based (three fruit) juice blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Apple (Control)	198.25	173.85	185.67	131.59	178.51	173.57	202.91
Apple: Pear: Mango (6.4: 1.6: 2)	219.78	172.40	194.88	127.26	170.46	176.96	221.09
Apple: Jamun: Pear (6.8: 1.2: 2)	282.18	245.76	263.22	214.44	252.73	251.67	
Apple: Mango: Jamun (6.8: 1.7: 1.5)	248.42	218.27	237.19	202.73	221.79	225.68	
Mean	237.16	202.57	220.24	169.01	205.87		
Grand Mean (I)	237.16	211.41		187.44			

$CD_{(0.05)}$ Juice (J)= 6.87 Storage conditions (C)= 4.86 Storage intervals (I)= 5.95 J x I= 11.90
J x C= 9.72 C x I= 8.42 J x C x I= 16.83

AT= Ambient Temperature (13-27^{o}C) RT= Refrigerated Temperature (0-4^{o}C)

Table 4.29 Effect of storage on antioxidant activity (%) of apple based (three fruit) juice blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Apple (Control)	72.15	71.78	70.47	70.56	68.34	70.66	75.14
Apple: Pear: Mango (6.4: 1.6: 2)	76.56	74.26	73.21	72.25	69.25	73.11	73.56
Apple: Jamun: Pear (6.8: 1.2: 2)	82.28	78.31	73.93	76.00	71.62	76.43	
Apple: Mango: Jamun (6.8: 1.7: 1.5)	80.09	79.64	77.32	77.84	75.91	78.16	
Mean	76.93	75.09	73.00	73.41	70.75		
Grand Mean (I)	76.93	74.05		72.08			

$CD_{(0.05)}$ Juice (J)= 1.75 Storage conditions (C)= NS Storage intervals (I)= 1.51 J X I= 3.03
J x C= 2.47 C x I= NS J x C x I= NS

AT= Ambient temperature (13-27^{o}C) RT= Refrigerated temperature (0-4^{o}C)

4.4.2.8 Non-enzymatic browning

The overall mean non enzymatic browning (NEB) of apple based (three fruit) blends was recorded to reduce with the advancement of storage period (Table 4.30). Maximum mean NEB was recorded as 1.839 in apple: mango: jamun blend. It decreased from a mean initial value of 1.255 to 0.851 after six month. Reduction was more at ambient storage where the mean NEB value was 1.006 as against 1.082 at refrigerated storage which decreased from a mean initial value of 1.255.

Table 4.30 Effect of storage on non-enzymatic browning of apple based (three fruit) juice blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Apple (Control)	0.371	0.386	0.379	0.393	0.382	0.380	1.006
Apple: Pear: Mango (6.4: 1.6: 2)	1.350	1.365	1.342	1.372	1.354	1.356	1.082
Apple: Jamun: Pear (6.8: 1.2: 2)	1.460	0.973	1.139	0.616	0.934	1.097	
Apple: Mango: Jamun (6.8: 1.7: 1.5)	1.839	1.173	1.448	0.775	0.984	1.343	
Mean	1.255	0.974	1.077	0.789	0.914		
Grand Mean (I)	1.255	1.026		0.851			

$CD_{(0.05)}$ Juice (J)= 0.05 Storage conditions (C)= 0.04 Storage intervals (I)= 0.05 J x I= 0.09
J x C= 0.08 C x I= 0. 07 J x C x I= 0.13

AT= Ambient temperature (13-27^{o}C) RT= Refrigerated temperature (0-4^{o}C)

4.4.2.9 Sensory quality

Apple based (three fruit) blends were evaluated for the sensory attributes by a panel of 7 judges immediately after preparation and during six month of storage. The colour score of different blends are presented in Table 4.31. Maximum colour score was achieved by apple: pear: mango blend (6.4: 1.6: 2) as 8.20 followed by 7.10 for apple: mango: jamun blend. The colour score was not significantly affected with the storage period and conditions. A gradual decrease in colour score was observed after six month with a mean value of 6.77 which decreased from an average initial value of 7.08. This score was higher under refrigerated storage than that at ambient storage.

A marginal decrease in the flavour score of juice blends was recorded during storage (Table 4.32). It decreased from a mean initial value of 7.38 to 7.23 at three month and to 7.12 after six month. Changes were more at ambient storage with mean value of 7.18 as against 7.30 for refrigerated storage. However, changes were not significant irrespective of different interaction factors.

The body score of apple based (three) fruit blends are presented in Table 4.33. No significant difference in body score was recorded for all the blends. It was recorded to decrease from an average initial value of 7.55 to 7.24 after six month of storage. Storage conditions and other interaction factors did not show any significant effect on the body score of blends.

The overall acceptability score of blends varied from 6.00 to 8.70 (Table 4.34). The mean maximum overall acceptability was recorded for apple: pear: mango blend (8.70). Blending resulted in a significant increase in overall acceptability score of all the blends. Overall acceptability score of the blends experienced a marginal decrease during the six month of storage (from a mean initial value of 7.44 to 7.20 after six month). Changes were more at ambient storage with a mean value of 7.27 as against 7.36 at refrigerated storage which decreased from a mean initial value of 7.44. No significant effect of various interaction factors was observed during storage.

Table 4.31 Effect of storage on colour of apple based (three fruit) juice blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Apple (Control)	7.00	6.80	6.90	6.60	6.90	6.87	6.86
Apple: Pear: Mango (6.4: 1.6: 2)	8.20	8.00	8.10	7.90	8.05	8.08	6.97
Apple: Jamun: Pear (6.8: 1.2: 2)	6.00	5.80	5.80	5.50	5.65	5.79	
Apple: Mango: Jamun (6.8: 1.7: 1.5)	7.10	6.80	7.02	6.60	6.95	6.93	
Mean	7.08	6.85	6.96	6.65	6.89		
Grand Mean (I)	7.08	6.90		6.77			

$CD_{(0.05)}$ Juice (J)= 1.50 Storage conditions (C)= NS Storage intervals (I)= NS J x I= NS
J x C= NS C x I= NS J x C x I= NS

AT= Ambient temperature (13-27^{o}C) RT= Refrigerated temperature (0-4^{o}C)

Table 4.32 Effect of storage on flavour of apple based (three fruit) juice blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Apple (Control)	7.00	6.80	6.90	6.60	6.90	6.87	7.18
Apple: Pear: Mango (6.4: 1.6: 2)	8.50	8.30	8.43	8.20	8.38	8.39	7.30
Apple: Jamun: Pear (6.8: 1.2: 2)	6.00	5.80	5.90	5.60	5.90	5.87	
Apple: Mango: Jamun (6.8: 1.7: 1.5)	8.00	7.80	7.90	7.60	7.80	7.85	
Mean	7.38	7.18	7.28	7.00	7.25		
Grand Mean (I)	7.38	7.23		7.12			

$CD_{(0.05)}$ Juice (J)= 1.59 Storage conditions (C)= NS Storage intervals (I)= NS J X I= NS
J x C= NS C x I= NS J x C x I= NS

AT= Ambient temperature (13-27^{o}C) RT= Refrigerated temperature (0-4^{o}C)

Table 4.33 Effect of storage on body of apple based (three fruit) juice blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Apple (Control)	7.20	7.00	7.10	6.80	6.90	7.03	7.35
Apple: Pear: Mango (6.4: 1.6: 2)	8.00	7.90	7.90	7.70	7.85	7.89	7.44
Apple: Jamun: Pear (6.8: 1.2: 2)	7.00	6.70	6.85	6.50	6.70	6.79	
Apple: Mango: Jamun (6.8: 1.7: 1.5)	8.00	7.80	7.90	7.60	7.83	7.86	
Mean	7.55	7.35	7.44	7.15	7.32		
Grand Mean (I)	7.55	7.39		7.24			

$CD_{(0.05)}$ Juice (J)= NS Storage conditions (C)= NS Storage intervals (I)= NS J x I= NS
J x C= NS C x I= NS J x C x I= NS

AT= Ambient temperature (13-27^{o}C) RT= Refrigerated temperature (0-4^{o}C)

Table 4.34 Effect of storage on overall acceptability of apple based (three fruit) juice blends

Juice	Storage intervals (month)					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Apple (Control)	6.00	5.90	5.90	5.80	5.90	5.92	7.27
Apple: Pear: Mango (6.4: 1.6: 2)	8.70	8.50	8.70	8.40	8.60	8.60	7.36
Apple: Jamun: Pear (6.8: 1.2: 2)	7.25	7.03	7.13	6.80	7.00	7.08	
Apple: Mango: Jamun (6.8: 1.7:1.5)	7.80	7.60	7.70	7.50	7.63	7.67	
Mean	7.44	7.26	7.36	7.13	7.28		
Grand Mean (I)	7.44	7.31		7.20			
$CD_{(0.05)}$ Juice (J)= 1.51 Storage conditions (C)= NS Storage intervals (I)= NS J x I= NS J x C= NS C x I= NS J x C x I= NS							

AT= Ambient temperature (13-27^{o}C) RT= Refrigerated temperature (0-4^{o}C)

4.4.3 Apple: Pear and vegetable juice blends

4.4.3.1 Total soluble solids (TSS)

Total soluble solids content of apple: pear and vegetable juice blends ranged from 9.43 to 10.68^{o}B (Table 4.35). Maximum mean TSS was recorded in control (10.68 ^{o}B). A marginal increase in TSS was recorded during storage of six month. Mean TSS after six month was recorded as 10.50 which increased from an average initial value of 10.28. In control samples, the TSS increased up to three month and thereafter, it remained stable. The maximum increase in TSS was recorded at six month storage in ambient conditions where mean value was 10.54 which increased from an average initial value of 10.28. It was noticed that increase was more under ambient storage as compared to refrigerated temperature. Various interaction factors did not affect the TSS of blends significantly during the storage.

4.4.3.2 Titratable acidity

Table 4.36 shows the effect of blending and storage on titratable acidity (TA) of apple: pear and one vegetable juice blends. The TA was maximum (0.36%) in control (apple: pear blend) and minimum (0.30%) in apple: pear: bottlegourd blend. A marginal increase in the acidity of all blends was recorded during the storage of six month where increase was from an average initial value of 0.33 to 0.36% after six month irrespective of storage conditions. Various products stored at ambient temperature

Table 4.35 Effect of storage on total soluble solids (°B) of Apple: Pear and vegetable juice blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Apple: Pear (Control)	10.68	10.81	10.72	10.95	10.81	10.78	10.42
Apple: Pear: Bottlegourd (7.2: 1.8: 1)	9.43	9.60	9.50	9.68	9.62	9.54	10.36
Apple: Pear: Bittergourd (7.6: 1.9: 0.5)	10.37	10.54	10.45	10.60	10.52	10.48	
Apple: Pear: Pumpkin (7.6: 1.9: 0.5)	10.43	10.66	10.52	10.75	10.70	10.58	
Apple: Pear: Tomato (7.6: 1.9: 0.5)	10.49	10.61	10.53	10.70	10.65	10.58	
Mean	10.28	10.44	10.34	10.54	10.46		
Grand Mean (I)	10.28	10.39		10.50			
$CD_{(0.05)}$ Juice (J)= 0.29 Storage conditions (C)= NS Storage intervals (I)= NS J x I=NS J x C= NS C x I= NS J x C x I= NS							

AT= Ambient temperature (13-27°C) RT= Refrigerated temperature (0-4°C)

Table 4.36 Effect of storage on titratable acidity (%) of Apple: Pear and vegetable juice blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Apple: Pear (Control)	0.36	0.37	0.36	0.39	0.37	0.37	0.35
Apple: Pear: Bottlegourd (7.2: 1.8: 1)	0.30	0.31	0.31	0.33	0.32	0.31	0.34
Apple: Pear: Bittergourd (7.6: 1.9: 0.5)	0.33	0.34	0.34	0.36	0.35	0.34	
Apple: Pear: Pumpkin (7.6: 1.9: 0.5)	0.33	0.34	0.35	0.34	0.35	0.34	
Apple: Pear: Tomato (7.6: 1.9: 0.5)	0.35	0.36	0.36	0.38	0.37	0.36	
Mean	0.33	0.34	0.34	0.36	0.35		
Grand Mean (I)	0.33	0.34		0.36			
$CD_{(0.05)}$ Juice (J)= 0.02 Storage conditions (C)= NS Storage intervals (I)= NS J x I= NS J x C= NS C x I= NS J x C x I= NS							

AT= Ambient temperature (13-27°C) RT= Refrigerated temperature (0-4°C)

Table 4.37 Effect of storage on reducing sugars (%) of Apple: Pear and vegetable juice blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Apple: Pear (Control)	6.89	6.94	6.90	7.04	6.95	6.94	6.03
Apple: Pear: Bottlegourd (7.2: 1.8: 1)	5.22	5.27	5.25	5.32	5.28	5.26	6.01
Apple: Pear: Bittergourd (7.6: 1.9: 0.5)	5.93	5.96	5.95	6.00	5.98	5.96	
Apple: Pear: Pumpkin (7.6: 1.9: 0.5)	5.94	5.97	5.96	6.01	5.98	5.97	
Apple: Pear: Tomato (7.6: 1.9: 0.5)	5.95	5.99	5.97	6.04	6.01	5.99	
Mean	5.99	6.03	6.01	6.08	6.04		
Grand Mean (I)	5.99	6.02		6.06			
$CD_{(0.05)}$ Juice (J)= 0.68 Storage conditions (C)= NS Storage intervals (I)= NS J x I= NS J x C= NS C x I= NS J x C x I= NS							

AT= Ambient temperature (13-27°C) RT= Refrigerated temperature (0-4°C)

experienced more changes as compared to those stored at low temperature however, the changes were not significant. Interaction of other factors affected the TA of blends insignificantly**.**

4.4.3.3 Reducing sugars

Table 4.37 shows the reducing sugars content of blends which varied from 5.22 to 6.89% being maximum (6.89%) in control and minimum (5.22%) in apple: pear: bottlegourd. An increasing trend was noticed in reducing sugars during six month of storage. The reducing sugars content increased from a mean initial value of 5.99 to 6.06 after six month irrespective of storage conditions. A higher increase in reducing sugars was observed at ambient storage which was from a mean initial value of 5.99 to 6.03% as against 6.01% at refrigerated storage. Any significant effect of other interaction factors during the storage was not observed on the reducing sugars of blends.

4.4.3.4 Total sugars

Total sugars content of the blends was recorded in a range of 7.77 to 10.49% (Table 4.38). A gradual but non-significant increase in total sugars was recorded during storage. Increase was from a mean initial value of 9.05 to 9.09% after six month of storage irrespective of storage conditions. The maximum increase in the total sugars of blends was recorded after six month of ambient storage with mean value of 9.10% which increased from an average initial value of 9.05% although, the changes were not significant. The increase was more at ambient storage as compared to refrigerated storage temperature.

4.4.3.5 Ascorbic acid

Ascorbic acid content of blends varied from 3.71 to 7.18 mg/100 mL (Table 4.39). Maximum ascorbic acid content was recorded in apple: pear: bittergourd (7.18 mg/100 mL) while it was minimum in apple: pear: pumpkin (3.71 mg/100 mL). A significant decrease in ascorbic acid content (48.29%) was recorded after six month of storage which was

Table 4.38 Effect of storage on total sugars (%) of Apple: Pear and vegetable juice blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Apple: Pear (Control)	9.11	9.13	9.12	9.15	9.13	9.13	9.08
Apple: Pear: Bottlegourd (7.2: 1.8: 1)	7.77	7.80	7.78	7.85	7.80	7.80	9.06
Apple: Pear: Bittergourd (7.6: 1.9: 0.5)	8.92	8.93	8.92	8.95	8.94	8.93	
Apple: Pear: Pumpkin (7.6: 1.9: 0.5)	8.96	8.98	8.97	9.00	8.98	8.98	
Apple: Pear: Tomato (7.6: 1.9: 0.5)	10.49	10.53	10.51	10.55	10.52	10.52	
Mean	9.05	9.07	9.06	9.10	9.07		
Grand Mean (I)	9.05	9.07		9.09			
$CD_{(0.05)}$ Juice (J) = 0.66 Storage conditions (C)= NS Storage intervals (I)= NS J x I= NS J x C= NS C x I= NS J x C x I= NS							

AT= Ambient temperature (13-27^{o}C) RT= Refrigerated temperature (0-4^{o}C)

Table 4.39 Effect of storage on ascorbic acid (mg/100 mL) of Apple: Pear and vegetable juice blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Apple: Pear (Control)	5.25	3.85	4.16	3.22	3.85	4.26	3.67
Apple: Pear: Bottlegourd (7.2: 1.8: 1)	4.54	3.09	3.72	1.26	1.85	3.17	4.01
Apple: Pear: Bittergourd (7.6: 1.9: 0.5)	7.18	5.46	6.22	3.95	4.50	5.75	
Apple: Pear: Pumpkin (7.6: 1.9: 0.5)	3.71	2.68	3.11	1.26	1.87	2.72	
Apple: Pear: Tomato (7.6: 1.9: 0.5)	4.19	3.59	3.88	1.78	2.15	3.30	
Mean	4.97	3.73	4.22	2.29	2.84		
Grand Mean (I)	4.97	3.98		2.57			
$CD_{(0.05)}$ Juice (J)= 0.62 Storage conditions (C)= NS Storage intervals (I)= 0.48 J x I= NS J x C= NS C x I= NS J x C x I= NS							

AT= Ambient temperature (13-27^{o}C) RT= Refrigerated temperature (0-4^{o}C)

Table 4.40 Effect of storage on total phenolics (mg/100 mL) of Apple: Pear and vegetable juice blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Apple: Pear (Control)	199.68	171.25	196.62	168.91	185.55	184.40	168.03
Apple: Pear: Bottlegourd (7.2: 1.8: 1)	185.32	165.67	177.18	148.94	160.10	167.44	178.10
Apple: Pear: Bittergourd (7.6: 1.9: 0.5)	195.32	175.67	187.18	158.94	170.10	177.44	
Apple: Pear: Pumpkin (7.6: 1.9: 0.5)	173.89	147.49	164.70	128.33	155.30	153.94	
Apple: Pear: Tomato (7.6: 1.9: 0.5)	184.52	161.66	170.37	154.83	165.62	167.40	
Mean	187.75	164.35	179.21	151.99	167.33		
Grand Mean (I)	187.75	171.78		159.66			
$CD_{(0.05)}$ Juice (J)= 10.13 Storage conditions (C)= 6.41 Storage intervals (I)=7.85 J x I= NS J x C= NS C x I= NS J x C x I= NS							

AT= Ambient temperature (13-27^{o}C) RT= Refrigerated temperature (0-4^{o}C)

which was significantly more than that after three month (19.92%). Reduction was higher at ambient storage (26.16%) as compared to refrigerated storage (19.32%) irrespective of storage intervals. No significant effect of various interaction factors on ascorbic acid of blends was observed during storage.

4.4.3.6 Total phenolics

Total phenolics content (TPC) of blends ranged from 173.89 to 199.68 mg/100 mL (Table 4.40). Maximum total phenolics content was recorded in control (apple: pear blend) as 199.68 mg/ 100 mL while it was minimum in apple: pear: pumpkin (173.89 mg/100 mL). A significant decrease in total phenolics content of blends was recorded after six month irrespective of storage conditions. TPC was reduced significantly after six month from a mean initial value of 187.75 to 159.66 mg/100 mL. Losses were significantly higher during ambient storage (10.50%) as compared to refrigerated storage (5.14 per cent). Interaction of various factors affected the TPC during storage non-significantly.

4.4.3.7 Antioxidant activity

A significant decrease in antioxidant activity (AA) of blends was recorded during storage however, reduction was higher at refrigerated storage as compared to ambient (Table 4.41). The AA decreased from a mean initial value of 69.07 to 66.03% after six month of storage irrespective of storage conditions. A mean value of 67.76% was recorded at ambient storage as against 67.30% at refrigerated temperature which decreased from an average initial value of 69.07 per cent. Various interaction factors did not exhibit any significant effect on the antioxidant activity of juice blends.

Table 4.41 Effect of storage on antioxidant activity (%) of Apple: Pear and vegetable juice blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Apple: Pear (Control)	72.89	72.97	72.93	73.12	73.02	72.96	67.76
Apple: Pear: Bottlegourd (7.2: 1.8: 1)	63.09	62.12	61.52	61.59	60.22	61.94	67.30
Apple: Pear: Bittergourd (7.6: 1.9: 0.5)	69.15	68.24	65.42	66.15	64.00	67.02	
Apple: Pear: Pumpkin (7.6: 1.9: 0.5)	71.65	69.57	70.09	67.52	69.11	69.93	
Apple: Pear: Tomato (7.6: 1.9: 0.5)	68.57	66.53	65.47	63.21	62.33	65.78	
Mean	69.07	67.89	67.09	66.32	65.74		
Grand Mean (I)	69.07	67.49		66.03			
$CD_{(0.05)}$ Juice (J)= 2.93 Storage conditions (C)= NS Storage intervals (I)= 2.27 J x I= NS J x C= NS C x I= NS J x C x I= NS							

AT= Ambient temperature (13-27^{o}C) RT= Refrigerated temperature (0-4^{o}C)

Table 4.42 Effect of storage on non-enzymatic browning of Apple: Pear and vegetable juice blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Apple: Pear (Control)	0.362	0.389	0.374	0.396	0.376	0.377	0.995
Apple: Pear: Bottlegourd (7.2: 1.8: 1)	0.882	1.108	0.948	1.300	1.170	1.048	0.952
Apple: Pear: Bittergourd (7.6: 1.9: 0.5)	1.081	1.148	1.107	1.227	1.153	1.133	
Apple: Pear: Pumpkin (7.6: 1.9: 0.5)	1.184	1.278	1.206	1.406	1.311	1.262	
Apple: Pear: Tomato (7.6: 1.9: 0.5)	0.994	1.054	1.044	1.121	1.086	1.049	
Mean	0.901	0.995	0.936	1.090	1.019		
Grand Mean (I)	0.901	0.966		1.055			
$CD_{(0.05)}$ Juice (J)= 0.04 Storage conditions (C)= NS Storage intervals (I)= NS J x I= NS J x C= NS C x I= NS J x C x I= NS							

AT= Ambient temperature (13-27^{o}C) RT= Refrigerated temperature (0-4^{o}C)

Table 4.43 Effect of storage on colour of Apple: Pear and vegetable juice blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Apple: Pear (Control)	6.00	5.80	5.90	5.70	5.80	5.84	6.26
Apple: Pear: Bottlegourd (7.2: 1.8: 1)	6.20	6.00	6.10	5.90	6.00	6.04	6.34
Apple: Pear: Bittergourd (7.6: 1.9: 0.5)	6.30	6.10	6.20	6.00	6.10	6.14	
Apple: Pear: Pumpkin (7.6: 1.9: 0.5)	6.70	6.50	6.60	6.30	6.50	6.52	
Apple: Pear: Tomato (7.6: 1.9: 0.5)	7.00	6.80	6.90	6.70	6.80	6.84	
Mean	6.44	6.24	6.34	6.12	6.24		
Grand Mean (I)	6.44	6.29		6.18			
$CD_{(0.05)}$ Juice (J)= 0.17 Storage conditions (C)= NS Storage intervals (I)= NS J x I= NS J x C= NS C x I= NS J x C x I= NS							

AT= Ambient temperature (13-27^{o}C) RT= Refrigerated temperature (0-4^{o}C)

4.4.3.8 Non-enzymatic browning

Non-enzymatic browning (NEB) of blends differed significantly depending on the composition of blend (Table 4.42). A marginal increase in the NEB of blends was recorded during storage. After six month, the mean value of NEB was recorded as 1.055 which increased from an average initial value of 0.901. NEB was higher under ambient storage as compared to refrigerated storage. Besides, various interaction factors did not affect NEB significantly.

4.4.3.9 Sensory quality

Colour score of apple: pear and vegetable blends are presented in Table 4.43. The maximum colour score (7.00) was achieved by apple: pear: tomato blend which was significantly higher than that of all other blends. No significant changes in the colour score of all the blends were recorded during storage however, it decreased from a mean initial value of 6.44 to 6.18. Storage conditions and other interaction factors also did not affect the colour score significantly.

Flavour score of the blends ranged from 5.00 to 7.00 (Table 4.44). Maximum flavour score (7.00) was recorded for control (apple: pear blend) and apple: pear: bottlegourd blend and was minimum (5.00) for apple: pear: bittergourd. No significant effect of storage interval and conditions on flavour score of blends was observed during storage however, the changes were more at ambient storage with a mean value of 6.40 as against 6.45 at refrigerated storage which decreased from a mean initial value of 6.54. Besides, various interaction factors did not affect flavour score of blends significantly.

Body score of the apple: pear and vegetable blends are presented in Table 4.45. The maximum body score was achieved by apple: pear and apple: pear: tomato blends (8.00). Body score of the blends decreased from an initial value of 7.32 to 7.07 after six month of storage however,

Table 4.44 Effect of storage on flavour of Apple: Pear and vegetable juice blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Apple: Pear (Control)	7.00	6.80	6.90	6.70	6.80	6.87	6.40
Apple: Pear: Bottlegourd (7.2: 1.8: 1)	7.00	6.90	6.90	6.70	6.80	6.88	6.45
Apple: Pear: Bittergourd (7.6: 1.9: 0.5)	5.00	4.90	5.00	4.80	4.90	4.93	
Apple: Pear: Pumpkin (7.6: 1.9: 0.5)	6.80	6.70	6.70	6.50	6.60	6.68	
Apple: Pear: Tomato (7.6: 1.9: 0.5)	6.90	6.70	6.80	6.60	6.70	6.77	
Mean	6.54	6.40	6.46	6.26	6.36		
Grand Mean (I)	6.54	6.43		6.31			

$CD_{(0.05)}$ Juice (J)= 0.47 Storage conditions (C)= NS Storage intervals (I)= NS J x I= NS
J x C= NS C x I= NS J x C x I= NS

AT= Ambient temperature (13-27^{o}C) RT= Refrigerated temperature (0-4^{o}C)

Table 4.45 Effect of storage on body of Apple: Pear and vegetable juice blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Apple: Pear (Control)	8.00	7.80	7.90	7.70	7.80	7.84	7.15
Apple: Pear: Bottlegourd (7.2: 1.8: 1)	6.00	5.80	6.00	5.70	5.90	5.88	7.23
Apple: Pear: Bittergourd (7.6: 1.9: 0.5)	7.00	6.80	6.90	6.60	6.80	6.82	
Apple: Pear: Pumpkin (7.6: 1.9: 0.5)	7.60	7.40	7.50	7.30	7.40	7.44	
Apple: Pear: Tomato (7.6: 1.9: 0.5)	8.00	7.80	7.90	7.70	7.80	7.84	
Mean	7.32	7.12	7.24	7	7.14		
Grand Mean (I)	7.32	7.18		7.07			

$CD_{(0.05)}$ Juice (J)= 1.44 Storage conditions (C)= NS Storage intervals (I)= NS J x I= NS
J x C= NS C x I= NS J x C x I= NS

AT= Ambient temperature (13-27^{o}C) RT= Refrigerated temperature (0-4^{o}C)

Table 4.46 Effect of storage on overall acceptability of Apple: Pear and vegetable juice blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Apple: Pear (Control)	7.00	6.80	6.90	6.70	6.80	6.84	6.61
Apple: Pear: Bottlegourd (7.2: 1.8: 1)	6.90	6.80	6.80	6.60	6.70	6.76	6.67
Apple: Pear: Bittergourd (7.6: 1.9: 0.5)	5.80	5.60	5.70	5.70	5.60	5.68	
Apple: Pear: Pumpkin (7.6: 1.9: 0.5)	6.83	6.70	6.70	6.50	6.65	6.68	
Apple: Pear: Tomato (7.6: 1.9: 0.5)	7.30	7.05	7.20	6.90	7.09	7.11	
Mean	6.77	6.59	6.66	6.48	6.57		
Grand Mean (I)	6.77	6.63		6.52			

$CD_{(0.05)}$ Juice (J)= 0.43 Storage conditions (C)= NS Storage intervals (I)= NS J x I= NS
J x C= NS C x I= NS J x C x I= NS

AT= Ambient temperature (13-27^{o}C) RT= Refrigerated temperature (0-4^{o}C)

changes were not significant. More decrease in body score was recorded at ambient storage as compared to refrigerated storage.

The maximum overall acceptability score was achieved by apple: pear: tomato blend (7.30) followed by control (7.00) and apple: pear: bottlegourd (6.90) (Table 4.46). Mean overall acceptability score of the blends decreased from an average initial value of 6.77 to 6.52 after six month irrespective of storage conditions. It also decreased up to a value of 6.61 and 6.67 at ambient and refrigerated storage, respectively from a mean initial value of 6.77.

4.4.4 Apple: Jamun and vegetable juice blends

4.4.4.1 Total soluble solids (TSS)

Data showing the effect of storage on quality characteristics of apple: jamun and vegetable juice blends are presented in Table 4.47. The TSS of the different juice blends ranged from 10.70 to 11.50^{o}B. Highest total soluble content was recorded in apple: jamun: tomato (11.43^{o}B) except control while it was lowest in apple: jamun: bottlegourd (10.70^{o}B). A slight increase in the TSS content was recorded with the advancement of storage period however, increase was not significant. It increased from an average initial value of 11.24 to 11.83^{o}B at six month of storage. Increase was more at ambient storage as compared to low temperature storage. The TSS increased from mean initial value of 11.24^{o}B to 11.63^{o}B and 11.44^{o}B at ambient and refrigerated storage, respectively. Various interaction factors exhibited no significant effect on TSS content.

4.4.4.2 Titratable acidity

Titratable acidity of apple: jamun and vegetable blends varied from 0.33 to 0.40 per cent. The maximum titratable acidity (0.40%) was recorded for apple: jamun blend while minimum acidity (0.33%) was recorded for apple: jamun: Bottlegourd blend. The titratable acidity of all the blends differed significantly. The changes in titratable acidity in different blends are presented in Table 4.48. A gradual increase in titratable acidity was recorded during storage however, changes were not significant. The titratable acidity increased

Table 4.47 Effect of storage on total soluble solids (^{o}B) of Apple: Jamun and vegetable juice blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Apple: Jamun (Control)	11.50	11.76	11.69	11.89	11.78	11.69	11.63
Apple: Jamun: Bottlegourd (8.1: 0.9: 1)	10.70	11.30	10.86	11.70	11.22	11.08	11.44
Apple: Jamun: Bittergourd (8.5: 1: 0.5)	11.27	11.56	11.51	12.35	11.76	11.62	
Apple: Jamun: Pumpkin (8.5: 1: 0.5)	11.32	11.85	11.58	12.32	11.81	11.70	
Apple: Jamun: Tomato (8.5: 1: 0.5)	11.43	11.70	11.58	11.82	11.65	11.60	
Mean	11.24	11.63	11.44	12.02	11.64		
Grand Mean (I)	11.24	11.54		11.83			
$CD_{(0.05)}$ Juice (J)= NS Storage conditions (C)= NS Storage intervals (I)= 0.51 J x I= NS J x C= NS C x I= NS J x C x I= NS							

AT= Ambient temperature (13-27^{o}C) RT= Refrigerated temperature (0-4^{o}C)

Table 4.48 Effect of storage on titratable acidity (%) of Apple: Jamun and vegetable juice blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Apple: Jamun (Control)	0.40	0.41	0.40	0.42	0.41	0.41	0.38
Apple: Jamun: Bottlegourd (8.1: 0.9: 1)	0.33	0.35	0.34	0.36	0.35	0.34	0.37
Apple: Jamun: Bittergourd (8.5: 1: 0.5)	0.35	0.36	0.35	0.37	0.36	0.36	
Apple: Jamun: Pumpkin (8.5: 1: 0.5)	0.35	0.37	0.36	0.38	0.37	0.36	
Apple: Jamun: Tomato (8.5: 1: 0.5)	0.38	0.40	0.39	0.41	0.40	0.39	
Mean	0.36	0.38	0.37	0.39	0.38		
Grand Mean (I)	0.36	0.37		0.38			
$CD_{(0.05)}$ Juice (J)= 0.02 Storage conditions (C)= NS Storage intervals (I)= 0.02 J x I= NS J x C= NS C x I= NS J x C x I= NS							

AT= Ambient temperature (13-27^{o}C) RT= Refrigerated temperature (0-4^{o}C)

Table 4.49 Effect of storage on reducing sugars (%) of Apple: Jamun and vegetable juice blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Apple: Jamun (Control)	7.77	7.83	7.80	7.87	7.84	7.82	6.85
Apple: Jamun: Bottlegourd (8.1: 0.9: 1)	6.32	6.35	6.33	6.37	6.35	6.34	6.83
Apple: Jamun: Bittergourd (8.5: 1: 0.5)	6.63	6.67	6.64	6.71	6.67	6.66	
Apple: Jamun: Pumpkin (8.5: 1: 0.5)	6.69	6.73	6.71	6.75	6.73	6.72	
Apple: Jamun: Tomato (8.5: 1: 0.5)	6.66	6.68	6.67	6.70	6.68	6.68	
Mean	6.81	6.85	6.83	6.88	6.85		
Grand Mean (I)	6.81	6.84		6.87			
$CD_{(0.05)}$ Juice (J) = 0.68 Storage conditions (C) = NS Storage intervals (I)= NS J x I=NS J x C = NS C x I = NS J x C x I = NS							

AT= Ambient temperature (13-27^{o}C), RT= Refrigerated temperature (0-4^{o}C) non significantly from a mean value of 0.36 to 0.38 at six month. Storage conditions also affected the titratable acidity of blends during storage where changes were more at ambient temperature as compared to refrigerated storage. No significant effect of various interaction factors on titratable acidity was recorded during storage.

4.4.4.3 Reducing sugars

Reducing sugars content of apple: jamun and vegetable juice blends was recorded to be in a range of 6.32 to 7.77% (Table 4.49). A steady increase in reducing sugars content was recorded with the advancement of storage period however, changes were not significant. It increased from an average initial value of 6.81% to 6.87% at six month. Changes were minimum at refrigerated storage as compared to ambient. A mean value of 6.85 was recorded at ambient storage as against 6.83% at refrigerated storage.

4.4.4.4 Total sugars

Data pertaining to the effect of storage on total sugars content of apple: jamun and vegetable juice blends are presented in Table 4.50. Total sugars content of all the blends varied significantly. It was found in the range of 8.92 to 9.87 per cent. The maximum total sugars content was recorded as 9.87% in control (apple: jamun blend) followed by apple: jamun: tomato blend (9.62%). A steady increase was recorded in total sugars content of blends. Total sugars content was not significantly affected by storage period and conditions. However, maximum increase in total sugars content was recorded after six month storage at ambient conditions which increased from an average initial value of 9.50 to 9.54 per cent. Besides, various interaction factors did not affect it significantly.

4.4.4.5 Ascorbic acid

Data obtained for the effect of storage on ascorbic acid content of apple: jamun and vegetable juice blends are presented in Table 4.51. Ascorbic acid content ranged from 7.86 to 13.41 mg/100 mL with maximum content in apple: jamun: bittergourd. A significant decrease in ascorbic acid content of all the juice blends was recorded during storage of six month. It decreased from an average initial value of 10.18 to 7.03 after six month. Losses were more at ambient temperature as compared to refrigerated storage.

Table 4.50 Effect of storage on total sugars (%) of Apple: Jamun and vegetable blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Apple: Jamun (Control)	9.87	9.91	9.89	9.96	9.93	9.91	9.52
Apple: Jamun: Bottlegourd (8.1: 0.9: 1)	8.92	8.95	8.93	8.97	8.95	8.94	9.51
Apple: Jamun: Bittergourd (8.5: 1: 0.5)	9.48	9.50	9.49	9.52	9.51	9.50	
Apple: Jamun: Pumpkin (8.5: 1: 0.5)	9.59	9.63	9.61	9.65	9.62	9.62	
Apple: Jamun: Tomato (8.5: 1: 0.5)	9.62	9.64	9.64	9.66	9.64	9.64	
Mean	9.50	9.53	9.51	9.55	9.53		
Grand Mean (I)	9.50	9.52		9.54			
$CD_{(0.05)}$ Juice (J)= 0.53 Storage conditions (C)= NS Storage intervals (I)= NS J x I= NS J x C= NS C x I= NS J x C x I= NS							

AT= Ambient temperature (13-27°C) RT= Refrigerated temperature (0-4°C)

Table 4.51 Effect of storage on ascorbic acid (mg/100 mL) of Apple: Jamun and vegetable blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Apple: Jamun (Control)	7.86	6.08	7.25	4.33	7.11	6.53	8.05
Apple: Jamun: Bottlegourd (8.1: 0.9: 1)	9.67	7.11	8.15	5.76	6.30	7.40	9.03
Apple: Jamun: Bittergourd (8.5: 1: 0.5)	13.41	10.60	11.73	8.28	10.87	10.98	
Apple: Jamun: Pumpkin (8.5: 1: 0.5)	10.31	8.37	9.25	6.34	8.19	8.49	
Apple: Jamun: Tomato (8.5: 1: 0.5)	9.64	7.21	8.48	5.84	7.25	7.68	
Mean	10.18	7.87	8.97	6.11	7.94		
Grand Mean (I)	10.18	8.42		7.03			
$CD_{(0.05)}$ Juice (J) = 0.65 Storage conditions (C) = 0.41 Storage intervals (I)= 0.50 J x I=NS J x C = NS C x I = NS J x C x I = NS							

AT= Ambient temperature (13-27°C), RT= Refrigerated temperature (0-4°C)

Table 4.52 Effect of storage on total phenolics (mg/100 mL) of Apple: Jamun and vegetable blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Apple: Jamun (Control)	238.48	217.77	229.67	195.32	211.74	221.91	204.30
Apple: Jamun: Bottlegourd (8.1: 0.9: 1)	214.42	194.52	207.54	140.14	184.53	192.60	216.14
Apple: Jamun: Bittergourd (8.5: 1: 0.5)	228.28	185.64	213.12	192.09	192.84	206.37	
Apple: Jamun: Pumpkin (8.5: 1: 0.5)	224.41	209.77	218.47	181.36	203.52	210.32	
Apple: Jamun: Tomato (8.5: 1: 0.5)	235.69	216.78	220.05	189.81	219.34	219.56	
Mean	228.26	204.90	217.77	179.74	202.39		
Grand Mean (I)	228.26	211.33		191.07			
$CD_{(0.05)}$ Juice (J) = 16.49 Storage conditions (C) = 10.43 Storage intervals (I)= 12.77 J x I= NS J x C = NS C x I = NS J x C x I = NS							

AT= Ambient temperature (13-27°C), RT= Refrigerated temperature (0-4°C)

4.4.4.6 Total phenolics

Effect of blending on the total phenolics of apple: jamun blend further blended with vegetable juices/pulps are presented in Table 4.52. The maximum total phenolics content was recorded in control (apple: jamun, 9: 1) as 238.48 mg/100 mL followed by apple: jamun: tomato blend (235.69 mg/100 mL). A significant effect of storage period and conditions was noticed on total phenolics of blends as it decreased from a mean initial value of 228.26 to 191.07 mg/100 mL after six month. It decreased less during refrigerated storage as against ambient storage. No significant effect of various interaction factors on total phenolics was recorded during storage of six month.

4.4.4.7 Antioxidant activity

Antioxidant activity of different blends varied from 70.56 to 75.15% (Table 4.53). Maximum antioxidant activity was recorded as 75.15% in apple: jamun blend followed by 74.37% in apple: jamun: tomato blend. A marginal decrease in antioxidant activity of blends was recorded during storage. Reduction in antioxidant activity was less during ambient storage as compared to refrigerated storage. The maximum decrease in total phenolics content was recorded after six month with mean value was 68.90 which decreased from a mean initial value of 73.45 per cent. Various interaction factors did not affect the antioxidant activity of blends.

4.4.4.8 Total anthocyanins

Apple: jamun and vegetable blends were found to be rich in total anthocyanins content with a range of 11.78-14.25 mg/100 mL (Table 4.54). Mean maximum total anthocyanins content was recorded as 14.25 mg/100 mL in apple: jamun blend while minimum content was recorded as 11.78 mg/100 mL in apple: jamun: bottlegord blend. A significant decrease in total anthocyanins of all the blends was recorded during storage of six month. Losses were 35.65% and 42.98% after three month and six month, respectively. Maximum reduction in total anthocyanins was recorded after six month of storage at ambient temperature. The reduction was higher at ambient storage with a mean value of

8.52 as against 10.19 mg/100 mL at refrigerated storage. No significant effect of interaction factors was recorded during storage.

4.4.4.9 Non-enzymatic browning

A significant difference was noticed in non-enzymatic browning (NEB) of all the blends. A decreasing trend was noticed in non-enzymatic browning of juice blends (Table 4.55). The decrease was more at six month of storage at ambient temperature. The NEB decreased from a mean initial value of 1.485 to 0.959 at six month. It was significantly affected by storage conditions as decrease was more at ambient storage as compared to refrigerated storage. The NEB was not significantly affected by various interaction factors.

Table 4.53 Effect of storage on antioxidant activity (%) of Apple: Jamun and vegetable blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Apple: Jamun (Control)	75.15	73.73	72.28	72.36	70.40	72.78	71.55
Apple: Jamun: Bottlegourd (8.1: 0.9: 1)	70.56	69.13	68.46	67.11	66.15	68.28	70.57
Apple: Jamun: Bittergourd (8.5: 1: 0.5)	72.86	69.56	68.67	68.83	67.54	69.49	
Apple: Jamun: Pumpkin (8.5: 1: 0.5)	74.32	72.58	70.81	69.49	68.29	71.10	
Apple: Jamun: Tomato (8.5: 1: 0.5)	74.37	72.74	70.29	70.48	68.37	71.25	
Mean	73.45	71.55	70.10	69.65	68.15	72.78	
Grand Mean (I)	73.45	70.83		68.90			

$CD_{(0.05)}$ Juice (J) = 1.66 Storage conditions (C) = NS Storage intervals (I)= 1.28 J x I= NS
J x C = NS C x I = NS J x C x I = NS

AT= Ambient temperature (13-27^{o}C), RT= Refrigerated temperature (0-4^{o}C)

Table 4.54 Effect of storage on total anthocyanins (mg/100 mL) of Apple: Jamun and vegetable blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Apple: Jamun (Control)	14.25	6.35	11.85	9.54	9.58	10.31	8.52
Apple: Jamun: Bottlegourd (8.1: 0.9: 1)	11.78	5.65	8.43	3.22	6.18	7.05	10.19
Apple: Jamun: Bittergourd (8.5: 1: 0.5)	12.47	6.37	9.85	4.46	7.74	8.18	
Apple: Jamun: Pumpkin (8.5: 1: 0.5)	12.32	6.19	9.56	7.48	7.48	8.61	
Apple: Jamun: Tomato (8.5: 1: 0.5)	12.57	6.84	10.46	8.25	8.35	9.29	
Mean	12.68	6.28	10.03	6.59	7.87		
Grand Mean (I)	12.68	8.16		7.23			

$CD_{(0.05)}$ Juice (J) = 0.30 Storage conditions (C) = 0.19 Storage intervals (I)= 0.23 J x I= 0.52
J x C = 0.42 C x I = 0.33 J x C x I = 0.74

AT= Ambient temperature (13-27^{o}C), RT= Refrigerated temperature (0-4^{o}C)

Table 4.55 Effect of storage on NEB of Apple: Jamun and vegetable blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Apple: Jamun (Control)	1.453	1.321	1.417	1.215	1.389	1.359	1.159
Apple: Jamun: Bottlegourd (8.1: 0.9: 1)	1.232	0.815	0.998	0.578	0.681	0.861	1.270
Apple: Jamun: Bittergourd (8.5: 1: 0.5)	1.431	1.082	1.286	0.831	0.929	1.112	
Apple: Jamun: Pumpkin (8.5: 1: 0.5)	1.543	1.187	1.296	1.131	1.210	1.273	
Apple: Jamun: Tomato (8.5: 1: 0.5)	1.764	1.126	1.483	0.676	0.945	1.199	
Mean	1.484	1.11	1.30	0.89	1.03		
Grand Mean (I)	1.485	1.201		0.959			
$CD_{(0.05)}$ Juice (J) = 0.07 Storage conditions (C) = 0.04 Storage intervals (I)= 0.05 J x I= 0.12 J x C = NS C x I = 0.07 J x C x I = NS							

AT= Ambient temperature (13-27^{o}C), RT= Refrigerated temperature (0-4^{o}C)

4.4.4.10 Sensory quality

Table 4.56 shows the colour score for apple: jamun and vegetable blends. The colour score of the blends ranged from 7.52 to 7.85. A gradual decrease in colour score was recorded during storage. A mean colour score was recorded as 7.26 after six month which decreased from an average initial value of 7.67. More decrease in colour score was recorded at ambient storage as compared to refrigerated storage.

The flavour score of the blends varied from 6.50 to 7.80. A gradual decrease in flavour score of blends was recorded with the advancement of storage period (Table 4.57). It decreased to a mean value of 7.27 at ambient storage as against 7.33 at refrigerated storage from a mean initial value of 7.43. Insignificant effect of various interaction factors was recorded during storage.

A marginal decrease in body score of blends was recorded with the advancement of storage period (Table 4.58). Body score decreased from an average initial value of 7.98 to 7.64 after six month of storage irrespective of storage conditions.

Similarly, a gradual decrease in overall acceptability score of blends was recorded during storage of six month with mean value of 7.42 which decreased from a mean initial value of 7.76 irrespective of storage conditions (Table 4.59). The minimum changes were noticed at refrigerated storage where mean initial overall acceptability score of 7.76 decreased to 7.63 as against 7.56 at ambient storage.

Table 4.56 Effect of storage on colour of Apple: Jamun and vegetable blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Apple: Jamun (Control)	7.85	7.60	7.70	7.45	7.53	7.63	7.42
Apple: Jamun: Bottlegourd (8.1: 0.9: 1)	7.60	7.40	7.50	7.20	7.35	7.41	7.50
Apple: Jamun: Bittergourd (8.5: 1: 0.5)	7.65	7.30	7.40	7.13	7.25	7.35	
Apple: Jamun: Pumpkin (8.5: 1: 0.5)	7.52	7.25	7.40	7.00	7.20	7.27	
Apple: Jamun: Tomato (8.5: 1: 0.5)	7.72	7.40	7.50	7.20	7.30	7.42	
Mean	7.67	7.39	7.50	7.20	7.33		
Grand Mean (I)	7.67	7.45		7.26			

$CD_{(0.05)}$ Juice (J) = NS Storage conditions (C) = NS Storage intervals (I)=0.19 J x I=NS
J x C = NS C x I = NS J x C x I =NS

AT= Ambient temperature (13-27^{o}C) RT= Refrigerated temperature (0-4^{o}C)

Table 4.57 Effect of storage on flavour of Apple: Jamun and vegetable blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Apple: Jamun (Control)	7.80	7.60	7.70	7.50	7.60	7.67	7.27
Apple: Jamun: Bottlegourd (8.1: 0.9: 1)	7.65	7.50	7.60	7.30	7.50	7.53	7.33
Apple: Jamun: Bittergourd (8.5: 1: 0.5)	6.50	6.33	6.40	6.25	6.30	6.38	
Apple: Jamun: Pumpkin (8.5: 1: 0.5)	7.70	7.50	7.50	7.30	7.37	7.51	
Apple: Jamun: Tomato (8.5: 1: 0.5)	7.50	7.30	7.40	7.20	7.30	7.37	
Mean	7.43	7.25	7.32	7.11	7.21		
Grand Mean (I)	7.43	7.28		7.16			

$CD_{(0.05)}$ Juice (J) = 0.15 Storage conditions (C) = NS Storage intervals (I)=0.12 J x I=NS
J x C = NS C x I = NS J x C x I =NS

AT= Ambient temperature (13-27^{o}C), RT= Refrigerated temperature (0-4^{o}C)

Table 4.58 Effect of storage on body of Apple: Jamun and vegetable blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Apple: Jamun (Control)	7.90	7.70	7.81	7.50	7.70	7.72	7.76
Apple: Jamun: Bottlegourd (8.1: 0.9: 1)	8.15	7.90	8.05	7.73	7.81	7.93	7.86
Apple: Jamun: Bittergourd (8.5: 1: 0.5)	8.03	7.78	7.90	7.64	7.73	7.82	
Apple: Jamun: Pumpkin (8.5: 1: 0.5)	7.80	7.57	7.71	7.30	7.60	7.60	
Apple: Jamun: Tomato (8.5: 1: 0.5)	8.00	7.80	7.90	7.60	7.80	7.82	
Mean	7.98	7.75	7.87	7.55	7.73		
Grand Mean (I)	7.98	7.81		7.64			

$CD_{(0.05)}$ Juice (J)= 0.28 Storage conditions (C)= NS Storage intervals (I)= 0.20 J x I= NS
J x C= NS C x I= NS J x C x I= NS

AT= Ambient temperature (13-27^{o}C) RT= Refrigerated temperature (0-4^{o}C)

Table 4.59 Effect of storage on overall acceptability of Apple: Jamun and vegetable blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Apple: Jamun (Control)	8.00	7.80	7.90	7.63	7.75	7.82	7.56
Apple: Jamun: Bottlegourd (8.1: 0.9: 1)	8.20	7.95	8.07	7.78	7.80	7.96	7.63
Apple: Jamun: Bittergourd (8.5: 1: 0.5)	7.30	7.10	7.22	6.90	7.00	7.10	
Apple: Jamun: Pumpkin (8.5: 1: 0.5)	7.80	7.63	7.70	7.45	7.61	7.64	
Apple: Jamun: Tomato (8.5: 1: 0.5)	7.50	7.30	7.40	7.10	7.20	7.30	
Mean	7.76	7.56	7.66	7.37	7.47		
Grand Mean (I)	7.76	7.61		7.42			
$CD_{(0.05)}$ Juice (J)= 0.31 Storage conditions (C)= NS Storage intervals (I)= 0.24 J x I= NS J x C= NS C x I= NS J x C x I= NS							

AT= Ambient temperature (13-27^oC) RT= Refrigerated temperature (0-4^oC)

4.4.5 Apple: Mango and vegetable juice blends

4.4.5.1 Total soluble solids

The total soluble solids (TSS) of blends ranged from 10.16 to 12.74^{o}B (Table 4.60). The maximum TSS was recorded in control (apple: mango blend) as 12.74^{o}B while it was minimum in apple: mango: bottlegourd (10.16^{o}B). A marginal increase in TSS of blends was recorded after six month irrespective of storage conditions. After six month, the TSS increased from a mean initial value of 11.67 to 12.10^{o}B. The changes were higher during ambient storage as compared to refrigerated storage. Insignificant effect of Interaction of various factors was observed during storage.

Table 4.60 Effect of storage on total soluble solids (^{o}B) of Apple: Mango and vegetable juice blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Apple: Mango (Control)	12.74	12.94	12.84	13.18	13.10	12.92	11.94
Apple: Mango: Bottlegourd (6.4: 1.6: 2)	10.16	10.38	10.30	10.50	10.42	10.32	11.83
Apple: Mango: Bittergourd (7.6: 1.9: 0.5)	11.85	12.40	12.05	12.64	12.20	12.17	
Apple: Mango: Pumpkin (7.6: 1.9: 0.5)	12.20	12.60	12.40	12.80	12.65	12.48	
Apple: Mango: Tomato (7.6: 1.9: 0.5)	11.38	11.58	11.50	11.80	11.70	11.56	
Mean	11.67	11.98	11.82	12.18	12.01		
Grand Mean (I)	11.67	11.90		12.10			
$CD_{(0.05)}$ Juice (J)= 0.33 Storage conditions (C)= NS Storage intervals (I)= 0.25 J x I= NS J x C= NS C x I= NS J x C x I= NS							

AT= Ambient temperature (13-27^oC) RT= Refrigerated temperature (0-4^oC)

Table 4.61 Effect of storage on titratable acidity (%) of Apple: Mango and vegetable juice blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Apple: Mango (Control)	0.28	0.29	0.28	0.31	0.28	0.29	0.31
Apple: Mango: Bottlegourd (6.4: 16: 2)	0.27	0.29	0.28	0.30	0.29	0.28	0.30
Apple: Mango: Bittergourd (7.6: 19: 0.5)	0.28	0.29	0.28	0.30	0.29	0.29	
Apple: Mango: Pumpkin (7.6: 19: 0.5)	0.30	0.32	0.31	0.34	0.32	0.32	
Apple: Mango: Tomato (7.6: 1.9: 0.5)	0.32	0.33	0.33	0.35	0.34	0.33	
Mean	0.29	0.30	0.30	0.32	0.30		
Grand Mean (I)	0.29	0.30		0.31			
$CD_{(0.05)}$ Juice (J)= 0.02 Storage conditions (C)= NS Storage intervals (I)= 0.01 J x I= NS J x C= NS C x I= NS J x C x I= NS							

AT= Ambient temperature (13-27^{o}C) RT= Refrigerated temperature (0-4^{o}C)

Table 4.62 Effect of storage on reducing sugars (%) of Apple: Mango and vegetable juice blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Apple: Mango (Control)	8.84	8.92	8.96	8.97	8.95	8.91	6.47
Apple: Mango: Bottlegourd (6.4: 1.6: 2)	5.43	5.46	5.44	5.48	5.46	5.45	6.46
Apple: Mango: Bittergourd (7.6: 1.9: 0.5)	6.02	6.09	6.05	6.13	6.08	6.07	
Apple: Mango: Pumpkin (7.6: 1.9: 0.5)	6.10	6.15	6.13	6.20	6.15	6.14	
Apple: Mango: Tomato (7.6: 1.9: 0.5)	5.72	5.76	5.74	5.79	5.77	5.75	
Mean	6.42	6.48	6.46	6.51	6.48		
Grand Mean (I)	6.42	6.47		6.50			
$CD_{(0.05)}$ Juice (J)= 0.65 Storage conditions (C)= NS Storage intervals (I)= NS J x I= NS J x C= NS C x I= NS J x C x I= NS							

AT= Ambient temperature (13-27^{o}C) RT= Refrigerated temperature (0-4^{o}C)

4.4.5.2 Titratable acidity

Table 4.61 shows the effect of blending and storage on titratable acidity (TA) of apple: mango and one vegetable juice blends. The TA was maximum (0.32%) in apple: mango: tomato and minimum (0.27%) in apple: mango: bottlegourd blend. A marginal increase in the acidity of all blends was recorded during the storage of six month where increase was from an average initial value of 0.29 to 0.31% after six month irrespective of storage conditions. Products stored at ambient temperature experienced more changes as compared to those stored at low temperature however, the changes were not significant. Interaction of various other factors affected the TA of blends insignificantly.

4.4.5.3 Reducing sugars

It is clear from the Table 4.62 that the reducing sugars content of blends ranged from 5.43 to 8.84 per cent. The mean maximum reducing sugars content was recorded in apple: mango juice blend (control) as 8.84% whereas it was minimum in apple: mango: bittergourd juice blend (5.43%) followed by apple: mango: tomato (5.72 per cent). An increasing trend was recorded in reducing sugars content of all the blends during storage. It was recorded to increase from an average initial value of 6.42 to 6.50% during six month of storage. An increase from average initial value of 6.42 to 6.47% was recorded at ambient temperature as against 6.46% at refrigerated conditions. Besides, interaction of various factors revealed the non-significant results for change in reducing sugars.

4.4.5.4 Total sugars

It is evident from the Table 4.63 that blending of juice/pulp resulted in decrease of total sugars in all the blends as compared to control (apple: mango). The mean maximum total sugars content was recorded in apple: mango juice blend (control) as 11.91% whereas it was minimum in apple: mango: bittergourd juice blend (9.44%). An increasing trend was recorded in total sugars content of all the blends

Table 4.63 Effect of storage on total sugars (%) of Apple: Mango and vegetable blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Apple: Mango (Control)	11.91	11.96	11.93	12.01	11.97	11.95	10.50
Apple: Mango: Bottlegourd (6.4: 1.6: 2)	9.53	9.55	9.53	9.57	9.54	9.54	10.48
Apple: Mango: Bittergourd (7.6: 1.9: 0.5)	9.44	9.45	9.44	9.47	9.46	9.45	
Apple: Mango: Pumpkin (7.6: 1.9: 0.5)	11.08	11.15	11.11	11.20	11.16	11.13	
Apple: Mango: Tomato (7.6: 1.9: 0.5)	10.36	10.39	10.38	10.43	10.40	10.39	
Mean	10.46	10.50	10.48	10.54	10.51		
Grand Mean (I)	10.46	10.49		10.52			

$CD_{(0.05)}$ Juice (J)= 0.51 Storage conditions (C)= NS Storage intervals (I)= NS J x I= NS
J x C= NS C x I= NS J x C x I= NS

AT= Ambient temperature (13-27^{o}C) RT= Refrigerated temperature (0-4^{o}C)

Table 4.64 Effect of storage on ascorbic acid (mg/100 mL) of Apple: Mango and vegetable blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Apple: Mango (Control)	10.59	9.25	10.35	5.18	9.92	9.31	8.97
Apple: Mango: Bottlegourd (6.4: 1.6: 2)	10.16	8.52	9.05	6.23	7.91	8.67	9.85
Apple: Mango: Bittergourd (7.6: 1.9: 0.5)	11.85	9.75	10.57	7.82	8.85	10.12	
Apple: Mango: Pumpkin (7.6: 1.9: 0.5)	10.25	8.67	9.26	6.89	8.23	8.93	
Apple: Mango: Tomato (7.6: 1.9: 0.5)	11.42	9.60	10.10	8.36	9.24	10.02	
Mean	10.85	9.16	9.87	6.90	8.83		
Grand Mean (I)	10.85	9.51		7.86			
$CD_{(0.05)}$ Juice (J)= 0.65 Storage conditions (C)= 0.41 Storage intervals (I)= 0.51 J x I= NS J x C= NS C x I= NS J x C x I= NS							

AT= Ambient temperature (13-27°C) RT= Refrigerated temperature (0-4°C)

Table 4.65 Effect of storage on total phenolics (mg/100 mL) of Apple: Mango and vegetable blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Apple: Mango (Control)	186.64	151.57	181.62	118.09	166.59	165.19	156.16
Apple: Mango: Bottlegourd (6.4: 1.6: 2)	182.88	157.32	181.34	132.55	168.27	167.54	170.57
Apple: Mango: Bittergourd (7.6: 1.9: 0.5)	184.10	163.95	176.23	145.47	170.77	170.77	
Apple: Mango: Pumpkin (7.6: 1.9: 0.5)	156.06	136.22	147.63	127.86	138.19	143.67	
Apple: Mango: Tomato (7.6: 1.9: 0.5)	196.63	165.84	168.18	137.23	153.34	169.64	
Mean	181.26	154.98	171.00	132.24	159.43		
Grand Mean (I)	181.26	162.99		145.84			
$CD_{(0.05)}$ Juice (J)=10.13 Storage conditions (C)= 6.41 Storage intervals (I)= 7.85 J x I= NS J x C= NS C x I= NS J x C x I= NS							

AT= Ambient temperature (13-27°C) RT= Refrigerated temperature (0-4°C)

during storage. It was recorded to increase from an average initial value of 10.46 to 10.52% during six month of storage. The storage temperature did not show any significant effect on the total sugars of different blends however, it resulted in an increase from average initial value of 10.46 to 10.50 at ambient temperature as against 10.48% at refrigerated conditions. Besides, interaction of various factors revealed that the results for change in total sugars were insignificant.

4.4.5.5 Ascorbic acid

Table 4.64 shows the ascorbic acid content of apple: mango and vegetable blends which varied from 10.16 to 11.85 mg/100 mL. A significant decrease in ascorbic acid content of apple: mango and vegetable juice blends was recorded with the advancement of storage period. It was significantly affected by both storage intervals and conditions. The maximum decrease in ascorbic acid content was recorded in apple: mango: bottlegourd blend (14.67%) after six month of ambient storage. An overall decrease in ascorbic acid content was recorded from an averagreinitial value of 10.85 to 7.86 mg/100 mL after six month. It was significantly affected by various interaction factors also.

4.4.5.6 Total phenolics

The total phenolics content of apple: mango and vegetable juices/pulps blends are presented in Table 4.65. The Maximum total phenolics content was recorded in apple: mango: tomato as 196.63 mg/100 mL followed by control (apple: mango blend, 186.64 mg/100 mL). A significant effect of storage period and conditions was noticed on total phenolics of blends. It decreased from a mean initial value of 181.26 to 145.84 after six month. It decreased only by 5.90% under refrigerated storage as against 13.85% during ambient storage. No significant effect of various interaction factors on total phenolics was recorded during storage of six month.

4.4.5.7 Total carotenoids

The total carotenoids content in apple: mango and vegetable blends ranged from 1.24 to 1.87 mg/100 mL (Table 4.66). Maximum total carotenoids content was recorded in apple: mango: tomato (1.87 mg/100 mL) followed by apple: mango: pumpkin (1.72 mg/100 mL). A gradual decrease in total carotenoids of blends was noticed with increase in storage period however, the reduction was not significant. It was recorded to decrease from an average initial value of 1.49 to 1.43 mg/100 mL after six month. The reduction was more at ambient storage (from an average initial value of 1.49 to 1.45 mg/100 mL) as compared to refrigerated storage (from an average initial value of 1.49 to 1.47 mg/100 mL). No significant effect of various interaction factors was recorded on total carotenoids of blends.

Table 4.66 Effect of storage on total carotenoids (mg/100 mL) of Apple: Mango and vegetable blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Apple: Mango (Control)	1.36	1.34	1.35	1.33	1.34	1.35	1.45
Apple: Mango: Bottlegourd (6.4: 1.6: 2)	1.24	1.23	1.23	1.21	1.22	1.23	1.47
Apple: Mango: Bittergourd (7.6: 1.9: 0.5)	1.28	1.26	1.27	1.24	1.26	1.27	
Apple: Mango: Pumpkin (7.6: 1.9: 0.5)	1.72	1.62	1.65	1.54	1.60	1.64	
Apple: Mango: Tomato (7.6: 1.9: 0.5)	1.87	1.82	1.84	1.76	1.83	1.83	
Mean	1.49	1.45	1.47	1.42	1.45		
Grand Mean (I)	1.49	1.46		1.43			
$CD_{(0.05)}$ Juice (J)= 0.07 Storage conditions (C)= NS Storage intervals (I)= NS J x I= NS J x C= NS C x I= NS J x C x I= NS							

AT= Ambient temperature (13-27^{o}C) RT= Refrigerated temperature (0-4^{o}C)

Table 4.67 Effect of storage on antioxidant activity (%) of Apple: Mango and vegetable blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Apple: Mango (Control)	73.17	71.21	69.80	72.25	71.33	71.82	69.68
Apple: Mango: Bottlegourd (6.4: 1.6: 2)	66.81	65.36	64.11	64.29	63.59	65.16	69.21
Apple: Mango: Bittergourd (7.6: 1.9: 0.5)	73.43	71.26	70.59	69.25	68.75	71.12	
Apple: Mango: Pumpkin (7.6: 1.9: 0.5)	72.70	70.63	69.47	68.54	66.32	70.06	
Apple: Mango: Tomato (7.6: 1.9: 0.5)	72.15	69.54	67.21	67.10	66.24	69.07	
Mean	71.65	69.60	68.24	68.29	67.25		
Grand Mean (I)	71.65	69.16		67.52			
$CD_{(0.05)}$ Juice (J)= 1.19 Storage conditions (C)= NS Storage intervals (I)= 0.92 J x I= NS J x C= NS C x I= NS J x C x I= NS							

AT= Ambient temperature (13-27^{o}C) RT= Refrigerated temperature (0-4^{o}C)

Table 4.68 Effect of storage on NEB of Apple: Mango and vegetable blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Apple: Mango (Control)	1.119	1.142	1.121	1.158	1.136	1.133	1.234
Apple: Mango: Bottlegourd (6.4: 1.6: 2)	1.273	1.295	1.281	1.302	1.294	1.286	1.224
Apple: Mango: Bittergourd (7.6: 1.9: 0.5)	1.268	1.285	1.274	1.290	1.280	1.278	
Apple: Mango: Pumpkin (7.6: 1.9: 0.5)	1.445	1.472	1.456	1.480	1.463	1.460	
Apple: Mango: Tomato (7.6: 1.9: 0.5)	0.974	0.991	0.986	1.015	0.996	0.989	
Mean	1.216	1.237	1.224	1.249	1.234	1.216	
Grand Mean (I)	1.216	1.230		1.241			
$CD_{(0.05)}$ Juice (J)= 0.03 Storage conditions (C)= NS Storage intervals (I)= NS J x I= NS J x C= NS C x I= NS J x C x I= NS							

AT= Ambient temperature (13-27^{o}C) RT= Refrigerated temperature (0-4^{o}C)

4.4.5.8 Antioxidant activity

Antioxidant activity (AA) of blends (Table 4.67) ranged from 66.81 to 73.43% being maximum in apple: mango: bittergourd (73.43%) and minimum in apple: mango: bottlegourd (66.81%).With the advancement of storage period AA of blends experienced significant decrease. Mean AA up to six month was recorded as 67.52% which decreased from its average initial value of 71.65 per cent. Retention of AA was more during ambient storage as compared to refrigerated storage where AA decreased from a mean initial value of 71.65 to 69.68 at ambient storage as against 69.21% at refrigerated storage.

4.4.5.9 Non-enzymatic browning

Data showing the effect of storage on non-enzymatic browning (NEB) are presented in Table 4.68. NEB of all the blends differed significantly depending on the composition of blends. Highest NEB was recorded in apple: mango: pumpkin blend as 1.445 followed by apple: mango: bottlegourd (1.273). A marginal increase in NEB was recorded during storage. Average NEB after six month was recorded as 1.241 which increased from an average initial value of 1.216. Average NEB was recorded as 1.234 and 1.224 during six month of ambient and refrigerated storage, respectively.

4.4.5.10 Sensory quality

Table 4.69 shows the colour score for apple: mango and vegetable blends. The colour score of the blends ranged from 8.00 to 8.80. A gradual but non-significant decrease in colour score was recorded during storage. A mean colour score was recorded as 8.06 after six month which decreased from an average initial value of 8.34. More decrease in colour score was recorded at ambient storage as compared to refrigerated storage.

A gradual decrease in flavour score of blends was recorded with the advancement of storage period (Table 4.70). It decreased to a mean value of 8.06 at ambient storage from a mean initial value of 8.19 as against 8.11 at refrigerated storage. No significant effect of various interaction factors was recorded during storage.

Body score of the blends varied from 8.00 to 8.50 (Table 4.71). A marginal decrease in body score of blends was recorded with the advancement of storage period. The body score decreased from an average initial value of 8.32 to 8.07 after six month of storage irrespective of storage conditions.

Similarly, a gradual decrease in overall acceptability score of blends was recorded during storage of six month with mean value 7.07 which decreased from a mean initial value of 7.32 irrespective of storage conditions (Table 4.72). The minimum changes were noticed at refrigerated storage where mean initial overall acceptability score of 7.32 decreased to 7.23 as against 7.15 at ambient storage.

Table 4.69 Effect of storage on colour of Apple: Mango and vegetable blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Apple: Mango (Control)	8.80	8.70	8.70	8.60	8.70	8.70	8.12
Apple: Mango: Bottlegourd (6.4: 1.6: 2)	8.50	8.00	8.20	7.90	8.10	8.14	8.24
Apple: Mango: Bittergourd (7.6: 1.9: 0.5)	8.00	7.80	7.90	7.70	7.90	7.86	
Apple: Mango: Pumpkin (7.6: 1.9: 0.5)	8.20	8.00	8.10	7.90	8.00	8.04	
Apple: Mango: Tomato (7.6: 1.9: 0.5)	8.20	7.80	8.20	7.70	8.10	8.00	
Mean	8.34	8.06	8.22	7.96	8.16	8.34	
Grand Mean (I)	8.34	8.14		8.06			
$CD_{(0.05)}$ Juice (J)= NS Storage conditions (C)= NS Storage intervals (I)= NS J x I= NS J x C= NS C x I= NS J x C x I= NS							

AT= Ambient temperature (13-27^{o}C) RT= Refrigerated temperature (0-4^{o}C)

Table 4.70 Effect of storage on flavour of Apple: Mango and vegetable blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Apple: Mango (Control)	8.85	8.70	8.80	8.60	8.70	8.73	8.06
Apple: Mango: Bottlegourd (6.4: 1.6: 2)	8.70	8.60	8.70	8.50	8.60	8.62	8.11
Apple: Mango: Bittergourd (7.6: 1.9: 0.5)	7.10	6.93	7.00	6.70	6.95	6.94	
Apple: Mango: Pumpkin (7.6: 1.9: 0.5)	8.30	8.15	8.03	8.27	8.20	8.19	
Apple: Mango: Tomato (7.6: 1.9: 0.5)	8.00	7.80	7.90	7.70	7.83	7.85	
Mean	8.19	8.04	8.09	7.95	8.06		
Grand Mean (I)	8.19	8.06		8.01			
$CD_{(0.05)}$ Juice (J)= 0.51 Storage conditions (C)= NS Storage intervals (I)= NS J x I=NS J x C= NS C x I= NS J x C x I= NS							

AT= Ambient temperature (13-27^{o}C) RT= Refrigerated temperature (0-4^{o}C)

Table 4.71 Effect of storage on body of Apple: Mango and vegetable blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Apple: Mango (Control)	8.50	8.30	8.40	8.10	8.33	8.36	8.17
Apple: Mango: Bottlegourd (6.4: 1.6: 2)	8.50	8.37	8.40	8.25	8.33	8.39	8.23
Apple: Mango: Bittergourd (7.6: 1.9: 0.5)	8.40	8.30	8.35	8.15	8.27	8.31	
Apple: Mango: Pumpkin (7.6: 1.9: 0.5)	8.00	7.80	7.90	7.50	7.60	7.80	
Apple: Mango: Tomato (7.6: 1.9: 0.5)	8.20	8.10	8.10	8.05	8.10	8.13	
Mean	8.32	8.17	8.23	8.01	8.13		
Grand Mean (I)	8.32	8.20		8.07			

$CD_{(0.05)}$ Juice (J)= 0.42 Storage conditions (C)= NS Storage intervals (I)=NS J x I=NS
J x C= NS C x I= NS J x C x I=NS

AT= Ambient temperature (13-27°C) RT= Refrigerated temperature (0-4°C)

Table 4.72 Effect of storage on overall acceptability of Apple: Mango and vegetable blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Apple: Mango (Control)	8.00	7.80	7.90	7.70	7.80	7.84	7.15
Apple: Mango: Bottlegourd (6.4: 1.6: 2)	7.00	6.80	6.90	6.60	6.80	6.82	7.23
Apple: Mango: Bittergourd (7.6: 1.9: 0.5)	6.00	5.80	6.00	5.70	5.90	5.88	
Apple: Mango: Pumpkin (7.6: 1.9: 0.5)	8.00	7.80	7.90	7.70	7.80	7.84	
Apple: Mango: Tomato (7.6: 1.9: 0.5)	7.60	7.40	7.50	7.30	7.40	7.44	
Mean	7.32	7.12	7.24	7	7.14		
Grand Mean (I)	7.32	7.18		7.07			

$CD_{(0.05)}$ Juice (J)= 1.43 Storage conditions (C)= NS Storage intervals (I)= NS J x I= NS
J x C= NS C x I= NS J x C x I= NS

AT= Ambient temperature (13-27°C) RT= Refrigerated temperature (0-4°C)

4.4.6 Apple: Pear: Mango and vegetable juice blends

4.4.6.1 Total soluble solids (TSS)

Perusal of the data in Table 4.73 revealed that the total soluble solids in blends ranged from 10.30 to 12.49°B. Significant difference was recorded in TSS content of all blends. Maximum TSS was recorded in apple: pear: mango juice blend (12.49°B) while minimum value was 10.30°B in apple: pear: mango: bottlegourd blend. A gradual increase in TSS was recorded with the advancement of storage period and it increased from average initial value of 11.61 to 11.95°B after six month, irrespective of all the factors however, changes were non-significant. Juice blends stored at ambient temperature showed more increase in TSS (from an initial value of 11.61 to 11.82°B) while those stored at refrigerated temperature resulted in a minimum change (from an initial value of 11.46 to 11.75^{o}B) during storage. The interaction of various factors revealed the non-significant results for change in TSS during storage at both the temperatures.

4.4.6.2 Titratable acidity

Results obtained for the changes in titratable acidity of the blends during storage are presented in Table 4.74. A significant difference was recorded in the titratable acidity of all the treatments. The maximum mean titratable acidity (0.36%) was recorded in apple: pear: mango: tomato juice blend while minimum was recorded as 0.31% in the apple: pear: mango: bittergourd blend. A gradual increase in titratable acidity was recorded from an initial mean value of 0.33 to 0.35 after six month of storage however, changes were not significant. Changes were same at both ambient as well as refrigerated storage with an increase from mean initial value of 0.33 to 0.34% for both. Data showed that there was an increasing trend of titratable acidity in all the blends during the storage, irrespective of storage conditions.

Table 4.73 Effect of storage on total soluble solids (^{o}B) of Apple: Pear: Mango and vegetable blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Apple: Pear: Mango (Control)	12.49	12.67	12.58	12.88	12.74	12.64	11.82
Apple: Pear: Mango: Bottlegourd (5.4: 1.4:1.7: 1.5)	10.30	10.57	10.42	10.73	10.55	10.48	11.75
Apple: Pear: Mango: Bittergourd (5.8: 1.4: 1.8: 1)	11.50	11.76	11.65	11.92	11.82	11.69	
Apple: Pear: Mango: Pumpkin (6.1: 1.5: 1.9: 0.5)	12.22	12.48	12.43	12.66	12.56	12.43	
Apple: Pear: Mango: Tomato (6.1: 1.5: 1.9: 0.5)	11.54	11.71	11.64	11.84	11.77	11.67	
Mean	11.89	11.84	11.61	12.01	11.74		
Grand Mean (I)	11.61	11.79		11.95			

$CD_{(0.05)}$ Juice (J)= 0.25 Storage conditions (C)= NS Storage intervals (I)= NS J x I= NS
J x C= NS C x I= NS J x C x I= NS

AT= Ambient temperature (13-27^{o}C) RT= Refrigerated temperature (0-4^{o}C)

Table 4.74 Effect of storage on titratable acidity (%) of Apple: Pear: Mango and vegetable blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Apple: Pear: Mango (Control)	0.33	0.34	0.33	0.35	0.34	0.34	0.34
Apple: Pear: Mango: Bottlegourd (5.4: 1.4:1.7: 1.5)	0.34	0.35	0.34	0.36	0.35	0.35	0.34
Apple: Pear: Mango: Bittergourd (5.8: 1.4: 1.8: 1)	0.31	0.32	0.32	0.33	0.32	0.32	
Apple: Pear: Mango: Pumpkin (6.1: 1.5: 1.9: 0.5)	0.32	0.34	0.33	0.35	0.34	0.33	
Apple: Pear: Mango: Tomato (6.1: 1.5: 1.9: 0.5)	0.36	0.37	0.37	0.39	0.38	0.37	
Mean	0.33	0.34	0.34	0.36	0.35		
Grand Mean (I)	0.33	0.34		0.35			
$CD_{(0.05)}$ Juice (J)= 0.22 Storage conditions (C)= NS Storage intervals (I)= NS J x I= NS J x C= NS C x I= NS J x C x I= NS							

AT= Ambient temperature (13-27°C) RT= Refrigerated temperature (0-4°C)

Table 4.75 Effect of storage on reducing sugars (%) of Apple: Pear: Mango and vegetable blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Apple: Pear: Mango (Control)	6.24	6.37	6.31	6.53	6.38	6.35	6.28
Apple: Pear: Mango: Bottlegourd (5.4: 1.4:1.7: 1.5)	6.05	6.07	6.05	6.09	6.07	6.07	6.26
Apple: Pear: Mango: Bittergourd (5.8: 1.4: 1.8: 1)	6.15	6.16	6.15	6.17	6.16	6.16	
Apple: Pear: Mango: Pumpkin (6.1: 1.5: 1.9: 0.5)	6.52	6.56	6.54	6.58	6.56	6.55	
Apple: Pear: Mango: Tomato (6.1: 1.5: 1.9: 0.5)	6.21	6.24	6.23	6.26	6.25	6.24	
Mean	6.23	6.28	6.26	6.23	6.28		
Grand Mean (I)	6.23	6.27		6.31			
$CD_{(0.05)}$ Juice (J)= 0.51 Storage conditions (C)= NS Storage intervals (I)= NS J x I= NS J x C= NS C x I= NS J x C x I= NS							

AT= Ambient temperature (13-27°C) RT= Refrigerated temperature (0-4°C)

4.4.6.3 Reducing sugars

The data presented in Table 4.75 reveals that reducing sugars content ranged from 6.05 to 6.52% in different blends. Apple: pear: mango: pumpkin blend contained maximum reducing sugars content as 6.52% followed by control (6.24%). It was minimum in apple: pear: mango: bottlegourd blend (6.05%). No significant variation was recorded in reducing sugars content of all the treatments. An increasing trend of reducing sugars was noticed in all the blends during the storage, irrespective of storage conditions. A gradual increase from an initial value of 6.23 (0 day) to 6.27 (3 month) and finally to 6.31% (6 month) was recorded during the storage. Storage conditions also did not affect the reducing sugars content as the increase was recorded from an average initial value of 6.23 to 6.28% in ambient storage as against 6.26% in refrigerated storage.

4.4.6.4 Total sugars

It is evident from the Table 4.76 that total sugars content of the blends ranged from 9.56 to 10.67 per cent. The mean maximum total sugars content was recorded in apple: pear: mango: pumpkin juice blend as 10.67 per cent. An increasing trend was recorded in total sugars content of all the blends during storage. It was recorded to increase from an average initial value of 10.07 to 10.11% during six month of storage. Storage conditions did not show any significant effect on the total sugars of different blends however, it resulted in an increase from average initial value of 10.07 to 10.10 at ambient temperature as against 10.09% at refrigerated conditions. Besides, interaction of various factors revealed the non-significant results for change in total sugars.

4.4.6.5 Ascorbic acid

The perusal of data in Table 4.77 indicates that ascorbic acid content of the blends reduced significantly during storage of six month. Average ascorbic acid content was recorded to be in the range of 8.29 to 15.79 mg/100 mL. The mean maximum ascorbic acid content was recorded in apple: pear: mango: bittergourd blend (15.79 mg/100 mL)

Table 4.76 Effect of storage on total sugars (%) of Apple: Pear: Mango and vegetable blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Apple: Pear: Mango (Control)	10.38	10.41	10.40	10.44	10.41	10.41	10.10
Apple: Pear: Mango: Bottlegourd (5.4: 1.4:1.7: 1.5)	9.56	9.59	9.57	9.61	9.60	9.59	10.09
Apple: Pear: Mango: Bittergourd (5.8: 1.4: 1.8: 1)	9.62	9.64	9.63	9.67	9.65	9.64	
Apple: Pear: Mango: Pumpkin (6.1: 1.5: 1.9: 0.5)	10.67	10.70	10.69	10.72	10.70	10.70	
Apple: Pear: Mango: Tomato (6.1: 1.5: 1.9: 0.5)	10.12	10.16	10.14	10.17	10.15	10.15	
Mean	10.07	10.10	10.09	10.12	10.10		
Grand Mean (I)	10.07	10.09		10.11			
$CD_{(0.05)}$ Juice (J)= 0.86 Storage conditions (C)= NS Storage intervals (I)= NS J x I= NS J x C= NS C x I= NS J x C x I= NS							

AT= Ambient temperature (13-27^{o}C) RT= Refrigerated 15.79 temperature (0-4^{o}C)

Table 4.77 Effect of storage on ascorbic acid (mg/100 mL) of Apple: Pear: Mango and vegetable blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Apple: Pear: Mango (Control)	9.85	9.12	9.47	8.87	9.29	9.41	8.61
Apple: Pear: Mango: Bottlegourd (5.4: 1.4:1.7: 1.5)	10.58	8.62	9.33	6.35	7.85	8.89	9.50
Apple: Pear: Mango: Bittergourd (5.8: 1.4: 1.8: 1)	15.79	12.66	14.48	10.21	12.61	13.59	
Apple: Pear: Mango: Pumpkin (6.1: 1.5: 1.9: 0.5)	8.29	6.09	7.31	4.13	5.82	6.33	
Apple: Pear: Mango: Tomato (6.1: 1.5: 1.9: 0.5)	7.25	5.29	6.22	3.46	4.62	5.37	
Mean	10.65	8.52	9.58	6.74	8.28	6.69	
Grand Mean (I)	10.61	9.05		7.51			
$CD_{(0.05)}$ Juice (J)= 2.45 Storage conditions (C)= NS Storage intervals (I)= 0.84 J x I= NS J x C= NS C x I= NS J x C x I= NS							

AT= Ambient temperature (13-27°C) RT= Refrigerated temperature (0-4°C)

Table 4.78 Effect of storage on total phenolics (mg/100 mL) of Apple: Pear: Mango and vegetable blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Apple: Pear: Mango (Control)	219.78	172.40	194. 88	157.26	170.46	184.09	169.46
Apple: Pear: Mango: Bottlegourd (5.4: 1.4:1.7: 1.5)	182.85	168.46	175.17	153.13	167.33	171.63	178.78
Apple: Pear: Mango: Bittergourd (5.8: 1.4: 1.8: 1)	186.95	177.35	180.31	162.31	170.39	177.38	
Apple: Pear: Mango: Pumpkin (6.1: 1.5: 1.9: 0.5)	176.50	159.64	168.27	146.55	157.62	164.18	
Apple: Pear: Mango: Tomato (6.1: 1.5: 1.9: 0.5)	189.32	164.12	178.37	155.23	163.48	173.31	
Mean	191.08	168.39	179.40	148.90	165.86		
Grand Mean (I)	191.08	173.90		157.38			
$CD_{(0.05)}$ Juice (J)= 10.42 Storage conditions (C)= 6.59 Storage intervals (I)= 8.07 J x I= 18.04 J x C= NS C x I= NS J x C x I= NS							

AT= Ambient temperature (13-27°C) RT= Refrigerated temperature (0-4°C)

while it was minimum in apple: pear: mango: tomato (7.25 mg/100 mL) followed by apple: pear: mango: tomato blend. A decreasing trend was recorded for ascorbic acid content of all the blends during the storage irrespective of storage conditions. Average ascorbic acid content was recorded to decrease significantly from an initial value of 10.61 to 7.51 mg/ 100 mL after six month of storage, irrespective of storage conditions. The decrease was higher at ambient storage where the decrease was from 10.61 to 8.61 as against 9.50 mg/100 mL at refrigerated storage.

4.4.6.6 Total phenolics

Data showing the effect of storage interval and storage condition on total phenolics of apple: pear: mango and vegetable blends are presented in Table

4.78. Total phenolics content (TPC) was found to be in the range from 176.50 to 219.78 mg/100 mL. A significant difference in the mean TPC was recorded in all the blends. It was highest in control (219.78 mg/100 mL) while lowest in apple: pear: mango: pumpkin (176.50 mg/100 mL). A gradual decrease in the TPC was recorded from a mean initial value of 191.08 to 157.38 mg/100 mL at the end of storage. TPC was found to be affected significantly by storage condition. It decreased from an average initial value of 191.08 to 169.46 at ambient storage against 178.78 mg/100 mL at refrigerated conditions. A significant effect of various interaction factors was recorded on total phenolics content.

4.4.6.7 Total carotenoids

Total carotenoids content of the blends ranged from 1.08 to 1.47 mg/100 mL (Table 4.79). It was maximum in apple: pear: mango: tomato blend (1.47 mg/100 mL) while minimum in apple: pear: mango: bottlegourd blend (1.08 mg/100 mL). It decreased marginally during the storage from a mean initial value of 1.25 to 1.22 mg/100 mL after six month, irrespective of storage conditions. Losses were more but insignificant at ambient storage as compared to refrigerated storage. Besides, interaction of various factors revealed the non-significant results for change in antioxidant activity.

Table 4.79 Effect of storage on total carotenoids (mg/100 mL) of Apple: Pear: Mango and vegetable blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Apple: Pear: Mango (Control)	1.25	1.19	1.22	1.15	1.20	1.21	1.22
Apple: Pear: Mango: Bottlegourd (5.4: 1.4:1.7: 1.5)	1.08	1.06	1.07	1.05	1.06	1.07	1.24
Apple: Pear: Mango: Bittergourd (5.8: 1.4: 1.8: 1)	1.14	1.12	1.13	1.10	1.12	1.13	
Apple: Pear: Mango: Pumpkin (6.1: 1.5: 1.9: 0.5)	1.30	1.28	1.29	1.27	1.38	1.30	
Apple: Pear: Mango: Tomato (6.1: 1.5: 1.9: 0.5)	1.47	1.45	1.46	1.43	1.44	1.45	
Mean	1.25	1.22	1.23	1.20	1.24		
Grand Mean (I)	1.25	1.23		1.22			
$CD_{(0.05)}$ Juice (J)= 0.06 Storage conditions (C)= NS Storage intervals (I)= NS J x I= NS J x C= NS C x I= NS J x C x I= NS							

AT= Ambient temperature (13-27^{o}C) RT= Refrigerated temperature (0-4^{o}C)

Table 4.80 Effect of storage on antioxidant activity (%) of Apple: Pear: Mango and vegetable blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Apple: Pear: Mango (Control)	76.56	74.26	73.21	72.25	69.25	73.11	71.13
Apple: Pear: Mango: Bottlegourd (5.4: 1.4:1.7: 1.5)	72.35	71.20	70.05	70.34	68.82	70.52	70.13
Apple: Pear: Mango: Bittergourd (5.8: 1.4: 1.8: 1)	68.04	67.30	66.41	66.52	65.13	66.91	
Apple: Pear: Mango: Pumpkin (6.1: 1.5: 1.9: 0.5)	72.57	70.88	69.22	69.31	68.10	70.44	
Apple: Pear: Mango: Tomato (6.1: 1.5: 1.9: 0.5)	73.56	71.46	70.08	70.39	68.63	71.28	
Mean	72.62	71.02	69.79	69.76	67.99		
Grand Mean (I)	72.62	70.41		69.17			
$CD_{(0.05)}$ Juice (J)= 1.35 Storage conditions (C)= NS Storage intervals (I)= 1.23 J x I= NS J x C= NS C x I= NS J x C x I= NS							

AT= Ambient temperature (13-27^oC) RT= Refrigerated temperature (0-4^oC)

Table 4.81 Effect of storage on non-enzymatic browning of Apple: Pear: Mango and vegetable blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Apple: Pear: Mango (Control)	1.350	1.365	1.342	1.372	1.354	1.357	0.955
Apple:Pear:Mango:Bottlegourd (5.4: 1.4:1.7: 1.5)	0.778	0.786	0.783	0.791	0.789	0.785	0.950
Apple: Pear: Mango: Bittergourd (5.8: 1.4: 1.8: 1)	0.853	0.862	0.857	0.873	0.863	0.862	
Apple: Pear: Mango: Pumpkin (6.1: 1.5: 1.9: 0.5)	0.879	0.884	0.879	0.891	0.884	0.883	
Apple: Pear: Mango: Tomato (6.1: 1.5: 1.9: 0.5)	0.872	0.881	0.877	0.887	0.882	0.880	
Mean	0.946	0.956	0.948	0.963	0.954		
Grand Mean (I)	0.946	0.952		0.959			
$CD_{(0.05)}$ Juice (J)= 0.01 Storage conditions (C)= NS Storage intervals (I)= NS J x I= NS J x C= NS C x I= NS J x C x I= NS							

AT= Ambient temperature (13-27^oC) RT= Refrigerated temperature (0-4^oC)

4.4.6.8 Antioxidant activity

Data on the effect of storage on the antioxidant activity (AA) of blends are presented in Table 4.80. The antioxidant activity ranged from 68.04 to 76.56% in different blends. No significant differences were observed in the AA of different juice/pulp blends. Storage intervals imposed a significant effect on the antioxidant activity of all the blends. The AA was observed to decrease from an average mean value of 72.62 (0 day) to 69.17 per cent (6 month) during storage. Changes were lower at ambient temperature as compared to refrigerated temperature in case of all blends where AA reduced from 72.62 to 71.13% at ambient temperature as against 70.13% at refrigerated temperature. Similar trend in AA was recorded in all the juice blends. Besides, interaction of various factors revealed the non-significant results for change in antioxidant activity.

4.4.6.9 Non-enzymatic browning

It is clear from the data given in Table 4.81 that the non-enzymatic browning (NEB) increased with the advancement of storage period in all the blends. NEB of all the blends varied significantly with highest value for control (1.350) and the lowest for apple: pear: mango: bottlegourd (0.778). NEB increased from a mean initial value of 0.946 to 0.959 after six month. No significant effect of storage period and storage conditions was recorded on NEB of juices. Besides, interaction of various factors did not impose significant changes in NEB.

4.4.6.10 Sensory quality

The colour rating was found to increase by blending of juices (Table 4.82). It was highest (8.35) in apple: pear: mango: bittergourd juice blend while lowest colour rating was recorded for apple: pear: mango: tomato blend (8.00). The colour rating of blends exhibited a slight decrease during storage. It was found to decrease from an initial value of 8.27 to 8.01 at six month of storage however, changes were not significant. Blends stored at refrigerated temperature had better liking than those stored at ambient temperature as colour rating decreased from an initial value of 8.27 to 8.11 and 8.18 at ambient and refrigerated storage conditions, respectively. The colour rating was not significantly affected by various interaction factors.

Data showing the effect of storage on the flavour rating of juice blends are presented in the Table 4.83. During storage the blends showed reduction in flavour score. However blends stored at low temperature were better than those stored at ambient temperature. During storage, the flavour rating was observed to decrease non-significantly from mean initial value of 8.12 to 7.87. Various interaction factors did not affect the flavour during the storage irrespective of storage conditions.

Perusal of the data presented in Table 4.84 indicated an insignificant decrease in the body score of all the blends. The maximum body score was recorded for apple: pear: mango: bottlegourd blend and control as 8.50 while it was minimum in apple: pear: mango: tomato blend (8.20). During storage, the body score was recorded to decrease from 8.37 at 0 day to 8.14 at 6 month. Storage conditions also affected the body score of blends as more decrease was recorded at ambient storage conditions. Besides, changes were non-significant irrespective of various interaction factors.

The overall acceptability (OAA) score of blends exhibited a gradual decrease with the advancement of storage conditions (Table 4.85). Blending exhibited significant difference in OAA rating of different blends. Apple: pear: mango: bottlegourd blend obtained superior rating (8.50) except control (8.60) for OAA while apple: pear: mango: bittergourd obtained lowest score on Hedonic scale (7.80) for OAA. The storage temperature also influenced the OAA score as it was lower at ambient temperature as compared to low temperature storage. OAA rating was found to decrease from an average initial value of 8.22 to 7.97 during six month of storage however, changes were non-significant.

Table 4.82 Effect of storage on colour of Apple: Pear: Mango and vegetable blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Apple: Pear: Mango (Control)	8.50	8.30	8.40	8.14	8.20	8.31	8.11
Apple:Pear:Mango:Bottlegourd (5.4: 1.4:1.7: 1.5)	8.30	8.20	8.25	8.10	8.20	8.21	8.18
Apple: Pear: Mango: Bittergourd (5.8: 1.4: 1.8: 1)	8.35	8.20	8.30	8.10	8.22	8.23	
Apple: Pear: Mango: Pumpkin (6.1: 1.5: 1.9: 0.5)	8.20	8.00	8.10	7.80	8.00	8.02	
Apple: Pear: Mango: Tomato (6.1: 1.5: 1.9: 0.5)	8.00	7.84	7.90	7.60	7.70	7.81	
Mean	8.27	8.11	8.19	7.95	8.06		
Grand Mean (I)	8.27	8.15		8.01			

$CD_{(0.05)}$ Juice (J)= NS Storage conditions (C)= NS Storage intervals (I)= NS J x I= NS
J x C= NS C x I= NS J x C x I= NS

AT= Ambient temperature (13-27^{o}C) RT= Refrigerated temperature (0-4^{o}

Table 4.83 Effect of storage on flavour of Apple: Pear: Mango and vegetable blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Apple: Pear: Mango (Control)	8.72	8.60	8.75	8.50	8.62	8.64	7.98
Apple:Pear:Mango:Bottlegourd (5.4:1.4:1.7: 1.5)	8.56	8.45	8.50	8.40	8.30	8.44	8.03
Apple: Pear: Mango: Bittergourd (5.8: 1.4: 1.8: 1)	7.00	6.80	6.90	6.60	6.70	6.80	
Apple: Pear: Mango: Pumpkin (6.1: 1.5: 1.9: 0.5)	8.10	7.95	8.00	7.80	7.92	7.95	
Apple: Pear: Mango: Tomato (6.1: 1.5: 1.9: 0.5)	8.20	8.06	8.12	7.90	8.00	8.06	
Mean	8.12	7.97	8.05	7.84	7.91		
Grand Mean (I)	8.12	8.01		7.87			
$CD_{(0.05)}$ Juice (J)= 0.62 Storage conditions (C)= NS Storage intervals (I)= NS J x I= NS J x C= NS C x I= NS J x C x I= NS							

AT= Ambient temperature (13-27°C) RT= Refrigerated temperature (0-4°C)

Table 4.84 Effect of storage on body of Apple: Pear: Mango and vegetable blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Apple: Pear: Mango (Control)	8.50	8.35	8.40	8.24	8.32	8.36	8.22
Apple:Pear:Mango:Bottlegourd (5.4: 1.4:1.7: 1.5)	8.50	8.30	8.50	8.20	8.40	8.38	8.29
Apple: Pear: Mango: Bittergourd (5.8: 1.4: 1.8: 1)	8.40	8.28	8.34	8.10	8.20	8.26	
Apple: Pear: Mango: Pumpkin (6.1: 1.5: 1.9: 0.5)	8.25	8.10	8.15	8.00	8.08	8.12	
Apple: Pear: Mango: Tomato (6.1: 1.5: 1.9: 0.5)	8.20	8.04	8.10	7.90	8.00	8.05	
Mean	8.37	8.21	8.30	8.09	8.20		
Grand Mean (I)	8.37	8.26		8.14			
$CD_{(0.05)}$ Juice (J)= NS Storage conditions (C)= NS Storage intervals (I)= NS J x I= NS J x C= NS C x I= NS J x C x I=NS							

AT= Ambient temperature (13-27°C) RT= Refrigerated temperature (0-4°C)

Table 4.85 Effect of storage on overall acceptability of Apple: Pear: Mango and vegetable blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Apple: Pear: Mango (Control)	8.60	8.40	8.50	8.25	8.42	8.43	8.06
Apple: Pear: Mango: Bottlegourd (5.4: 1.4:1.7: 1.5)	8.50	8.35	8.40	8.20	8.30	8.35	8.13
Apple: Pear: Mango: Bittergourd (5.8: 1.4: 1.8: 1)	7.80	7.60	7.72	7.50	7.60	7.64	
Apple: Pear: Mango: Pumpkin (6.1: 1.5: 1.9: 0.5)	8.00	7.80	7.94	7.72	7.80	7.85	
Apple: Pear: Mango: Tomato (6.1: 1.5: 1.9: 0.5)	8.20	8.00	8.10	7.90	8.00	8.04	
Mean	8.22	8.03	8.13	7.91	8.02		
Grand Mean (I)	8.22	8.08		7.97			
$CD_{(0.05)}$ Juice (J)= 0.54 Storage conditions (C)= NS Storage intervals (I)= NS J x I= NS J x C= NS C x I= NS J x C x I= NS							

AT= Ambient temperature (13-27°C) RT= Refrigerated temperature (0-4°C)

4.4.7 Apple: Jamun: Pear and vegetable juice blends

4.4.7.1 Total soluble solids (TSS)

Perusal of the data in Table 4.86 revealed that the total soluble solids in blends ranged from 7.58 to 11.31^{o}B. Significant difference was recorded in TSS content of all blends. Maximum TSS was recorded in control (11.31^{o}B) followed by apple: jamun: pear: tomato (11.22 ^{o}B) while minimum value was recorded as 7.58^{o}B in apple: jamun: pear: bottlegourd blend. A gradual increase in TSS was recorded with the advancement of storage period and it increased from average initial value of 10.44 to 10.69^{o}B after six month, irrespective of all the factors however, changes were non-significant. Juice blends stored at ambient temperature showed more increase in TSS (from an initial value of 10.44 to 10.60^{o}B) while those stored at refrigerated temperature resulted in a minimum change (from an initial value of 10.44 to 10.54^{o}B) during storage. The interaction of various factors revealed the non-significant results for change in TSS during storage at both the temperatures.

4.4.7.2 Titratable acidity

Results obtained for the changes in titratable acidity of the blends during storage are presented in Table 4.87. A significant difference was recorded in the titratable acidity of all the treatments. The maximum mean titratable acidity (0.43%) was recorded in apple: jamun: pear: tomato juice blend while minimum was recorded as 0.27% in the Apple: Jamun: Pear: Bottlegourd blend. A gradual increase in titratable acidity was recorded from an initial mean value of 0.39 to 0.41 after six month of storage however, changes were not significant. Changes were same at both ambient storage as well as refrigerated storage with an increase from mean initial value of 0.39 to 0.40% for both. Data showed that there was an increasing trend of titratable acidity in all the blends during the storage, irrespective of storage conditions.

4.4.7.3 Reducing sugars

The data presented in Table 4.88 reveals that reducing sugars content ranged from 4.05 to 6.13% in different blends. Apple: jamun: pear blend (control) contained maximum reducing sugars content as 6.13% followed by apple: jamun: pear: tomato (6.10%). It was minimum in apple: pear: mango: bottlegourd blend (4.05%). No significant variation was recorded in reducing sugars content of all the treatments. An increasing trend of reducing sugars was noticed in all the blends during the storage, irrespective of storage conditions. A gradual increase from an initial value of 5.64 (0 day) to 5.67 (3 month) and finally to 5.69% (6 month) was recorded during the storage. Storage conditions also did not affect the reducing sugars content as the increase was recorded from an average initial value of 5.64 to 5.67% in ambient storage as against 5.66% in refrigerated storage.

Table 4.86 Effect of storage on total soluble solids (°B) of Apple: Jamun: Pear and vegetable blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Apple: Jamun: Pear (Control)	11.31	11.55	11.47	11.69	11.58	11.52	10.60
Apple: Jamun: Pear: Bottlegourd (5.4: 0.6:1.5: 2.5)	7.58	7.69	7.62	7.80	7.71	7.68	10.54
Apple: Jamun: Pear: Bittergourd (6.8: 0.8: 1.9: 0.5)	10.95	11.12	11.02	11.25	11.15	11.10	
Apple: Jamun: Pear: Pumpkin (6.8: 0.8: 1.9: 0.5)	11.13	11.35	11.24	11.48	11.38	11.32	
Apple: Jamun: Pear: Tomato (6.8: 0.8: 1.9: 0.5)	11.22	11.38	11.30	11.45	11.40	11.35	
Mean	10.44	10.62	10.53	10.73	10.64		
Grand Mean (I)	10.44	10.57		10.69			
$CD_{(0.05)}$ Juice (J)= 0.02 Storage conditions (C)= NS Storage intervals (I)= 0.01 J x I= NS J x C= NS C x I= NS J x C x I= NS							

AT= Ambient temperature (13-27°C) RT= Refrigerated temperature (0-4°C)

Table 4.87 Effect of storage on titratable acidity (%) of Apple: Jamun: Pear and vegetable blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Apple: Jamun: Pear (Control)	0.41	0.43	0.42	0.46	0.43	0.43	0.40
Apple:Jamun:Pear:Bottlegourd (5.4:0.6:1.5:2.5)	0.27	0.29	0.28	0.30	0.29	0.28	0.40
Apple:Jamun:Pear:Bittergourd (6.8:0.8: 1.9: 0.5)	0.41	0.42	0.42	0.44	0.43	0.42	
Apple: Jamun: Pear: Pumpkin (6.8: 0.8: 1.9: 0.5)	0.41	0.42	0.42	0.44	0.43	0.42	
Apple: Jamun: Pear: Tomato (6.8: 0.8: 1.9: 0.5)	0.43	0.44	0.44	0.45	0.44	0.44	
Mean	0.39	0.40	0.40	0.42	0.40		
Grand Mean (I)	0.39	0.40		0.41			
$CD_{(0.05)}$ Juice (J)= 0.02 Storage conditions (C)= NS Storage intervals (I)= NS J x I= NS J x C= NS C x I= NS J x C x I= NS							

AT= Ambient temperature (13-27°C) RT= Refrigerated temperature (0-4°C)

Table 4.88 Effect of storage on reducing sugars (%) of Apple: Pear: Mango and vegetable blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Apple: Jamun: Pear (Control)	6.13	6.18	6.16	6.22	6.19	6.17	5.67
Apple: Jamun: Pear: Bottlegourd (5.4: 0.6:1.5: 2.5)	4.05	4.08	4.07	4.03	4.10	4.07	5.66
Apple:Jamun: Pear: Bittergourd (6.8: 0.8: 1.9: 0.5)	5.93	5.95	5.94	5.97	5.96	5.95	
Apple: Jamun: Pear: Pumpkin (6.8: 0.8: 1.9: 0.5)	6.00	6.04	6.02	6.07	6.05	6.04	
Apple: Jamun: Pear: Tomato (6.8: 0.8: 1.9: 0.5)	6.10	6.13	6.12	6.16	6.14	6.13	
Mean	5.64	5.68	5.66	5.69	5.69		
Grand Mean (I)	5.64		5.67		5.69		
$CD_{(0.05)}$ Juice (J)= 0.53 Storage conditions (C)= NS Storage intervals (I)= NS J x I= NS J x C= NS C x I= NS J x C x I= NS							

AT= Ambient temperature (13-27^{o}C) RT= Refrigerated temperature (0-4^{o}C)

4.4.7.4 Total sugars

It is evident from the Table 4.89 that total sugars content of the blends ranged from 5.58 to 8.69 per cent. The mean maximum total sugars content was recorded in control (8.69%) followed by apple: jamun: pear: tomato juice blend as 8.47 per cent. An increasing trend was recorded in total sugars content of all the blends during storage. It was recorded to increase from an average initial value of 7.85 to 7.89% during six month of storage. Temperature did not show any significant effect on the total sugars of different blends however, it resulted in an increase from average initial value of 7.85 to 7.88% at ambient temperature as against 7.87% at refrigerated conditions. Besides, interaction of various factors revealed the non-significant results for change in total sugars.

4.4.7.5 Ascorbic acid

The perusal of data in Table 4.90 indicates that ascorbic acid content of the blends reduced significantly during storage of six month. Average ascorbic acid content was recorded to be in the range of 7.03 to 10.65 mg/100 mL. The mean maximum ascorbic acid content was recorded in apple: jamun: pear: mango: bittergourd blend (10.65 mg/100 mL) while it was minimum in apple: jamun: pear: pumpkin (7.03 mg/100 mL) followed by apple: jamun: pear: tomato blend (7.51 mg/100 mL). A decreasing trend was recorded for ascorbic acid content of all the blends during the storage irrespective of storage conditions. Average ascorbic acid content was recorded to decrease significantly from an initial value of 8.67 to 6.09 mg/ 100 mL after six month of storage, irrespective of storage conditions. The decrease was higher at ambient storage where the decrease was from 8.67 to 6.98 as against 7.58 mg/100 mL at refrigerated storage.

4.4.7.6 Total phenolics

Data showing the effect of storage interval and storage condition on total phenolics of apple: jamun: pear and vegetable blends are presented in Table 4.91 Total phenolics content (TPC) was found to be in the range from 169.79 to 282.18 mg/100 mL. A significant difference in the mean TPC was recorded in all the blends. It was highest in control (282.18 mg/100 mL) while lowest in apple: jamun: pear: bottlegourd (169.79 mg/100 mL). A gradual decrease in the TPC was recorded from a mean initial value of 226.24 to 185.74 mg/100 mL with the advancement of storage. TPC was found to be affected significantly by storage condition. It decreased from an average initial value of 226.24 to 203.39 at ambient storage against 215.25 mg/100 mL at refrigerated conditions. A significant effect of various interaction factors was recorded on total phenolics content.

Table 4.89 Effect of storage on total sugars (%) of Apple: Jamun: Pear and vegetable blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Apple: Jamun: Pear (Control)	8.69	8.73	8.71	8.77	8.74	8.72	7.88
Apple: Jamun: Pear: Bottlegourd (5.4: 0.6:1.5: 2.5)	5.58	5.60	5.59	5.61	5.60	5.59	7.87
Apple: Jamun: Pear: Bittergourd (6.8: 0.8: 1.9: 0.5)	8.19	8.22	8.20	8.23	8.21	8.21	
Apple: Jamun: Pear: Pumpkin (6.8: 0.8: 1.9: 0.5)	8.34	8.30	8.36	8.38	8.37	8.36	
Apple: Jamun: Pear: Tomato (6.8: 0.8: 1.9: 0.5)	8.47	8.50	8.49	8.52	8.51	8.49	
Mean	7.85	7.88	7.87	7.90	7.89		
Grand Mean (I)	7.85	7.88		7.89			

$CD_{(0.05)}$ Juice (J)= 0.32 Storage conditions (C)= NS Storage intervals (I)= NS J x I= NS
J x C= NS C x I= NS J x C x I= NS

AT= Ambient temperature (13-27^{o}C) RT= Refrigerated temperature (0-4^{o}C)

Table 4.90 Effect of storage on ascorbic acid (mg/100 mL) of Apple: Jamun: Pear and vegetable blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Apple: Jamun: Pear (Control)	9.53	8.86	9.24	8.59	9.08	9.06	6.98
Apple: Jamun: Pear: Bottlegourd (5.4: 0.6:1.5: 2.5)	8.15	6.34	7.36	4.98	5.68	6.50	7.58
Apple: Jamun: Pear: Bittergourd (6.8: 0.8: 1.9: 0.5)	10.65	7.69	8.47	5.64	7.31	7.95	
Apple: Jamun: Pear: Pumpkin (6.8: 0.8: 1.9: 0.5)	7.03	5.72	6.34	4.24	5.60	5.79	
Apple: Jamun: Pear: Tomato (6.8: 0.8: 1.9: 0.5)	7.51	5.16	6.55	4.65	5.13	5.80	
Mean	8.57	6.75	7.59	5.62	6.56		
Grand Mean (I)	8.67	7.17		6.09			

$CD_{(0.05)}$ Juice (J)= 0.50 Storage conditions (C)= 0.32 Storage intervals (I)= 0.39 J x I= 0.87
J x C= NS C x I= 0.55 J x C x I= NS

AT= Ambient temperature (13-27°C) RT= Refrigerated temperature (0-4°C)

Table 4.91 Effect of storage on total phenolics (mg/100 mL) of Apple: Jamun: Pear and vegetable blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Apple: Jamun: Pear (Control)	282.18	245.76	263.22	214.44	252.73	251.67	203.39
Apple:Jamun:Pear:Bottlegourd (5.4:0.6:1.5:2.5)	169.79	161.43	165.05	132.68	153.23	156.44	215.25
Apple:Jamun:Pear:Bittergourd (6.8:0.8: 1.9: 0.5)	223.46	219.80	216.83	165.68	205.32	206.22	
Apple: Jamun: Pear: Pumpkin (6.8: 0.8: 1.9: 0.5)	220.34	206.63	215.32	156.26	190.08	197.73	
Apple: Jamun: Pear: Tomato (6.8: 0.8: 1.9: 0.5)	237.43	240.21	221.17	174.71	212.55	217.21	
Mean	226.64	214.77	216.32	168.75	202.78		
Grand Mean (I)	226.64	215.54		185.74			

$CD_{(0.05)}$ Juice (J)= 4.81 torage conditions (C)= 3.04 Storage intervals (I)= 3.73 J x I= 8.33
J x C= NS C x I= 5.27 J x C x I= 11.78

AT= Ambient temperature (13-27°C) RT= Refrigerated temperature (0-4°C)

4.4.7.7 Total anthocyanins

Data presented in Table 4.92 reveals that total anthocyanins of apple: jamun: pear and vegetable blends ranged from 9.30 to 12.45 mg/100 mL. The mean maximum total anthocyanins content was recorded as 12.45 mg/100 mL (control) followed by 11.78 mg/100 mL (apple: jamun: pear: tomato). The mean minimum total anthocyanins content was recorded in apple: jamun: pear: bottlegourd (9.30 mg/100 mL). A significant decrease in total anthocyanins was recorded during storage. It decreased from a mean initial value of 11.37 to 8.09 mg/100 mL after six month of storage, irrespective of storage factors. Storage conditions also exhibited a significant effect on total anthocyanins of juice blends. Interaction factors also affected the total anthocyanins content significantly.

4.4.7.8 Antioxidant activity

Data on the effect of storage on the antioxidant activity (AA) of blends are presented in Table 4.93. The antioxidant activity ranged from 65.43 to 82.28% in different blends. No significant differences were observed in the AA of different juice/pulp blends. Storage intervals imposed a significant effect on the antioxidant activity of all the blends. The AA was observed to decrease from an average mean value of 72.36 (0 day) to 67.04 per cent (6 month) during storage. Changes were lower at ambient temperature as compared to refrigerated temperature in case of all blends where AA reduced from 72.36 to 69.44% at ambient temperature as against 69.40% at refrigerated temperature. Similar trends were recorded in all the juice blends. Besides, interaction of various factors revealed the non-significant results for change in antioxidant activity.

4.4.7.9 Non-enzymatic browning

It is clear from the data given in Table 4.94 that the non-enzymatic browning (NEB) of blends decreased with the advancement of storage period. NEB of all the blends varied significantly with highest value for

Table 4.92 Effect of storage on total anthocyanins (mg/100 mL) Apple: Jamun: Pear and vegetable blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Apple: Jamun: Pear (Control)	12.45	10.23	11.05	9.15	10.76	11.02	9.24
Apple:Jamun:Pear:Bottlegourd (5.4:0.6:1.5: 2.5)	9.30	7.56	8.12	5.21	6.92	7.74	9.95
Apple:Jamun:Pear:Bittergourd (6.8:0.8:1.9:0.5)	11.63	8.59	9.67	7.62	8.29	9.57	
Apple:Jamun:Pear:Pumpkin (6.8: 0.8: 1.9: 0.5)	11.67	8.73	9.88	6.96	7.83	9.46	
Apple: Jamun: Pear: Tomato (6.8: 0.8: 1.9: 0.5)	11.78	9.09	10.32	8.63	9.51	10.19	
Mean	11.37	8.84	9.81	7.51	8.66		
Grand Mean (I)	11.37	9.32		8.09			
$CD_{(0.05)}$ Juice (J)= 0.37 Storage conditions (C)= 0.23 Storage intervals (I)= 0.29 J x I= 0.64 J x C= NS C x I= 0.40 J x C x I= NS							

AT= Ambient temperature (13-27^{o}C) RT= Refrigerated temperature (0-4^{o}C)

Table 4.93 Effect of storage on antioxidant activity (%) of Apple: Jamun: Pear and vegetable blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Apple: Jamun: Pear (Control)	82.28	78.31	73.93	76.00	71.62	76.43	69.44
Apple:Jamun:Pear:Bottlegourd (5.4:0.6:1.5: 2.5)	65.43	64.12	63.44	62.09	61.36	63.65	69.40
Apple:Jamun:Pear:Bittergourd (6.8:0.8:1.9:0.5)	70.93	68.39	67.22	66.52	65.41	68.23	
Apple: Jamun: Pear: Pumpkin (6.8: 0.8: 1.9: 0.5)	71.55	68.93	67.31	66.58	65.49	68.57	
Apple: Jamun: Pear: Tomato (6.8: 0.8: 1.9: 0.5)	71.61	69.13	67.87	68.45	66.83	69.25	
Mean	72.36	68.90	68.83	67.05	67.02		
Grand Mean (I)	72.36	68.87		67.04			
$CD_{(0.05)}$ Juice (J)= 0.82 Storage conditions (C)= NS Storage intervals (I)= 0.63 J x I= 1.42 J x C= 0.90 C x I= NS J x C x I= 2.00							

AT= Ambient temperature (13-27^{o}C) RT= Refrigerated temperature (0-4^{o}C)

Table 4.94 Effect of storage on non-enzymatic browning of Apple: Jamun: Pear and vegetable blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Apple: Jamun: Pear (Control)	1.460	0.973	0.616	1.139	0.934	1.097	1.001
Apple:Jamun:Pear: Bottlegourd (5.4: 0.6:1.5: 2.5)	1.364	0.832	1.186	0.683	0.932	1.060	1.191
Apple:Jamun: Pear:Bittergourd (6.8: 0.8: 1.9: 0.5)	1.452	0.862	1.241	0.701	0.984	1.115	
Apple: Jamun: Pear: Pumpkin (6.8: 0.8: 1.9: 0.5)	1.467	0.729	0.986	0.657	0.854	1.027	
Apple: Jamun: Pear: Tomato (6.8: 0.8: 1.9: 0.5)	1.486	0.951	1.269	0.786	1.109	1.181	
Mean	1.446	0.869	1.164	0.689	0.963		
Grand Mean (I)	1.446	1.017		0.826			
$CD_{(0.05)}$ Juice (J)= 0.12 Storage conditions (C)= 0.05 Storage intervals (I)= 0.08 J x I= NS J x C= NS C x I= NS J x C x I= NS							

AT= Ambient temperature (13-27^{o}C) RT= Refrigerated temperature (0-4^{o}C)

apple: jamun: pear: tomato blend (1.486) and the lowest for apple: jamun: pear: bottlegourd (1.364). The mean NEB decreased from a mean initial value of 1.446 to 0.826 after six month of storage. A significant effect of storage period and storage conditions was recorded on NEB of juices. Besides, interaction of various factors did not impose significant changes in NEB.

4.4.7.10 Sensory quality

The colour rating was found to increase by blending of juices (Table 4.95). It was highest (7.60) in control and apple: jamun: pear: bottlegourd blend while lowest colour rating was recorded for apple: jamun: pear: bittergourd blend. The colour rating of blends showed slight decrease during storage. It was found to decrease from an initial value of 7.30 to

6.90 at six month of storage however, changes were not significant. Blends stored at refrigerated temperature had better liking than those stored at ambient temperature. It decreased from an initial value of 7.30 to 7.06 and 7.13 at ambient and refrigerated storage conditions, respectively. The colour rating was not significantly affected by various interaction factors.

Data showing the effect of storage on the flavour rating of blends are presented in the Table 4.96. During storage the blends suffered losses in flavour score. However blends stored at low temperature were better than those stored at ambient temperature. During storage, the flavour rating was observed to decrease non-significantly from mean initial value of 7.08 to 6.77. Highest flavour rating was recorded as 7.80 (apple: jamun: pear: bottlegourd blend) while it was lowest for apple: jamun: pear: bittergourd (5.50). Various interaction factors did not affect the flavour during the storage irrespective of storage conditions.

Perusal of the data presented in Table 4.97 indicates perceivable decrease in the body score of all the blends during storage. The maximum body score was recorded for apple: jamun: pear: bottlegourd blend as 7.50 while it was minimum in apple: jamun: pear: bittergourd (7.00) except control. During storage, the body score was recorded to decrease from 7.24 at 0 day to 6.97 at 6 month. Storage conditions also affected the body score of blends as more decrease was recorded at ambient storage conditions. Besides, changes were non-significant irrespective of various interaction factors.

The overall acceptability (OAA) score of blends exhibited a gradual decrease with the advancement of storage conditions (Table 4.98). Blending exhibited a significant increase in OAA rating of different blends. Apple: jamun: pear: bottlegourd blend obtained superior rating (7.80) for OAA while apple: jamun: pear: bittergourd blend obtained lowest score on Hedonic scale (6.50) for OAA except control. The storage temperature also influenced the OAA score as it was lower at ambient temperature as compared to low temperature storage. OAA rating was found to decrease from an average initial value of 7.32 to 7.02 during six month of storage however, changes were non-significant.

Table 4.95 Effect of storage on colour of Apple: Jamun: Pear and vegetable blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Apple: Jamun: Pear (Control)	7.60	7.30	7.40	7.00	7.20	7.30	7.06
Apple: Jamun: Pear: Bottlegourd (5.4: 0.6:1.5: 2.5)	7.60	7.30	7.40	7.20	7.30	7.36	7.13
Apple: Jamun:Pear: Bittergourd (6.8: 0.8: 1.9: 0.5)	7.10	6.90	7.00	6.70	6.80	6.90	
Apple: Jamun: Pear: Pumpkin (6.8: 0.8: 1.9: 0.5)	7.00	6.70	6.80	6.50	6.60	6.72	
Apple: Jamun: Pear: Tomato (6.8: 0.8: 1.9: 0.5)	7.20	7.00	7.10	6.80	6.90	7.00	
Mean	7.30	7.04	7.14	6.84	6.96		
Grand Mean (I)	7.30	7.09		6.90			

$CD_{(0.05)}$ Juice (J)= NS Storage conditions (C)= NS Storage intervals (I)= 0.37 J x I= NS
J x C= NS C x I= NS J x C x I= NS

AT= Ambient temperature (13-27^{o}C) RT= Refrigerated temperature (0-4^{o}C)

Table 4.96 Effect of storage on flavour of Apple: Jamun: Pear and vegetable blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Apple: Jamun: Pear (Control)	7.80	7.60	7.70	7.40	7.50	7.60	6.89
Apple: Jamun: Pear: Bottlegourd (5.4: 0.6:1.5: 2.5)	7.90	7.70	7.80	7.60	7.70	7.74	6.96
Apple: Jamun:Pear:Bittergourd (6.8: 0.8: 1.9: 0.5)	5.50	5.30	5.40	5.10	5.20	5.30	
Apple: Jamun: Pear: Pumpkin (6.8: 0.8: 1.9: 0.5)	7.20	7.00	7.10	6.80	6.90	7.00	
Apple: Jamun: Pear: Tomato (6.8: 0.8: 1.9: 0.5)	7.00	6.80	6.90	6.70	6.82	6.84	
Mean	7.08	6.88	6.98	6.72	6.82		
Grand Mean (I)	7.08	6.93		6.77			

$CD_{(0.05)}$ Juice (J)= 0.65 Storage conditions (C)= NS Storage intervals (I)= NS J x I= NS
J x C= NS C x I= NS J x C x I= NS

AT= Ambient temperature (13-27^{o}C) RT= Refrigerated temperature (0-4^{o}C)

Table 4.97 Effect of storage on body of Apple: Jamun: Pear and vegetable blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Apple: Jamun: Pear (Control)	7.20	7.00	7.12	6.80	7.00	7.02	7.06
Apple: Jamun: Pear: Bottlegourd (5.4: 0.6:1.5: 2.5)	7.50	7.20	7.30	7.10	7.20	7.26	7.13
Apple: Jamun:Pear:Bittergourd (6.8: 0.8: 1.9: 0.5)	7.00	6.80	6.90	6.60	6.84	6.83	
Apple: Jamun: Pear: Pumpkin (6.8: 0.8: 1.9: 0.5)	7.30	7.10	7.15	6.95	7.04	7.11	
Apple: Jamun: Pear: Tomato (6.8: 0.8: 1.9: 0.5)	7.20	7.10	7.18	7.02	7.10	7.12	
Mean	7.24	7.04	7.13	6.89	7.04		
Grand Mean (I)	7.24	7.09		6.97			

$CD_{(0.05)}$ Juice (J)= NS Storage conditions (C)= NS Storage intervals (I)= NS J x I= NS
J x C= NS C x I= NS J x C x I= NS

AT= Ambient temperature (13-27^{o}C) RT= Refrigerated temperature (0-4^{o}C)

Table 4.98 Effect of storage on overall acceptability of Apple: Jamun: Pear and vegetable blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Apple: Jamun: Pear (Control)	7.60	7.40	7.50	7.20	7.30	7.40	7.14
Apple: Jamun:Pear:Bottlegourd (5.4: 0.6:1.5: 2.5)	7.80	7.65	7.70	7.42	7.57	7.63	7.20
Apple: Jamun:Pear:Bittergourd (6.8: 0.8: 1.9: 0.5)	6.50	6.27	6.35	6.10	6.20	6.28	
Apple: Jamun: Pear: Pumpkin (6.8: 0.8: 1.9: 0.5)	7.50	7.40	7.35	7.20	7.30	7.35	
Apple: Jamun: Pear: Tomato (6.8: 0.8: 1.9: 0.5)	7.20	7.00	7.10	6.92	7.00	7.04	
Mean	7.32	7.14	7.20	6.97	7.07		
Grand Mean (I)	7.32	7.17		7.02			
$CD_{(0.05)}$ Juice (J)= NS Storage conditions (C)= NS Storage intervals (I)= NS J x I= NS J x C= NS C x I= NS J x C x I= NS							

AT= Ambient temperature (13-27^{o}C) RT= Refrigerated temperature (0-4^{o}C

4.4.8 Apple: Mango: Jamun and vegetable juice blends

4.4.8.1 Total soluble solids (TSS)

Perusal of the data in Table 4.99 reveals that the total soluble solids in blends ranged from 11.92 to 12.93^{o}B. Significant difference was recorded in TSS content of all blends. Maximum TSS was recorded in control (12.93^{o}B) followed by apple: mango: jamun: pumpkin (12.49 ^{o}B) while minimum value was recorded as 11.92^{o}B in apple: mango: jamun: bottlegourd blend. A gradual increase in TSS was recorded with the advancement of storage period and it increased from average initial value of 12.41 to 12.80^{o}B after six month, irrespective of all the factors however, changes were non-significant. Juice blends stored at ambient temperature showed more increase in TSS (from an initial value of 12.41 to 12.65^{o}B) while those stored at refrigerated temperature resulted in a minimum change (from an initial value of 12.41 to 12.55^{o}B) during storage. The interaction of various factors revealed the non-significant results for change in TSS during storage at both the temperatures.

4.4.8.2 Titratable acidity

Results obtained for the changes in titratable acidity of the blends during storage are presented in Table 4.100. A significant difference was recorded in the titratable acidity of all the treatments. The maximum mean titratable acidity (0.43%) was recorded in apple: mango: jamun: tomato blend and control while minimum was recorded as 0.36% in the apple: mango: jamun: pumpkin blend. A gradual increase in titratable acidity was recorded from an initial mean value of 0.39 to 0.42% after six month of storage however, changes were not significant. It increased from a mean initial value of 0.39 to 0.41 at ambient storage as against 0.40% at refrigerated storage. Data shows that increase in titratable acidity was insignificant in all the blends during the storage, irrespective of storage conditions.

Table 4.99 Effect of storage on total soluble solids (^oB) of Apple: Mango: Jamun and vegetable blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Apple: Mango: Jamun (Control)	12.93	13.29	13.15	13.51	13.38	13.20	12.65
Apple: Mango:Jamun: Bottlegourd (5.4: 1.4:1.7: 1.5)	11.92	12.10	12.00	12.40	12.20	12.09	12.55
Apple: Mango: Jamun: Bittergourd (5.8: 1.4: 1.8: 1)	12.45	12.68	12.50	12.85	12.70	12.61	
Apple: Mango: Jamun: Pumpkin (6.1: 1.5: 1.9: 0.5)	12.49	12.73	12.64	12.90	12.72	12.66	
Apple: Mango: Jamun: Tomato (6.1: 1.5: 1.9: 0.5)	12.24	12.52	12.38	12.75	12.54	12.45	
Mean	12.41	12.66	12.53	12.88	12.71		
Grand Mean (I)	12.41	12.60		12.80			
$CD_{(0.05)}$ Juice (J)= 0.61 Storage conditions (C)= NS Storage intervals (I)= NS J x I= NS J x C= NS C x I= NS J x C x I= NS							

AT= Ambient temperature (13-27^oC) RT= Refrigerated temperature (0-4^oC)

Table 4.100 Effect of storage on titratable acidity (%) of Apple: Mango: Jamun and vegetable blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Apple: Mango: Jamun (Control)	0.43	0.44	0.44	0.46	0.45	0.44	0.41
Apple: Mango: Jamun:Bottlegourd (5.4: 1.4:1.7: 1.5)	0.37	0.38	0.38	0.40	0.39	0.38	0.40
Apple: Mango: Jamun: Bittergourd (5.8: 1.4: 1.8: 1)	0.38	0.39	0.38	0.40	0.39	0.39	
Apple: Mango: Jamun: Pumpkin (6.1: 1.5: 1.9: 0.5)	0.36	0.38	0.37	0.40	0.38	0.38	
Apple: Mango: Jamun: Tomato (6.1: 1.5: 1.9: 0.5)	0.43	0.44	0.43	0.45	0.44	0.44	
Mean	0.39	0.41	0.40	0.42	0.41		
Grand Mean (I)	0.39	0.40		0.42			
$CD_{(0.05)}$ Juice (J)= 0.02 Storage conditions (C)= NS Storage intervals (I)= 0.01 J x I= NS J x C= NS C x I= NS J x C x I= NS							

AT= Ambient temperature (13-27^oC) RT= Refrigerated temperature (0-4^oC)

Table 4.101 Effect of storage on reducing sugars (%) of Apple: Mango: Jamun and vegetable blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Apple: Mango: Jamun (Control)	6.43	6.59	6.52	6.71	6.58	6.57	6.21
Apple: Mango: Jamun:Bottlegourd (5.4: 1.4:1.7: 1.5)	6.05	6.09	6.07	6.11	6.09	6.08	6.19
Apple: Mango: Jamun: Bittergourd (5.8: 1.4: 1.8: 1)	6.25	6.28	6.27	6.30	6.28	6.28	
Apple: Mango: Jamun: Pumpkin (6.1: 1.5: 1.9: 0.5)	5.97	6.01	5.99	6.05	6.03	6.01	
Apple: Mango: Jamun: Tomato (6.1: 1.5: 1.9: 0.5)	6.07	6.12	6.10	6.15	6.13	6.11	
Mean	6.15	6.22	6.19	6.26	6.22		
Grand Mean (I)	6.15	6.20		6.24			

$CD_{(0.05)}$ Juice (J)= NS Storage conditions (C)= NS Storage intervals (I)= NS J x I= NS
J x C= NS C x I= NS J x C x I= NS

AT= Ambient temperature (13-27^{o}C) RT= Refrigerated temperature (0-4^{o}C)

4.4.8.3 Reducing sugars

The data presented in Table 4.101 reveals that reducing sugars content ranged from 5.97 to 6.43% in different blends. Apple: mango: jamun: bittergourd blend contained maximum reducing sugars content as 6.25% except control. It was minimum in apple: mango: jamun: pumpkin blend (5.97%). No significant variation was recorded in reducing sugars content of all the treatments. An increasing trend of reducing sugars was noticed in all the blends during the storage, irrespective of storage conditions. A gradual increase from an initial value of 6.15 (0 day) to 6.20 (3 month) and finally to 6.24% (6 month) was recorded during the storage. Storage conditions also did not affect the reducing sugars content as the increase was recorded from an average initial value of 6.15 to 6.21% in ambient storage as against 6.19% in refrigerated storage.

4.4.8.4 Total sugars

It is evident from the Table 4.102 that total sugars content of the blends ranged from 10.41 to 11.48 per cent. The mean maximum total sugars content was recorded in apple: mango: jamun blend as 11.48 per cent. An increasing trend was recorded in total sugars content of all the blends during storage. It was recorded to increase from an average initial value of 10.74 to 10.79% during six month of storage. Temperature did not show any significant effect on the total sugars of different blends however, it resulted in an increase from average initial value of 10.74 to 10.77 at ambient temperature as against 10.76% at refrigerated conditions. Besides, interaction of various factors revealed the non-significant results for change in total sugars.

4.4.8.5 Ascorbic acid

The perusal of data in Table 4.103 indicates that ascorbic acid content of the blends reduced significantly during storage of six month. Average ascorbic acid content was recorded to be in the range of 16.20 to 22.15 mg/100 mL. The mean maximum ascorbic acid content was

Table 4.102 Effect of storage on total sugars (%) of Apple: Mango: Jamun and vegetable blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Apple: Mango: Jamun (Control)	11.48	11.52	11.51	11.56	11.53	11.52	10.77
Apple:Mango:Jamun:Bottlegourd (5.4: 1.4:1.7: 1.5)	10.41	10.43	10.42	10.45	10.43	10.43	10.76
Apple: Mango: Jamun: Bittergourd (5.8: 1.4: 1.8: 1)	10.89	10.93	10.91	10.96	10.93	10.92	
Apple: Mango: Jamun: Pumpkin (6.1: 1.5: 1.9: 0.5)	10.41	10.44	10.43	10.47	10.45	10.44	
Apple: Mango: Jamun: Tomato (6.1: 1.5: 1.9: 0.5)	10.52	10.54	10.53	10.56	10.55	10.54	
Mean	10.74	10.77	10.76	10.80	10.78		
Grand Mean (I)	10.74	10.77		10.79			
$CD_{(0.05)}$ Juice (J)= 0.26 Storage conditions (C)= NS Storage intervals (I)= NS J x I= NS J x C= NS C x I= NS J x C x I= NS							

AT= Ambient temperature (13-27^{o}C) RT= Refrigerated temperature (0-4^{o}C)

Table 4.103 Effect of storage on ascorbic acid (mg/100 mL) of Apple: Mango: Jamun and vegetable blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Apple: Mango: Jamun (Control)	22.15	20.49	21.63	19.76	21.23	21.05	16.03
Apple:Mango:Jamun:Bottlegourd (5.4: 1.4:1.7: 1.5)	16.82	13.65	14.84	10.48	12.39	13.64	16.87
Apple: Mango: Jamun: Bittergourd (5.8: 1.4: 1.8: 1)	20.87	16.68	18.32	14.80	15.34	17.20	
Apple: Mango: Jamun: Pumpkin (6.1: 1.5: 1.9: 0.5)	17.58	14.69	15.64	11.95	13.29	14.63	
Apple: Mango: Jamun: Tomato (6.1: 1.5: 1.9: 0.5)	16.20	13.12	14.65	11.21	12.15	13.47	
Mean	18.72	15.73	17.02	13.64	14.88		
Grand Mean (I)	18.72	16.37		14.26			
$CD_{(0.05)}$ Juice (J)= 1.00 Storage conditions (C)= 0.63 Storage intervals (I)= 0.77 J x I= NS J x C= NS C x I= NS J x C x I= NS							

AT= Ambient temperature (13-27^{o}C) RT= Refrigerated temperature (0-4^{o}C)

Table 4.104 Effect of storage on total phenolics (mg/100 mL) of Apple: Mango: Jamun and vegetable blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Apple: Mango: Jamun (Control)	248.42	218.27	237.19	202.73	221.79	225.68	191.44
Apple:Mango:Jamun:Bottlegourd (5.4: 1.4:1.7: 1.5)	202.58	162.88	185.89	157.12	173.65	176.42	215.30
Apple: Mango: Jamun: Bittergourd (5.8: 1.4: 1.8: 1)	206.82	137.15	189.43	109.24	171.36	162.80	
Apple: Mango: Jamun: Pumpkin (6.1: 1.5: 1.9: 0.5)	217.84	155.13	205.52	134.86	191.44	180.96	
Apple: Mango: Jamun: Tomato (6.1: 1.5: 1.9: 0.5)	284.22	248.03	253.18	186.36	240.16	242.39	
Mean	231.98	184.29	214.24	158.06	199.68		
Grand Mean (I)	231.98	119.27		178.87			
$CD_{(0.05)}$ Juice (J)= 3.80 Storage conditions (C)= 2.40 Storage intervals (I)= 2.94 J x I= 6.58 J x C= 5.55 C x I= 4.16 J x C x I= 9.30							

AT= Ambient temperature (13-27^{o}C) RT= Refrigerated temperature (0-4^{o}C)

recorded in apple: mango: jamun: bittergourd blend (22.87 mg/100 mL) except control while it was minimum in apple: mango: jamun: tomato blend (16.20 mg/100 mL). A decreasing trend was recorded for ascorbic acid content of all the blends during the storage irrespective of storage conditions. Average ascorbic acid content was recorded to decrease significantly from an initial value of 18.72 to 14.26 mg/ 100 mL after six month of storage, irrespective of storage conditions. The decrease was higher at ambient storage where the decrease was from 18.72 to 16.03 as against 16.87 mg/100 mL at refrigerated storage.

4.4.8.6 Total phenolics

Data showing the effect of storage interval and storage condition on total phenolics of apple: mango: jamun and vegetable blends are presented in Table 4.104. Total phenolics content (TPC) was found to be in the range from 202.58 to 284.22 mg/100 mL. A significant difference in the mean TPC was recorded in all the blends. It was highest in apple: mango: jamun: tomato (284.22 mg/100 mL) while lowest in apple: mango: jamun: bottlegourd (202.58 mg/100 mL). A gradual decrease in the TPC was recorded from a mean initial value of 231.98 to 178.87 mg/100 mL with the advancement of storage. TPC was found to be affected significantly by storage condition. It decreased from an average initial value of 231.98 to 191.44 at ambient storage against 215.30 mg/100 mL at refrigerated conditions. A significant effect of various interaction factors was recorded on total phenolics content.

4.4.8.7 Total carotenoids

Total carotenoids content of the blends ranged from 0.97 to 1.46 mg/100 mL (Table 4.105). It was maximum in apple: mango: jamun: tomato blend (1.49 mg/100 mL) while minimum in apple: mango: jamun: bottlegourd blend (0.97 mg/100 mL). It decreased marginally during the storage from a mean initial value of 1.22 to 1.18 mg/100 mL after six month. Besides this, interaction of various factors revealed the non-significant results for change in antioxidant activity.

Table 4.105 Effect of storage on total carotenoids (mg/100 mL) of Apple: Mango: Jamun and vegetable blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Apple: Mango: Jamun (Control)	1.19	1.11	1.17	1.06	1.13	1.13	1.19
Apple: Mango: Jamun: Bottlegourd (5.4: 1.4:1.7: 1.5)	0.97	0.96	0.97	0.95	0.96	0.96	1.21
Apple: Mango: Jamun: Bittergourd (5.8: 1.4: 1.8: 1)	1.22	1.21	1.21	1.20	1.21	1.21	
Apple: Mango: Jamun: Pumpkin (6.1: 1.5: 1.9: 0.5)	1.24	1.23	1.23	1.21	1.23	1.23	
Apple: Mango: Jamun: Tomato (6.1: 1.5: 1.9: 0.5)	1.46	1.45	1.46	1.43	1.46	1.45	
Mean	1.22	1.19	1.21	1.17	1.20		
Grand Mean (I)	1.22	1.20		1.18			
$CD_{(0.05)}$ Juice (J)= 0.15 Storage conditions (C)= NS Storage intervals (I)= NS J x I= NS J x C= NS C x I= NS J x C x I= NS							

AT= Ambient temperature (13-27^{o}C) RT= Refrigerated temperature (0-4^{o}C)

Table 4.106 Effect of storage on total anthocyanins (mg/100 mL) of Apple: Mango: Jamun and vegetable blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Apple: Mango: Jamun (Control)	22.86	18.69	19.88	15.27	17.76	18.89	18.46
Apple:Mango:Jamun:Bottlegourd (5.4: 1.4:1.7: 1.5)	20.54	17.63	18.26	14.26	16.39	17.42	19.37
Apple: Mango: Jamun: Bittergourd (5.8: 1.4: 1.8: 1)	21.40	18.66	19.81	15.69	17.42	18.60	
Apple: Mango: Jamun: Pumpkin (6.1: 1.5: 1.9: 0.5)	20.58	17.82	18.69	15.34	16.81	17.85	
Apple: Mango: Jamun: Tomato (6.1: 1.5: 1.9: 0.5)	21.62	19.33	20.16	17.21	18.36	19.34	
Mean	21.40	18.43	19.36	15.55	17.35		
Grand Mean (I)	21.40	18.89		16.45			
$CD_{(0.05)}$ Juice (J)= 0.80 Storage conditions (C)= 0.51 Storage intervals (I)= 0.62 J x I= NS J x C= NS C x I= 0.88 J x C x I= NS							

AT= Ambient temperature (13-27^{o}C) RT= Refrigerated temperature (0-4^{o}C)

Table 4.107 Effect of storage on antioxidant activity (%) of Apple: Mango: Jamun and vegetable blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Apple: Mango: Jamun (Control)	80.09	79.64	77.32	77.84	75.91	78.16	70.12
Apple:Mango:Jamun:Bottlegourd (5.4: 1.4:1.7: 1.5)	72.47	70.36	68.59	68.24	67.41	69.41	69.03
Apple: Mango: Jamun: Bittergourd (5.8: 1.4: 1.8: 1)	69.99	68.59	66.27	66.37	64.31	67.11	
Apple: Mango: Jamun: Pumpkin (6.1: 1.5: 1.9: 0.5)	70.65	68.12	66.53	66.38	65.31	67.40	
Apple: Mango: Jamun: Tomato (6.1: 1.5: 1.9: 0.5)	66.35	64.59	63.21	62.10	61.08	63.47	
Mean	71.91	70.26	68.38	68.19	66.80		
Grand Mean (I)	71.91	69.32		67.50			
$CD_{(0.05)}$ Juice (J)= 1.16 Storage conditions (C)= 1.94 Storage intervals (I)= NS J x I= 1.50 J x C= NS C x I= NS J x C x I= NS							

AT= Ambient temperature (13-27^{o}C) RT= Refrigerated temperature (0-4^{o}C)

4.4.8.8 Total anthocyanins

Table 4.106 shows that total anthocyanins content of blends ranged from 20.54 to 22.86 mg/100 mL. It was maximum in control (22.86 mg/100 mL) and minimum in apple: mango: jamun: bottlegourd (20.54 mg/100 mL). A significant reduction in total anthocyanins content was recorded with the advancement of storage period where it decreased from a mean initial value of 21.40 to 16.45 mg/100 mL. Besides, interaction of various factors revealed the significant effect on change in antioxidant activity.

4.4.8.9 Antioxidant activity

Data on the effect of storage on the antioxidant activity (AA) of blends are presented in Table 4.107. The antioxidant activity ranged from 66.35 to 80.09% in different blends. Significant differences were observed in the AA of different juice/pulp blends. Storage intervals imposed a significant effect on the antioxidant activity of all the blends. The AA was observed to decrease from an average mean value of 71.91 (0 day) to 67.50 per cent (6 month) during storage. Changes were lower at ambient temperature as compared to refrigerated temperature in case of all blends where AA reduced from 71.91 to 70.12% at ambient temperature as against 69.03% at refrigerated temperature. Similar trends were recorded in all the juice blends. Besides, interaction of various factors revealed the non-significant results for change in antioxidant activity.

Table 4.108 Effect of storage on NEB of Apple: Mango: Jamun and vegetable blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Apple: Mango: Jamun (Control)	1.839	1.173	1.448	0.775	0.984	1.244	1.017
Apple:Mango:Jamun:Bottlegourd (5.4: 1.4:1.7: 1.5)	1.182	0.851	0.915	0.709	0.798	0.891	1.105
Apple: Mango: Jamun: Bittergourd (5.8: 1.4: 1.8: 1)	1.189	0.863	0.922	0.714	0.819	0.901	
Apple: Mango: Jamun: Pumpkin (6.1: 1.5: 1.9: 0.5)	1.214	0.931	0.987	0.765	0.856	0.951	
Apple: Mango: Jamun: Tomato (6.1: 1.5: 1.9: 0.5)	1.321	0.968	1.126	0.765	0.975	1.031	
Mean	1.349	0.957	1.080	0.746	0.886		
Grand Mean (I)	1.349	1.018		0.816			
$CD_{(0.05)}$ Juice (J)= 0.01 Storage conditions (C)= 0.01 Storage intervals (I)= 0.01 J x I= 0.02 J x C= 0.02 C x I= 0.01 J x C x I= 0.03							

AT= Ambient temperature (13-27^{o}C) RT= Refrigerated temperature (0-4^{o}C)

Table 4.109 Effect of storage on colour of Apple: Mango: Jamun and vegetable blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Apple: Mango: Jamun (Control)	8.00	7.82	7.90	7.60	7.77	7.82	7.86
Apple:Mango:Jamun:Bottlegourd (5.4: 1.4:1.7: 1.5)	8.20	8.05	8.12	7.85	8.00	8.04	7.93
Apple: Mango: Jamun: Bittergourd (5.8: 1.4: 1.8: 1)	8.10	7.90	8.00	7.80	7.90	7.94	
Apple: Mango: Jamun: Pumpkin (6.1: 1.5: 1.9: 0.5)	7.90	7.70	7.80	7.50	7.68	7.72	
Apple: Mango: Jamun: Tomato (6.1: 1.5: 1.9: 0.5)	8.00	7.80	7.90	7.60	7.70	7.80	
Mean	8.04	7.85	7.94	7.67	7.81		
Grand Mean (I)	8.04	7.90		7.74			
$CD_{(0.05)}$ Juice (J)= NS Storage conditions (C)= NS Storage intervals (I)= NS J x I= NS J x C= NS C x I= NS J x C x I= NS							

AT= Ambient temperature (13-27^{o}C) RT= Refrigerated temperature (0-4^{o}C)

Table 4.110 Effect of storage on flavour of Apple: Mango: Jamun and vegetable blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Apple: Mango: Jamun (Control)	8.20	8.00	8.10	7.90	8.00	8.04	7.70
Apple:Mango:Jamun:Bottlegourd (5.4: 1.4:1.7: 1.5)	8.10	7.92	8.14	7.90	8.00	8.01	7.78
Apple: Mango: Jamun: Bittergourd (5.8: 1.4: 1.8: 1)	7.20	7.00	7.12	7.0	7.10	7.08	
Apple: Mango: Jamun: Pumpkin (6.1: 1.5: 1.9: 0.5)	7.90	7.80	7.85	7.64	7.70	7.78	
Apple: Mango: Jamun: Tomato (6.1: 1.5: 1.9: 0.5)	7.80	7.60	7.80	7.55	7.70	7.69	
Mean	7.84	7.66	7.80	7.60	7.70		
Grand Mean (I)	7.84	7.73		7.65			
$CD_{(0.05)}$ Juice (J)= 0.45 Storage conditions (C)= NS Storage intervals (I)= NS J x I= NS J x C= NS C x I= NS J x C x I= NS							

AT= Ambient temperature (13-27^{o}C) RT= Refrigerated temperature (0-4^{o}C)

4.4.8.10 Non-enzymatic browning

It is clear from the data given in Table 4.108 that the non-enzymatic browning (NEB) decreases with the advancement of storage period in all the blends. The mean NEB of all the blends varies significantly with highest value for apple: mango: jamun blend (1.839) and the lowest for apple: mango: jamun: bottlegourd (1.182). A significant effect of storage period and storage conditions was recorded on NEB of juices. Besides, interaction of various factors did not impose significant changes in NEB.

4.4.8.11 Sensory quality

The colour rating of blends is presented in Table 4.109. It was highest (8.20) in apple: mango: jamun: bottlegourd blend while lowest colour rating was recorded for apple: mango: jamun: pumpkin (7.90). The colour rating of blends showed slight decrease during storage. It was found to decrease from an initial value of 8.04 to 7.74 at six month of storage however, changes were not significant. Blends stored at refrigerated temperature had better liking than those stored at ambient temperature. It decreased from an initial value of 8.04 to 7.80 and 7.93 at ambient and refrigerated storage conditions, respectively. The colour rating was not significantly affected by various interaction factors.

Data showing the effect of storage on the flavour rating of blends are presented in the Table 4.110. During storage the blends suffered losses in flavour score. However blends stored at low temperature were better than those stored at ambient temperature. During storage, the flavour rating was observed to decrease non-significantly from mean initial value of 7.84 to 7.65. Highest flavour rating was recorded as 8.20 (control) while it was lowest for apple: mango: jamun: bittergourd blend (7.20). Various interaction factors did not affect the flavour during the storage irrespective of storage conditions.

Perusal of the data presented in Table 4.111 indicated perceivable decrease in the body score of all the blends. The maximum body score was recorded for apple: mango: jamun: bittergourd (8.12) which was statistically at par with apple: mango: jamun: bottlegourd (8.10) while it was minimum in apple: mango: jamun: pumpkin blend (7.80). During storage, the body score was recorded to decrease from 7.98 at 0 day to 7.74 at 6 month. Storage conditions also affected the body score of blends as more decrease was recorded at ambient storage conditions. Besides, changes were non-significant irrespective of various interaction factors.

The overall acceptability (OAA) score of blends exhibited a gradual decrease with the advancement of storage conditions (Table 4.112). The storage temperature also influenced the OAA score as it was lower at ambient temperature as compared to low temperature storage. OAA rating was found to decrease from an average initial value of 7.65 to 7.32 during six month of storage however, changes were non-significant.

Table 4.111 Effect of storage on body of Apple: Mango: Jamun and vegetable blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Apple: Mango: Jamun (Control)	8.00	7.80	7.90	7.70	7.90	7.86	7.83
Apple:Mango:Jamun:Bottlegourd (5.4: 1.4:1.7: 1.5)	8.10	8.00	8.02	7.90	8.00	8.00	7.89
Apple: Mango: Jamun: Bittergourd (5.8: 1.4: 1.8: 1)	8.12	8.00	8.05	7.84	7.90	7.98	
Apple: Mango: Jamun: Pumpkin (6.1: 1.5: 1.9: 0.5)	7.80	7.60	7.70	7.50	7.42	7.60	
Apple: Mango: Jamun: Tomato (6.1: 1.5: 1.9: 0.5)	7.90	7.70	7.80	7.55	7.67	7.72	
Mean	7.98	7.82	7.89	7.70	7.78		
Grand Mean (I)	7.98	7.86		7.74			
$CD_{(0.05)}$ Juice (J) = 0.37 Storage conditions (C) = NS Storage intervals (I)=NS J x I=NS J x C = NS C x I = NS J x C x I =NS							

AT= Ambient temperature (13-27^oC) RT= Refrigerated temperature (0-4^oC)

Table 4.112 Effect of storage on overall acceptability of Apple: Mango: Jamun and vegetable blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Apple: Mango: Jamun (Control)	8.00	7.85	7.90	7.60	7.84	7.84	7.45
Apple:Mango:Jamun:Bottlegourd (5.4: 1.4:1.7: 1.5)	7.90	7.70	7.80	7.50	7.60	7.70	7.53
Apple: Mango: Jamun: Bittergourd (5.8: 1.4: 1.8: 1)	7.00	6.82	6.90	6.65	6.72	6.82	
Apple: Mango: Jamun: Pumpkin (6.1: 1.5: 1.9: 0.5)	7.75	7.50	7.62	7.30	7.44	7.52	
Apple: Mango: Jamun: Tomato (6.1: 1.5: 1.9: 0.5)	7.60	7.40	7.50	7.20	7.30	7.40	
Mean	7.65	7.45	7.54	7.25	7.38		
Grand Mean (I)	7.65	7.50		7.32			
$CD_{(0.05)}$ Juice (J)= 0.58 Storage conditions (C)= NS Storage intervals (I)= NS J x I= NS J x C= NS C x I= NS J x C x I= NS							

AT= Ambient temperature (13-27^oC) RT= Refrigerated temperature (0-4^oC

4.5 Development of juice blends from winter season fruits and vegetables

4.5.1 Development of Kinnow based (two fruit) juice blends

Sensory evaluation of all the blends was performed on 09 point Hedonic rating scale considering both organoleptic and functional quality of blends. Sensory score for the proportions of fruit juices/pulps used for the preparation of Kinnow based (two fruit) juice blends are presented in Table 4.113. A significant difference was observed among the sensory scores of all the blends. On the basis of overall acceptability 9.5: 0.5, 8: 2 and 5.5: 4.5 proportions were found best for kinnow: aonla, kinnow: papaya and kinnow: red grapes blends. Kinnow: aonla blend (9.5: 0.5) achieved the maximum colour, flavour, body and overall acceptability score as 7.70, 6.70, 7.20 and 7.25, respectively which was statistically at par with control for which scores for respective parameters were recorded as 7.80, 6.80, 7.20 and 7.30, respectively. Kinnow and papaya juice/pulp mixed in proportions of 8: 2 exhibited maximum sensory score for colour, flavour, body, and overall acceptability as 7.80, 7.70, 7.30 and 7.47, respectively. Kinnow: red grapes blend (5.5: 4.5) ranked best among all the proportions with colour, flavour, body and overall acceptability score of 7.64, 8.15, 7.90 and 8.10 against 7.20, 7.00, 7.10 and 7.40, respectively for control. The best juice blend in each category standardized as above were further prepared and stored at ambient and low temperature for detailed shelf-life study as well as for the preparation of three fruits/vegetable juice/pulp blends.

4.5.2 Development of Kinnow based (three fruit) juice blends

Sensory score for the standardization of proportion of winter season three fruits juice/pulp blends are presented in Table 4.114a – 4.114c. Kinnow: aonla blend (9.5: 0.5) selected as the best as above in 4.113 was further blended with red grapes juice in different proportions as mentioned in Table 4.114a and the blend of kinnow, aonla, red grapes in the proportion of 5.7, 0.3 and 4, respectively had maximum acceptability on the basis of colour (8.20), flavour (8.20), body (8.00) and overall acceptability (8.20). Similarly, the blend of kinnow, papaya and aonla in the proportion of 7.2: 1.8: 1 was adjudged best with colour score of 7.60, flavour score of 7.37, body score of 7.65 and overall acceptability score of 7.50 (Table 4.114b). However, three fruit juice blend of kinnow, red grapes and papaya blended in the proportion of 4.4, 3.6 and 2, respectively was ranked as the best with a highest sensory score for colour (7.60), flavour (8.55), body (8.30) and score of 8.22 for overall acceptability (Table 4.114c). The best juice blend in each category standardized as above were further prepared and stored at ambient and low temperature for detailed shelf-life study as well as for the preparation of vegetable juice/pulp blends.

4.5.3 Development of Kinnow: Aonla and vegetable juice blends

Kinnow: aonla blend (9.5: 0.5) as standardized from previous experiment (Table 4.113) was further blended with juice/pulp of vegetables *viz*., tomato, carrot, beetroot and cabbage in different proportions and data obtained for sensory evaluation are presented in Table 4.115. Kinnow: aonla blend mixed with tomato juice in the proportion of 9: 0.5: 0.5 was rated best among all the proportions. Maximum mean overall acceptability score was recorded as 7.15 for proportion of 9.5: 0.5. The sensory score for other parameters of blend like colour, flavour and body were recorded as 7.10, 7.07 and 7.25, respectively. Further, the other blends like kinnow: aonla: carrot, kinnow: aonla: beetroot and kinnow: aonla: cabbage blends containing kinnow: aonla and respective vegetable juice/pulp in proportions of 5.2: 0.3: 4.5, 6.6: 0.4: 3 and 9: 0.5: 0.5, respectively achieved highest acceptability with colour score of 8.30, 7.60 and 7.30, respectively while flavour score for the respective blends were recorded as 8.50, 7.50 and 7.10, respectively. The overall acceptability score of kinnow: aonla: carrot, kinnow: aonla: beetroot and kinnow: aonla: cabbage blend was recorded as 8.30, 7.60 and 7.30, respectively. Acceptability of blends was found to decrease with increase in the concentration of vegetable juice/pulp except carrot juice. Blends were prepared in standardized proportions for the storage study.

4.5.4 Development of Kinnow: Papaya and vegetable juice blends

Kinnow: papaya blends containing tomato, carrot, beetroot and cabbage in proportions of 7.2: 1.8: 1, 5.6: 1.4: 3, 6.4: 1.6: 2 and 7.6: 1.9: 0.5, respectively, were rated best among each type of blends with mean overall acceptability score of 7.20, 7.54, 7.10 and 7.40, respectively (Table 4.116). Kinnow: papaya: tomato blend (7.2: 1.8: 1) achieved sensory score of 7.24 for colour, 7.20 for flavour and 7.40 for body against 7.40, 7.35 and 7.50 for respective characters in control while kinnow: papaya: carrot (5.6: 1.4: 3) scored 7.80 for colour, 7.60 for flavour and 7.70 for body. Colour, flavour and body score for kinnow: papaya: beetroot (6.4: 1.6: 2) were recorded as 7.30, 7.10 and 7.10, respectively whereas for kinnow: papaya: cabbage (7.6: 1.9: 0.5) these were recorded as 7.40, 7.50 and 7.40, respectively. Those blends scoring highest score were selected for further study.

4.5.5 Development of Kinnow: Red grapes and vegetable juice blends

Data presented in Table 4.117 show the sensory scores recorded for the different proportions used for blending kinnow: red grapes blend with different vegetable juice/pulp. Kinnow: red grapes blend (5.5: 4.5) was mixed with vegetable juice/pulp in different proportions to standardize the best proportion of each vegetable in blend. For kinnow: red grapes: tomato blend, a proportion of 4.7: 3.8: 1.5 was found as the best with an average overall acceptability score of 8.05. Blends containing kinnow: red grapes blend and carrot juice in proportion of 6: 4 (actual proportion of 3.3: 2.7: 4) was found as most acceptable among all the proportions used with an average score of 8.65 for overall acceptability, 8.80 for colour, 8.70 for flavour and 8.70 for body. Among different proportions used, 9: 1 (actual proportion of 5: 4: 1) was found acceptable for both kinnow: red grapes: beetroot and kinnow: red grapes: cabbage blends with a mean acceptability score of 8.25 and 8.40, colour score of 8.30 and 8.20, flavour score of 8.40 and 8.40 and body score of 8.30 and 8.40, respectively.

4.5.6 Development of Kinnow: Aonla: Red grapes and vegetable juice blends

Effect of blending on the acceptability of kinnow: aonla: red grapes and vegetable juice/pulp in different proportions have been presented in Table 4.118. Data showed that kinnow: aonla: red grapes blends further blended with tomato, carrot, beetroot and cabbage juice/pulp in the proportion of 8.5: 1.5, 6: 4, 9.5: 0.5 and 9: 1, respectively, were found to be most acceptable with a mean overall acceptability score of 8.40, 8.60, 8.45 and 8.27 for the respective blends. Colour flavour and body score for the kinnow: aonla: red grapes: tomato blend was recorded as 7.90, 8.40, 8.06, respectively. Similarly, for kinnow: aonla: red grapes: carrot, the colour score was recorded as 8.40 while flavour and body score was recorded as 8.45 and 7.90, respectively. The actual proportions of the best blends were calculated as 4.8: 0.3: 3.4: 1.5 and 3.4: 0.2: 2.4: 4 for kinnow: aonla: red grapes: tomato and kinnow: aonla: red grapes: carrot, respectively while 5.4: 0.3: 3.8: 0.5 and 5.1: 0.3: 3.6: 1 for both kinnow: aonla: red grapes: beetroot and kinnow: aonla: red grapes: cabbage.

4.5.7 Development of Kinnow: Papaya: Aonla and vegetable juice blends

Kinnow: papaya: aonla blends were prepared in standardized proportion (7.2: 1.8: 1) and were further blended with tomato, carrot, beetroot and cabbage juice/pulp in different proportions to find out the best one for each type of blend (Table 4.119). Among different proportions used for kinnow: papaya: aonla: tomato blend, the proportion of 6.5: 1.6: 0.9: 1 was found best with maximum mean overall acceptability score of 8.00, colour score of 8.15, flavour score of 7.80 and body score of 8.25. Whereas, proportion of 4.3: 1.1: 0.6: 4 was found acceptable in case of kinnow: papaya: aonla: carrot, 5.8: 1.4: 0.8: 2 for kinnow: papaya: aonla: beetroot and 6.5: 1.6: 0.9: 1 for kinnow: papaya: aonla: cabbage blends with an average overall acceptability score of 8.00, 8.52 and 7.80, colour score of 8.00, 8.23 and 8.40, flavour score of 7.60, 7.27 and 8.27 and body score of 6.75, 6.90 and 8.00, respectively.

4.5.8 Development of Kinnow: Red grapes: Papaya and vegetable juice blends

Table 4.120 shows the average sensory score recorded for different proportions used for blending of kinnow: red grapes: papaya and vegetable juice/pulp. Best proportions for blending of kinnow: red grapes: papaya blend with vegetable juice/pulp were found as 9.5: 0.5, 7: 3, 9.5: 0.5 and 8: 2 for kinnow: red grapes: papaya: tomato, kinnow: red grapes: papaya: carrot, kinnow: red grapes: papaya: beetroot and kinnow: red grapes: papaya: cabbage blends and their actual proportions were calculated as 4.2: 3.4: 1.9: 0.5, 3.4: 2.3: 1.3: 3, 4.2: 3.4: 1.9: 0.5 and 3.5: 2.9: 1.6: 2, respectively. Colour, flavour, body and overall acceptability score for kinnow: red grapes: papaya: tomato was recorded as 7.60, 7.87, 8.35 and 7.87, respectively while for kinnow: red grapes: papaya: carrot these were recorded as 8.27, 8.40, 8.50 and 8.60, respectively. Standardized kinnow: red grapes: papaya: beetroot achieved a sensory score of 7.60 for colour, 7.80 for flavour, 8.40 for body and 7.90 for overall acceptability while kinnow: red grapes: papaya: cabbage (3.5: 2.9: 1.6: 2) blend achieved a sensory score of 7.55, 7.35, 7.93 and 7.67 for colour, flavour, body and overall acceptability. All the blends were prepared in standardized proportions for the further study.

Table 4.113 Development of Kinnow based (two fruit) juice blends

Juice blend	Parameter	Proportion/Sensory score										$CD_{(0.05)}$
		10: 0	9.5: 0.5	9: 1	8.5: 1.5	8: 2	7.5: 2.5	7: 3	6.5: 3.5	6: 4	5.5: 4.5	
Kinnow: Aonla	Colour	7.80	7.70	7.60	7. 53	7.40	7.20	7.13	7.00	6.80	6.60	0.08
	Flavour	6.80	6.70	6.50	6.40	6.30	6.20	6.12	6.00	5.80	5.60	0.14
	Body	7.20	7.20	7.10	7.00	6.90	6.80	6.75	6.70	6.60	6.52	0.01
	Overall acceptability	7.30	7.25	7.10	7.00	6.80	6.70	6.65	6.50	6.42	6.30	0.06
Kinnow: Papaya	Colour	7.50	7.53	7.60	7.70	7.80	7.83	7.85	7.85	7.90	7.92	0.48
	Flavour	7.40	7.50	7.60	7.70	7.70	7.65	7.60	7.50	7.45	7.40	0.23
	Body	7.40	7.40	7.37	7.35	7.30	7.20	7.12	7.00	6.94	6.80	0.11
	Overall acceptability	7.20	7.30	7.40	7.45	7.47	7.30	7.20	7.10	7.00	6.90	0.13
Kinnow: Red grapes	Colour	7.20	7.25	7.30	7.30	7.35	7.40	7.42	7.50	7.60	7.64	0.12
	Flavour	7.00	7.20	7.30	7.50	7.60	7.75	7.83	7.90	8.10	8.15	0.13
	Body	7.10	7.14	7.20	7.30	7.41	7.50	7.56	7.70	7.80	7.90	0.09
	Overall acceptability	7.40	7.45	7.43	7.50	7.60	7.70	7.80	7.90	7.95	8.10	0.14

Table 4.114a Development of Kinnow: Aonla: Red grapes juice blend

Parameter	Proportion*/Sensory score										
	10: 0 (9.5:0.5:0)	9.5: 0.5 (9:0.5:0.5)	9: 1 (8.5:0.5:1)	8.5: 1.5 (8.1:0.4:1.5)	8: 2 (7.6:0.4:2)	7.5: 2.5 (7.1:0.4:2.5)	7: 3 (6.6:0.4:3)	6.5: 3.5 (6.2:0.3:3.5)	6: 4 (5.7:0.3: 4)	5.5: 4.5 (5.2:0.3: 4.5)	$CD_{(0.05)}$
Colour	7.25	7.50	7.73	7.85	8.00	8.05	8.10	8.10	8.20	8.22	0.08
Flavour	7.10	7.20	7.30	7.45	7.60	7.80	7.95	8.10	8.20	8.25	0.06
Body	7.80	7.90	8.00	8.00	7.95	7.80	7.84	7.90	8.00	7.93	0.11
Overall acceptability	7.55	7.70	7.80	8.00	8.10	8.15	8.20	8.22	8.20	8.15	0.03

*Figures given in parenthesis represent the actual proportion of three fruits in the blend

Table 4.114b Development of Kinnow: Papaya: Aonla juice blend

Parameter	Proportion*/Sensory score										
	100: 0 (8:2:0)	9.5: 0.5 (7.6:1.9:0.5)	9: 1 (7.2:1.8:1)	8.5: 1.5 (6.8:1.7:1.5)	8: 2 (6.4:1.6:2)	7.5: 2.5 (6:1.5:2.5)	7: 3 (5.6:1.4:3)	6.5: 3.5 (5.2:1.3:3.5)	6: 4 (4.8:1.2:4)	5.5: 4.5 (4.4:1.1:4.5)	$CD_{(0.05)}$
Colour	7.75	7.70	7.60	7.50	7.40	7.20	7.00	6.90	6.70	6.60	0.08
Flavour	7.40	7.40	7.37	7.35	7.30	7.25	7.20	7.15	7.00	6.80	0.04
Body	7.52	7.60	7.65	7.70	7.68	7.63	7.55	7.40	7.35	7.25	0.06
Overall acceptability	7.50	7.45	7.50	7.30	7.20	7.15	7.05	7.00	6.80	6.60	0.06

*Figures given in parenthesis represent the actual proportion of three fruits in the blend

Table 4.114c Development of Kinnow: Red grapes: Papaya juice blend

Parameter	Proportion*/Sensory score										
	10: 0 (5.5:4.5:0)	9.5: 0.5 (5.2:4.3:0.5)	9: 1 (5:4:1)	8.5: 1.5 (4.7:3.8:1.5)	8: 2 (4.4:3.6:2)	7.5: 2.5 (4.1:3.4:2.5)	7: 3 (3.8:3.2:3)	6.5: 3.5 (3.6:2.9:3.5)	6: 4 (3.3:2.7:4)	5.5: 4.5 (3:2.5:4.5)	$CD_{(0.05)}$
Colour	8.80	8.74	8.70	7.65	7.60	7.55	7.40	7.35	7.40	7.30	0.06
Flavour	8.70	8.70	8.67	8.60	8.55	8.40	8.17	8.00	7.90	7.80	0.17
Body	8.5	8.50	8.40	8.45	8.30	8.15	8.00	7.80	7.60	7.50	0.25
Overall acceptability	8.50	8.50	8.45	8.30	8.22	8.10	7.95	7.75	7.50	7.30	0.35

*Figures given in parenthesis represent the actual proportion of three fruits in the blend

Table 4.115 Development of Kinnow, aonla and vegetable juice blends

Juice blend	Parameter	Proportion*/Sensory score										$CD_{(0.05)}$
		10: 0 (9.5:0.5:0)	9.5: 0.5 (9:0.5:0.5)	9: 1 (8.5:0.5:1)	8.5: 1.5 (8.1:0.4:1.5)	8: 2 (7.6:0.4:2)	7.5: 2.5 (7.1:0.4:2.5)	7: 3 (6.6:0.4:3)	6.5: 3.5 (6.2:0.3:3.5)	6: 4 (5.7:0.3:4)	5.5: 4.5 (5.2:0.3:4.5)	
Kinnow: Aonla: Tomato	Colour	7.20	7.10	6.90	6.80	6.70	6.60	6.50	6.40	6.35	6.20	0.06
	Flavour	7.15	7.07	6.90	6.82	6.70	6.60	6.45	6.20	6.00	5.80	0.05
	Body	7.33	7.25	7.10	7.10	7.05	7.00	6.90	6.80	6.70	6.70	0.04
	Overall acceptability	7.25	7.15	7.00	6.90	6.80	6.60	6.40	6.20	6.10	6.10	0.11
Kinnow: Aonla: Carrot	Colour	7.00	7.10	7.28	7.30	7.40	7.65	7.80	7.90	8.10	8.30	0.06
	Flavour	7.20	7.30	7.47	7.55	7.70	7.90	8.10	8.15	8.30	8.50	0.03
	Body	7.20	7.30	7.40	7.50	7.60	7.70	7.80	7.90	8.00	8.10	0.05
	Overall acceptability	7.15	7.30	7.40	7.50	7.60	7.80	7.90	8.10	8.20	8.30	0.10
Kinnow: Aonla: Beetroot	Colour	7.17	7.30	7.40	7.50	7.50	7.60	7.60	7.62	7.65	7.70	0.08
	Flavour	7.30	7.40	7.45	7.50	7.60	7.60	7.50	7.40	7.30	7.10	0.12
	Body	7.40	7.45	7.50	7.60	7.63	7.70	7.70	7.60	7.50	7.50	0.05
	Overall acceptability	7.30	7.40	7.50	7.60	7.70	7.70	7.60	7.50	7.40	7.45	0.04
Kinnow: Aonla: Cabbage	Colour	7.30	7.30	7.25	7.20	7.08	7.00	6.90	6.70	6.80	6.70	0.06
	Flavour	7.10	7.10	7.00	6.90	6.70	6.60	6.47	6.30	6.22	6.14	0.07
	Body	7.25	7.20	7.10	7.00	6.90	6.80	6.70	6.60	6050	6.40	0.07
	Overall acceptability	7.35	7.40	7.30	7.20	7.00	6.80	6.50	6.52	6.40	6.30	0.06

*Figures given in parenthesis represent the actual proportion of two fruits and one vegetable in the blend

Table 4.116 Development of Kinnow, papaya and vegetable juice blends

Juice blend	Parameter	Proportion*/Sensory score										$CD_{(0.05)}$
		10: 0 (8:2:0)	9.5: 0.5 (7.6:1.9: 0.5)	9: 1 (7.2:1.8:1)	8.5: 1.5 (6.8:1.7:1.5)	8: 2 (6.4:1.6:2)	7.5: 2.5 (6:1.5:2.5)	7: 3 (5.6:1.4:3)	6.5: 3.5 (5.2:1.3:3. 5)	6: 4 (4.8:1.2:4)	5.5: 4.5 (4.4:1.1:4. 5)	
Kinnow: Papaya: Tomato	Colour	7.40	7.30	7.24	7.10	7.00	7.00	6.90	6.80	6.70	6.60	0.09
	Flavour	7.35	7.30	7.20	7.10	7.00	6.90	6.80	6.60	6.40	6.20	0.11
	Body	7.50	7.50	7.40	7.43	7.35	7.30	7.20	7.10	7.00	6.80	0.14
	Overall acceptability	7.40	7.30	7.20	7.15	7.04	6.90	6.80	6.70	6.60	6.40	0.20
Kinnow: Papaya: Carrot	Colour	7.20	7.30	7.40	7.50	7.60	7.70	7.80	7.80	7.82	7.85	0.09
	Flavour	7.30	7.40	7.50	7.60	7.70	7.65	7.60	7.50	7.40	7.30	0.03
	Body	7.40	7.50	7.60	7.70	7.75	7.80	7.70	7.63	7.50	7.51	0.06
	Overall acceptability	7.40	7.50	7.50	7.70	7.70	7.65	7.54	7.40	7.30	7.20	0.18
Kinnow: Papaya : Beetroot	Colour	7.60	7.50	7.40	7.30	7.30	7.20	7.14	7.00	6.90	6.90	0.13
	Flavour	7.50	7.35	7.30	7.20	7.10	7.00	6.90	6.80	6.70	6.60	0.43
	Body	7.50	7.40	7.30	7.20	7.10	7.00	6.90	6.80	6.70	6.60	0.09
	Overall acceptability	7.50	7.40	7.30	7.20	7.10	7.00	6.90	6.70	6.50	6.40	0.47
Kinnow: Papaya : Cabbage	Colour	7.50	7.40	7.30	7.27	7.22	7.15	7.10	7.05	7.00	6.90	0.10
	Flavour	7.60	7.50	7.40	7.30	7.20	7.10	7.00	6.80	6.70	6.50	0.18
	Body	7.44	7.40	7.35	7.24	7.20	7.10	7.00	6.87	6.70	6.60	0.12
	Overall acceptability	7.45	7.40	7.32	7.24	7.12	7.00	6.90	6.75	6.60	6.50	0.03

*Figures given in parenthesis represent the actual proportion of two fruits and one vegetable in the blends.

Table 4.117 Development of Kinnow, red grapes and vegetable juice blends

Juice blend	Parameter	Proportion*/Sensory score										$CD_{(0.05)}$
		10: 0 (5.5:4.5: 0)	9.5: 0.5 (5.2:4.3: 0.5)	9: 1 (5:4:1)	8.5: 1.5 (4.7:3.8:1. 5)	8: 2 (4.4:3.6:2)	7.5: 2.5 (4.1:3.4:2.5)	7: 3 (3.8:3.2:3)	6.5: 3.5 (3.6:2.9:3. 5)	6: 4 (3.3:2.7:4)	5.5: 4.5 (3:2.5:4.5)	
Kinnow: Red grapes: Tomato	Colour	8.00	7.90	7.84	7.80	7.70	7.60	7.53	7.40	7.33	7.25	0.12
	Flavour	8.50	8.40	8.40	8.35	8.30	8.20	8.10	8.00	7.90	7.80	0.06
	Body	8.30	8.40	8.45	8.50	8.47	8.40	8.35	8.30	8.20	8.10	0.08
	Overall acceptability	8.25	8.20	8.10	8.05	7.90	7.70	7.50	7.30	7.25	7.20	0.22
Kinnow: Red grapes: Carrot	Colour	8.10	8.20	8.30	8.40	8.50	8.65	8.70	8.80	8.80	8.85	0.18
	Flavour	8.40	8.45	8.50	8.60	8.65	8.70	8.75	8.80	8.70	8.60	0.17
	Body	8.40	8.40	8.43	8.45	8.50	8.55	8.60	8.67	8.70	8.80	0.07
	Overall acceptability	8.30	8.35	8.40	8.43	8.51	8.55	8.60	8.70	8.65	8.60	0.07
Kinnow: Red grapes: Beetroot	Colour	8.20	8.30	8.30	8.27	8.25	8.20	8.10	8.00	7.80	7.70	0.11
	Flavour	8.60	8.50	8.40	8.20	8.05	8.00	7.80	7.60	7.40	7.20	0.07
	Body	8.50	8.40	8.30	8.20	8.10	8.00	7.90	7.80	7.70	7.60	0.03
	Overall acceptability	8.40	8.30	8.25	8.20	8.10	8.00	7.90	7.80	7.70	7.60	0.16
Kinnow: Red grapes: Cabbage	Colour	8.30	8.25	8.20	8.10	8.00	7.80	7.70	7.55	7.50	7.40	0.04
	Flavour	8.50	8.43	8.40	8.30	8.15	8.00	7.80	7.85	7.70	7.60	0.06
	Body	8.50	8.47	8.40	8.30	8.22	8.15	8.05	8.00	7.90	7.80	0.07
	Overall acceptability	8.50	8.43	8.40	8.30	8.00	7.90	7.70	7.55	7.40	7.30	0.11

*Figures given in parenthesis represent the actual proportion of two fruits and one vegetable in the blend

Table 4.118 Development of Kinnow, aonla, red grapes and vegetables juice blends

Juice blend	Parameter	Proportion*/Sensory score										CD$_{(0.05)}$
		10: 0 (5.7:0.3:4:0)	9.5:0.5 (5.4: 0.2: 3.8: 0.5)	9: 1 (5.1:0.3: 3.6:1)	8.5: 1.5 (4.8:0.3: 3.4:1.5)	8: 2 (4.6:0.2: 3.2:2)	7.5: 2.5 (4.3:0.2: 3:2.5)	7: 3 (4:0.2:2.8:3)	6.5: 3.5 (3.7:0.2: 2.6:3.5)	6: 4 (3.4:0.2: 2.4:4)	5.5: 4.5 (3.1:0.2: 2.2:4.5)	
Kinnow: Aonla: Red grapes:Tomato	Colour	8.00	8.0	7.95	7.90	7.80	7.70	7.64	7.54	7.40	7.30	0.12
	Flavour	8.50	8.50	8.45	8.40	8.20	8.10	7.97	7.90	7.80	7.70	0.07
	Body	8.20	8.15	8.10	8.06	8.25	8.14	8.08	8.00	7.90	7.80	0.09
	Overall acceptability	8.50	8.47	8.40	8.40	8.10	8.03	7.92	7.80	7.65	7.57	0.14
Kinnow: Aonla: Red grapes: Carrot	Colour	8.10	8.10	8.20	8.24	8.30	8.40	8.50	8.52	8.40	8.35	0.12
	Flavour	8.00	8.05	8.10	8.20	8.25	8.30	8.40	8.50	8.45	8.47	0.12
	Body	8.00	8.02	8.10	8.15	8.25	8.20	8.10	8.00	7.90	7.80	0.10
	Overall acceptability	8.00	8.05	8.10	8.20	8.27	8.33	8.41	8.50	8.60	8.50	0.08
Kinnow: Aonla: Red grapes: Beetroot	Colour	8.40	8.35	8.20	8.10	8.07	8.00	7.90	7.83	7.70	7.60	0.12
	Flavour	8.60	8.55	8.45	8.30	8.10	8.00	7.80	7.50	7.40	7.30	0.10
	Body	8.20	8.10	8.00	7.90	7.75	7.60	7.50	7.40	7.30	7.20	0.13
	Overall acceptability	8.60	8.45	8.30	8.20	8.10	7.97	7.85	7.70	7.66	7.50	0.20
Kinnow: Aonla: Red grapes: Cabbage	Colour	8.25	8.20	8.20	8.00	7.90	7.80	7.60	7.40	7.30	7.20	0.09
	Flavour	8.30	8.20	8.14	8.00	7.95	7.84	7.70	7.60	7.50	7.40	0.15
	Body	8.30	8.27	8.20	8.10	8.00	7.93	7.80	7.75	7.60	7.47	0.11
	Overall acceptability	8.35	8.30	8.27	8.10	8.00	7.85	7.72	7.65	7.40	7.20	0.11

*Figures given in parenthesis represent the actual proportion of three fruits and one vegetable in the blend

Table 4.119 Development of Kinnow, papaya, aonla and vegetable juice blends

Juice blend	Parameter	Proportion*/Sensory score										$CD_{(0.05)}$
		10: 0 (7.2:1.8 :1:0)	9.5:0. 5 (6.8:1.7: 1:0.5)	9: 1 (6.5:1.6: 0.9:1)	8.5: 1.5 (6.1:1.5:0. 9:1.5)	8: 2 (5.8:1.4: 0.8:2)	7.5: 2.5 (5.4:1.3:0. 8:2.5)	7: 3 (5.0:1.3: 0.7:3)	6.5:3.5 (4.7:1.2:0. 6:3.5)	6: 4 (4.3:1.1: 0.6 :4)	5.5: 4.5 (4:1:0.5: 4.5)	
Kinnow: Papaya: Aonla: Tomato	Colour	8.20	8.18	8.15	8.10	8.05	8.00	7.95	7.90	7.80	7.70	0.09
	Flavour	7.90	7.85	7.80	7.70	7.60	7.55	7.40	7.30	7.20	7.00	0.05
	Body	8.35	8.30	8.25	8.20	8.12	7.94	7.80	7.60	7.55	7.40	0.05
	Overall acceptability	8.10	8.05	8.00	7.90	7.80	7.70	7.56	7.40	7.33	7.20	0.05
Kinnow: Papaya: Aonla : Carrot	Colour	7.30	7.33	7.40	7.50	7.60	7.80	7.90	8.00	8.00	8.02	0.06
	Flavour	6.50	6.55	6.60	6.80	6.90	7.10	7.20	7.40	7.60	7.70	0.04
	Body	6.00	6.10	6.20	6.30	6.40	6.50	6.70	6.75	6.75	6.64	0.06
	Overall acceptability	7.10	7.20	7.30	7.45	7.52	7.60	7.70	7.80	8.00	7.90	0.08
Kinnow: Papaya: Aonla : Beetroot	Colour	8.05	8.10	8.15	8.20	8.23	8.30	8.31	8.35	8.40	8.40	0.13
	Flavour	7.10	7.20	7.30	7.32	7.27	7.10	6.90	6.80	6.50	6.30	0.06
	Body	7.10	7.20	7.30	7.10	6.90	6.80	6.70	6.65	6.52	6.45	0.07
	Overall acceptability	7.35	8.40	8.50	8.55	8.52	8.40	8.30	8.10	8.00	6.80	0.09
Kinnow: Papaya: Aonla : Cabbage	Colour	8.50	8.47	8.40	8.35	8.27	8.15	7.90	7.75	7.60	7.50	0.11
	Flavour	8.35	8.30	8.27	8.10	8.00	7.80	7.65	7.53	7.47	7.35	0.14
	Body	8.13	8.07	8.00	7.97	7.80	7.71	7.63	7.57	7.40	7.27	0.15
	Overall acceptability	8.00	7.93	7.80	7.75	7.60	7.53	7.45	7.39	7.25	7.17	0.23

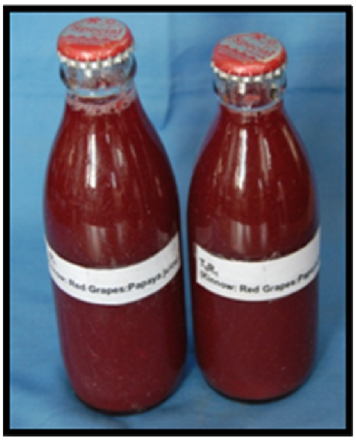
*Figures given in parenthesis represent the actual proportion of three fruits and one vegetable in the blend

Table 4.120 Development of Kinnow, red grapes, papaya and vegetable juice blends

Juice blend	Parameter	Proportion*/Sensory score										$CD_{(0.05)}$
		10: 0 (4.4:3.6: 2: 0)	9.5:0.5 (4.2:3.4: 1.9:0.5)	9: 1 (4:3.2: 1.8:1)	8.5:1.5 (3.7:3.1: 1.7: 1.5)	8: 2 (3.5:2.9: 1.6:2)	7.5:2.5 (3.3:2.7: 1.5:2.5)	7: 3 (3.1:2.5: 1.4:3)	6.5:3.5 (2.9:2.3: 1.3:3.5)	60: 40 (2.6:2.2: 1.2:4)	5.5:4.5 (2.4:2:1 .1:4.5)	
Kinnow: Red grapes: Papaya: Tomato	Colour	7.55	7.60	7.65	7.55	7.50	7.45	7.40	7.30	7.25	7.20	0.11
	Flavour	7.80	7.87	7.82	7.65	7.60	7.53	7.45	7.39	7.27	7.13	0.07
	Body	8.40	8.35	8.29	8.13	7.90	7.75	7.67	7.54	7.33	7.15	0.09
	Overall acceptability	7.95	7.87	7.83	7.65	6.53	7.40	7.33	7.17	7.05	7.00	0.10
Kinnow: Red grapes: Papaya : Carrot	Colour	7.80	7.90	8.00	8.10	8.20	8.22	8.27	8.30	8.20	8.10	0.16
	Flavour	7.95	8.07	8.10	8.20	8.25	8.32	8.40	8.37	8.30	8.25	0.06
	Body	8.32	8.35	8.40	8.45	8.50	8.54	8.50	8.47	8.40	8.30	0.12
	Overall acceptability	8.20	8.30	8.37	8.40	8.45	8.50	8.60	8.62	8.55	8.50	0.03
Kinnow: Red grapes: Papaya : Beetroot	Colour	7.65	7.60	7.50	7.43	7.35	7.20	7.17	7.10	7.05	6.95	0.06
	Flavour	7.85	7.80	7.70	7.55	7.37	7.25	7.10	6.87	6.63	6.47	0.03
	Body	8.55	8.40	8.25	8.14	8.00	7.85	7.45	7.23	7.15	7.05	0.17
	Overall acceptability	8.00	7.90	7.85	7.69	7.45	7.30	7.21	7.17	7.00	6.90	0.12
Kinnow: Red grapes: Papaya : Cabbage	Colour	7.70	7.73	7.70	7.63	7.55	7.47	7.35	7.29	7.15	7.03	0.06
	Flavour	8.05	7.97	7.73	7.51	7.35	7.20	7.13	7.02	6.90	6.77	0.07
	Body	8.45	8.30	8.15	8.07	7.93	7.85	7.70	7.60	7.45	7.30	0.11
	Overall acceptability	8.15	8.10	7.90	7.77	7.67	7.50	7.37	7.25	7.13	7.05	0.49

*Figures given in parenthesis represent the actual proportion of three fruits and one vegetable in the blend

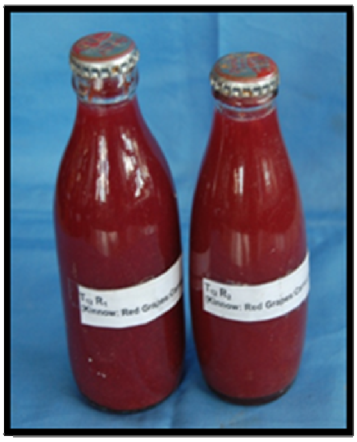
Kinnow: Red grapes



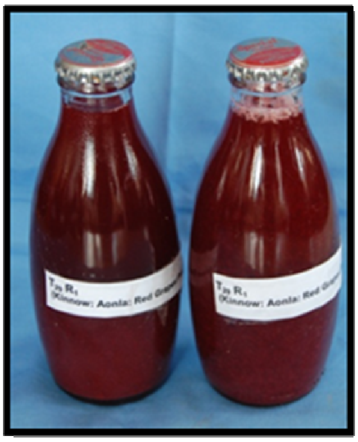
Kinnow: Red grapes: Papaya

Kinnow: Aonla: Carrot

Kinnow: Papaya: Carrot



Kinnow: Red grapes: Carrot



Kinnow: Aonla: Red grapes: Carrot

Plate 4.2 Best fruit and vegetable juice pulp blends of winter season

4.6 Effect of storage on quality characteristics of winter season juice blends

4.6.1 Kinnow based (two) fruit juice blends

4.6.1.1 Total soluble solids

The total soluble solids (TSS) of blends ranged from 10.00 to 12.80^{o}B (Table 4.121). The maximum TSS was recorded in kinnow: red grapes as 12.80^{o}B while it was minimum in control (10.00^{o}B). A marginal increase in TSS of blends was recorded during storage irrespective of storage conditions. After six month, the TSS increased from a mean initial value of 10.83 to 11.33^{o}B. The changes were higher during ambient storage as compared to refrigerated storage. Insignificant effect of interaction of various factors was observed during storage.

4.6.1.2 Titratable acidity

Table 4.122 shows the effect of blending and storage on titratable acidity (TA) of kinnow based (two fruit) blends. The TA was maximum (1.18%) in kinnow: aonla and minimum (0.90%) in kinnow: papaya blend. A marginal increase in the acidity of all blends was recorded during the storage of six month where increase was from an average initial value of 1.04 to 1.07% after six month irrespective of storage conditions however, changes were insignificant. Products stored at ambient temperature experienced more changes with a mean value of 1.06% as against 1.05% at low temperature storage which increased from a mean initial value of 1.04 per cent. Interaction of various other factors affected the TA of blends insignificantly.

4.6.1.3 Reducing sugars

It is clear from the Table 4.123 that the reducing sugars content of blends ranged from 4.55 to 6.46 per cent. The mean maximum reducing sugars content was recorded in kinnow: red grapes juice blend (control) as 6.46% whereas it was minimum in control (4.55%) followed by kinnow: aonla (4.56 per cent). An increasing trend was recorded in reducing sugars content of all the blends during storage. It was recorded

Table 4.121 Effect of storage on total soluble solids (^oB) of Kinnow based (two fruit) juice blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Kinnow (Control)	10.00	10.30	10.20	10.60	10.40	10.25	11.13
Kinnow: Aonla (9.5: 0.5)	10.20	10.40	10.30	10.70	10.50	10.38	11.02
Kinnow: Papaya (8: 2)	10.30	10.71	10.52	10.90	10.75	10.58	
Kinnow: Red grapes (5.5: 4.5)	12.80	13.15	13.00	13.54	13.25	13.09	
Mean	10.83	11.14	11.01	11.44	11.23		
Grand Mean (I)	10.83	11.07		11.33			
$CD_{(0.05)}$ Juice (J)= 0.22 Storage conditions (C)= NS Storage intervals (I)= 0.19 J x I=NS J x C= NS C x I= NS J x C x I= NS							

AT= Ambient temperature (13-27^{o}C) RT= Refrigerated temperature (0-4^{o}C)

Table 4.122 Effect of storage on titratable acidity (%) of Kinnow based (two fruit) juice blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Kinnow (Control)	1.07	1.10	1.09	1.11	1.09	1.09	1.06
Kinnow: Aonla (9.5: 0.5)	1.18	1.20	1.19	1.22	1.21	1.20	1.05
Kinnow: Papaya (8: 2)	0.90	0.92	0.91	0.93	0.92	0.91	
Kinnow: Red grapes (5.5: 4.5)	1.02	1.03	1.03	1.05	1.04	1.03	
Mean	1.04	1.06	1.06	1.08	1.07		
Grand Mean (I)	1.04	1.06		1.07			
$CD_{(0.05)}$ Juice (J)= 0.07 Storage conditions (C)= NS Storage intervals (I)= NS J x I= NS J x C= NS C x I= NS J x C x I= NS							

AT= Ambient temperature (13-27^{o}C) RT= Refrigerated temperature (0-4^{o}C)

Table 4.123 Effect of storage on reducing sugars (%) of Kinnow based (two fruit) juice blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Kinnow (Control)	4.55	4.59	4.58	4.61	4.60	4.59	5.15
Kinnow: Aonla (9.5: 0.5)	4.56	4.58	4.56	4.59	4.57	4.57	5.14
Kinnow: Papaya (8: 2)	4.90	4.94	4.92	4.98	4.95	4.93	
Kinnow: Red grapes (5.5: 4.5)	6.46	6.49	6.48	6.52	6.50	6.49	
Mean	5.12	5.15	5.14	5.18	5.16		
Grand Mean (I)	5.12	5.14		5.17			
$CD_{(0.05)}$ Juice (J)= 0.08 Storage conditions (C)= NS Storage intervals (I)= NS J x I= NS J x C= NS C x I= NS J x C x I= NS							

AT= Ambient temperature (13-27^{o}C) RT= Refrigerated temperature (0-4^{o}C)

to increase from an average initial value of 5.12 to 5.17% during six month of storage. An increase from average initial value of 5.12 to 5.15% was recorded at ambient temperature as against 5.14% at refrigerated conditions. Besides, interaction of various factors revealed the non-significant results for change in reducing sugars.

4.6.1.4 Total sugars

It is evident from the Table 4.124 that total sugars in all the blends ranged from 7.42 to 9.62 per cent. The mean maximum total sugars content was recorded in kinnow: red grapes juice blend (control) as 9.62% whereas it was minimum in kinnow: papaya juice blend (7.42%). An increasing trend was recorded in total sugars content of all the blends during storage. It was recorded to increase from an average initial value of 8.06 to 8.11% during six month of storage. The storage temperature did not show any significant effect on the total sugars of different blends however, it resulted in an increase from average initial value of 8.06 to 8.09 at ambient temperature as against 8.08% at refrigerated conditions. Besides, interaction of various factors revealed that the results for change in total sugars were insignificant.

4.6.1.5 Ascorbic acid

Table 4.125 shows the ascorbic acid content of kinnow based (two fruit) juice blends which varied from 15.20 to 40.21 mg/100 mL. A significant decrease in ascorbic acid content of juice blends was recorded with the advancement of storage period. It was significantly affected by both storage intervals and conditions. The ascorbic acid content decreased from an initial value of 24.87 to 20.68 mg/100 mL after six month of storage irrespective of storage conditions. The mean ascorbic acid content at ambient storage was recorded as 22.37 mg/100 mL as against 23.18 mg/100 mL at refrigerated storage which decreased from a mean initial value of 24.87mg/100 mL. Various interaction factors also affected the ascorbic acid content of blends during storage.

Table 4.124 Effect of storage on total sugars (%) of Kinnow based (two fruit) juice blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Kinnow (Control)	7.65	7.68	7.66	7.70	7.68	7.67	8.09
Kinnow: Aonla (9.5: 0.5)	7.55	7.58	7.57	7.60	7.58	7.57	8.08
Kinnow: Papaya (8: 2)	7.42	7.46	7.44	7.49	7.47	7.45	
Kinnow: Red grapes (5.5: 4.5)	9.62	9.65	9.64	9.69	9.67	9.65	
Mean	8.06	8.09	8.08	8.12	8.10		
Grand Mean (I)	8.06	8.09		8.11			
$CD_{(0.05)}$ Juice (J)= 0.07 Storage conditions (C)= NS Storage intervals (I)= NS J x I=NS J x C= NS C x I= NS J x C x I= NS							

AT= Ambient temperature (13-27^{o}C) RT= Refrigerated temperature (0-4^{o}C)

Table 4.125 Effect of storage on ascorbic acid (mg/100 mL) of Kinnow based (two fruit) juice blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Kinnow (Control)	25.50	22.76	23.82	20.14	21.77	23.25	22.37
Kinnow: Aonla (9.5: 0.5)	40.21	37.52	38.30	34.72	36.28	37.87	23.18
Kinnow: Papaya (8: 2)	18.55	16.26	17.16	14.46	15.82	16.80	
Kinnow: Red grapes (5.5: 4.5)	15.20	12.63	13.86	10.51	11.72	13.19	
Mean	24.87	22.29	23.29	19.96	21.40		
Grand Mean (I)	24.87	22.79		20.68			
$CD_{(0.05)}$ Juice (J)= 0.29 Storage conditions (C)= 0.20 Storage intervals (I)= 0.25 J x I=0.45 J x C= NS C x I= 0.35 J x C x I= NS							

AT= Ambient temperature (13-27^{o}C) RT= Refrigerated temperature (0-4^{o}C)

Table 4.126 Effect of storage on total phenolics (mg/100 mL) of Kinnow based (two fruit) juice blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Kinnow (Control)	8.45	7.34	7.78	5.10	6.68	7.30	18.22
Kinnow: Aonla (9.5: 0.5)	23.05	20.37	21.52	18.16	19.68	20.97	18.61
Kinnow: Papaya (8: 2)	18.56	17.09	17.82	15.48	16.71	17.37	
Kinnow: Red grapes (5.5: 4.5)	30.25	28.51	27.47	26.24	25.35	28.01	
Mean	20.08	18.33	18.65	16.25	17.11		
Grand Mean (I)	20.08	18.49		16.68			
$CD_{(0.05)}$ Juice (J)= 0.18 Storage conditions (C)= 0.13 Storage intervals (I)= 0.16 J x I= 0.31 J x C= 0.26 C x I= 0.22 J x C x I= 0.44							

AT= Ambient temperature (13-27^{o}C) RT= Refrigerated temperature (0-4^{o}C)

4.6.1.6 Total phenolics

The total phenolics content of kinnow based (two fruit) juices/pulps blends are presented in Table 4.126. The Maximum total phenolics content was recorded in kinnow: red grapes blend as 30.25 mg/100 mL followed by kinnow: aonla blend (23.05 mg/100 mL). A significant effect of storage period and conditions was noticed on total phenolics of blends. It decreased from a mean initial value of 20.08 to 16.68 after six month. A significant effect of various interaction factors on total phenolics was recorded during storage of six month.

4.6.1.7 Total carotenoids

The total carotenoids content in blends ranged from 1.34 to 3.21 mg/100 mL (Table 4.127). The mean maximum total carotenoids content was recorded in kinnow: papaya blend (3.21 mg/100 mL) followed by control (2.39 mg/100 mL). A gradual decrease in total carotenoids of blends was noticed with increase in storage period however, the reduction was not significant. It was recorded to decrease from an average initial value of 2.32 to 2.29 mg/100 mL after six month. The reduction was more at ambient storage (from an average initial value of 2.32 to 2.30 mg/100 mL) as compared to refrigerated storage (from an average initial value of 2.32 to 2.31 mg/100 mL). No significant effect of various interaction factors was recorded on total carotenoids of blends.

4.6.1.8 Antioxidant activity

Antioxidant activity (AA) of blends ranged from 24.00 to 65.62% being maximum in kinnow: red grapes (65.62%) and minimum in control (24.00%) (Table 4.128).With the advancement of storage period AA of blends experienced significant decrease. Mean AA after six month was recorded as 45.64% which decreased from its average initial value of 49.90 per cent. Retention of AA was more during ambient storage as compared to refrigerated storage where AA decreased from a mean initial value of 49.90 to 48.01 at ambient storage as against 47.25% at refrigerated storage.

Table 4.127 Effect of storage on total carotenoids (mg/100 mL) of Kinnow based (two fruit) juice blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Kinnow (Control)	2.39	2.36	2.37	2.34	2.36	2.37	2.30
Kinnow: Aonla (9.5: 0.5)	2.34	2.32	2.33	2.30	2.32	2.33	2.31
Kinnow: Papaya (8: 2)	3.21	3.19	3.20	3.18	3.20	3.20	
Kinnow: Red grapes (5.5: 4.5)	1.34	1.32	1.33	1.30	1.32	1.33	
Mean	2.32	2.30	2.31	2.28	2.30		
Grand Mean (I)	2.32	2.30		2.29			
$CD_{(0.05)}$ Juice (J)= 0.18 Storage conditions (C)= NS Storage intervals (I)= NS J x I= NS J x C= NS C x I= NS J x C x I= NS							

AT= Ambient temperature (13-27^{o}C) RT= Refrigerated temperature (0-4^{o}C)

Table 4.128 Effect of storage on antioxidant activity (%) of Kinnow based (two fruit) juice blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Kinnow (Control)	24.00	23.81	22.43	21.22	20.91	22.73	48.01
Kinnow: Aonla (9.5: 0.5)	50.43	48.37	47.21	46.33	45.56	48.06	47.25
Kinnow: Papaya (8: 2)	59.56	57.60	56.38	55.41	54.82	57.22	
Kinnow: Red grapes (5.5: 4.5)	65.62	62.19	60.70	61.54	59.33	62.50	
Mean	49.90	47.99	46.68	46.13	45.16		
Grand Mean (I)	49.90	47.34		45.64			
$CD_{(0.05)}$ Juice (J)= 0.34 Storage conditions (C)= 0.24 Storage intervals (I)= 0.29 J x I= 0.58 J x C= NS C x I= 0.41 J x C x I= NS							

AT= Ambient temperature (13-27^{o}C) RT= Refrigerated temperature (0-4^{o}C)

Table 4.129 Effect of storage on non-enzymatic browning of Kinnow based (two fruit) juice blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Kinnow (Control)	0.754	0.761	0.757	0.766	0.761	0.760	0.944
Kinnow: Aonla (9.5: 0.5)	0.787	0.794	0.790	0.798	0.794	0.793	0.942
Kinnow: Papaya (8: 2)	0.893	0.901	0.897	0.908	0.902	0.900	
Kinnow: Red grapes (5.5: 4.5)	1.326	1.316	1.320	1.319	1.323	1.321	
Kinnow (Control)	0.940	0.943	0.941	0.948	0.945		
Grand Mean (I)	0.940	0.942		0.946			
$CD_{(0.05)}$ Juice (J)= 0.01 Storage conditions (C)= NS Storage intervals (I)= NS J x I= NS J x C= NS C x I= NS J x C x I= NS							

AT= Ambient temperature (13-27^{o}C) RT= Refrigerated temperature (0-4^{o}C)

4.6.1.9 Non-enzymatic browning

Data showing the effect of storage on non-enzymatic browning (NEB) are presented in Table 4.129. NEB of all the blends differed significantly depending on the composition of blends. Highest NEB was recorded in kinnow: red grapes blend as 1.326 followed by kinnow: papaya (0.893). A marginal increase in mean NEB was recorded during storage. Kinnow: red grapes blend exhibited a insignificant decrease in NEB during storage. Average NEB after six month was recorded as 0.946 which increased from an average initial value of 0.940. Average NEB was recorded as 0.944 and 0.942 during six month of ambient and refrigerated storage, respectively which increased from a mean initial value of 0.940.

4.6.1.10 Sensory quality

Table 4.130 shows the colour score for kinnow based (two fruit) blends. The colour score of the blends ranged from 7.40 to 7.53. A gradual but non-significant decrease in colour score was recorded during storage. A mean colour score was recorded as 7.16 after six month which decreased from an average initial value of 7.46. More decrease in colour score was recorded at ambient storage as compared to refrigerated storage.

A gradual decrease in flavour score of blends was recorded with the advancement of storage period (Table 4.131). It decreased to a mean value of 6.31 at ambient storage from a mean initial value of 6.81 as against 6.57 at refrigerated storage. No significant effect of various interaction factors was recorded during storage.

Body score of the blends varied from 6.30 to 7.50 (Table 4.132). A marginal decrease in body score of blends was recorded with the advancement of storage period. The body score decreased from an average initial value of 6.87 to 6.69 after six month of storage irrespective of storage conditions.

Similarly, a gradual decrease in overall acceptability score of blends was recorded during storage of six month with mean value 6.67 which decreased from a mean initial value of 6.98 irrespective of storage conditions (Table 4.133). The minimum changes were noticed at refrigerated storage where mean initial overall acceptability score of 6.98 decreased to 6.87 as against 6.81 at ambient storage.

Table 4.130 Effect of storage on colour of Kinnow based (two fruit) juice blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Kinnow (Control)	7.53	6.70	6.90	6.50	6.80	6.89	7.26
Kinnow: Aonla (9.5: 0.5)	7.53	7.70	7.80	7.60	7.70	7.67	7.36
Kinnow: Papaya (8: 2)	7.40	7.20	7.30	7.00	7.20	7.22	
Kinnow: Red grapes (5.5: 4.5)	7.50	7.30	7.40	7.20	7.30	7.34	
Mean	7.49	7.23	7.35	7.08	7.25		
Grand Mean (I)	7.46	7.29		7.16			

$CD_{(0.05)}$ Juice (J)= 0.19 Storage conditions (C)= NS Storage intervals (I)= NS J x I= NS
J x C= NS C x I= NS J x C x I = NS

AT= Ambient temperature (13-27^{o}C) RT= Refrigerated temperature (0-4^{o}C)

Table 4.131 Effect of storage on flavour of Kinnow based (two fruit) juice blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Kinnow (Control)	6.33	5.80	6.10	5.50	5.87	5.92	6.31
Kinnow: Aonla (9.5: 0.5)	6.83	5.00	6.00	4.50	5.50	5.57	6.57
Kinnow: Papaya (8: 2)	7.00	6.70	6.80	6.50	6.60	6.72	
Kinnow: Red grapes (5.5: 4.5)	7.40	7.20	7.30	7.00	7.10	7.20	
Mean	6.89	6.18	6.55	5.88	6.27		
Grand Mean (I)	6.81	6.36		6.07			

$CD_{(0.05)}$ Juice (J)= 0.45 Storage conditions (C)= NS Storage intervals (I)= NS J x I= NS
J x C= NS C x I= NS J x C x I= NS

AT= Ambient temperature (13-27^{o}C) RT= Refrigerated temperature (0-4^{o}C)

Table 4.132 Effect of storage on body of Kinnow based (two fruit) juice blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Kinnow (Control)	6.30	6.20	6.20	6.10	6.20	6.20	6.75
Kinnow: Aonla (9.5: 0.5)	6.87	6.80	6.90	6.70	6.80	6.81	6.81
Kinnow: Papaya (8: 2)	6.80	6.60	6.70	6.50	6.60	6.64	
Kinnow: Red grapes (5.5: 4.5)	7.50	7.40	7.50	7.20	7.40	7.40	
Mean	6.87	6.75	6.83	6.63	6.75		
Grand Mean (I)	6.87	6.74		6.69			

$CD_{(0.05)}$ Juice (J)= 0.24 Storage conditions (C)= NS Storage intervals (I)= NS J x I= NS
J x C= NS C x I= NS J x C x I= NS

AT= Ambient temperature (13-27^{o}C) RT= Refrigerated temperature (0-4^{o}C)

Table 4.133 Effect of storage on overall acceptability of Kinnow based (two fruit) juice blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Kinnow (Control)	6.50	6.30	6.30	5.80	6.03	6.24	6.81
Kinnow: Aonla (9.5: 0.5)	7.13	7.00	7.07	6.83	6.97	7.02	6.87
Kinnow: Papaya (8: 2)	6.80	6.70	6.70	6.50	6.60	6.68	
Kinnow: Red grapes (5.5: 4.5)	7.50	7.40	7.40	7.20	7.40	7.40	
Mean	6.98	6.85	6.87	6.58	6.75		
Grand Mean (I)	6.98	6.86		6.67			
$CD_{(0.05)}$ Juice (J)= 0.22 Storage conditions (C)= NS Storage intervals (I)= NS J x I=NS J x C= NS C x I= NS J x C x I= NS							

AT= Ambient temperature (13-27^{o}C) RT= Refrigerated temperature (0-4^{o}C)

4.6.2 Kinnow based (three) fruit juice blends

4.6.2.1 Total soluble solids (TSS)

Data given in Table 4.134 reveal that the total soluble solids in blends ranged from 10.00 to 12.60^{o}B. Significant difference was recorded in TSS content of all blends. Maximum TSS was recorded in kinnow: aonla: red grapes (12.60^{o}B) while minimum value was 10.00^{o}B in kinnow juice sample (control). A gradual increase in TSS was recorded with the advancement of storage period which increased from average initial value of 11.37 to 11.73^{o}B after six month irrespective of all the factors however, changes were non-significant. Juice blends stored at ambient temperature showed more increase in TSS (from an initial value of 11.37 to 11.58^{o}B) while those stored at refrigerated temperature resulted in a minimum change (from an initial value of 11.37 to 11.50^{o}B) during storage. The interaction of various factors revealed the non-significant results for change in TSS during storage at both the temperatures.

4.6.2.2 Titratable acidity

Data obtained for the changes in titratable acidity of the kinnow based (three fruit) blends during storage are presented in Table 4.135. The mean maximum titratable acidity (1.07%) was recorded in control which was statistically at par with kinnow: aonla: red grapes while minimum was recorded as 0.82% in the kinnow: red grapes: papaya blend. A gradual increase in titratable acidity was recorded from an initial mean value of 1.00 to 1.03% after six month of storage however, changes were not significant. Changes were more at ambient storage where increase was from mean initial value of 1.00 to 1.02% as compared to refrigerated storage where the increase was from a mean initial value of 1.00 to 1.01 per cent. Insignificant effect of different interaction factors was observed for all the blends.

4.6.2.3 Reducing sugars

Perusal of data presented in Table 4.136 reveals that reducing sugars content ranged from 4.55 to 6.71% in different Kinnow based (three fruit) juice/pulp blends. Kinnow: red grapes: aonla blend contained maximum reducing sugars content as 6.71% followed by kinnow: papaya: aonla juice/pulp blend (4.92%). It was minimum in control (4.55%). No significant variation was recorded in reducing sugars content of all the treatments. An increasing trend of reducing sugars was noticed in all the blends during the storage irrespective of storage conditions. A gradual increase from an initial value of 5.25 (0 day) to 5.28 (3 month) and finally to 5.30% (6 month) was recorded during the storage. Storage conditions also did not affect the reducing sugars content as the increase was recorded from an average initial value of 5.25 to 5.28% in ambient storage as against 5.27% in refrigerated storage.

Table 4.134 Effect of storage on TSS (^{o}B) of Kinnow based (three fruit) juice blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Kinnow (Control)	10.00	10.30	10.20	10.60	10.40	10.25	11.58
Kinnow: Aonla: Red grapes (5.7: 0.3: 4)	12.60	12.80	12.70	13.10	12.90	12.78	11.50
Kinnow: Papaya: Aonla (7.2: 1.8: 1)	10.38	10.55	10.43	10.70	10.60	10.51	
Kinnow: Red grapes: Papaya (4.4: 3.6: 2)	12.48	12.60	12.57	12.84	12.70	12.61	
Mean	11.37	11.56	11.48	11.81	11.65		
Grand Mean (I)	11.37	11.52		11.73			
$CD_{(0.05)}$ Juice (J)= 0.35 Storage conditions (C)= NS Storage intervals (I)= NS J x I= NS J x C= NS C x I= NS J x C x I= NS							

AT= Ambient temperature (13-27^{o}C) RT= Refrigerated temperature (0-4^{o}C)

Table 4.135 Effect of storage on titratable acidity (%) of Kinnow based (three fruit) juice blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Kinnow (Control)	1.07	1.10	1.09	1.11	1.09	1.09	1.02
Kinnow: Aonla: Red grapes (5.7: 0.3: 4)	1.05	1.07	1.06	1.08	1.07	1.07	1.01
Kinnow: Papaya: Aonla (7.2: 1.8: 1)	1.06	1.07	1.07	1.09	1.08	1.07	
Kinnow: Red grapes: Papaya (4.4: 3.6: 2)	0.82	0.84	0.83	0.85	0.84	0.83	
Mean	1.00	1.02	1.01	1.03	1.02		
Grand Mean (I)	1.00	1.02		1.03			
$CD_{(0.05)}$ Juice (J)= 0.04 Storage conditions (C)= NS Storage intervals (I)= NS J x I= NS J x C= NS C x I= NS J x C x I= NS							

AT= Ambient temperature (13-27^{o}C) RT= Refrigerated temperature (0-4^{o}C)

Table 4.136 Effect of storage on reducing sugars (%) of Kinnow based (three fruit) juice blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Kinnow (Control)	4.55	4.59	4.58	4.61	4.60	4.58	5.28
Kinnow: Aonla: Red grapes (5.7: 0.3: 4)	6.71	6.75	6.73	6.77	6.75	6.74	5.27
Kinnow: Papaya: Aonla (7.2: 1.8: 1)	4.92	4.94	4.93	4.97	4.95	4.94	
Kinnow: Red grapes: Papaya (4.4: 3.6: 2)	4.82	4.86	4.84	4.88	4.86	4.85	
Mean	5.25	5.29	5.27	5.31	5.29		
Grand Mean (I)	5.25	5.28		5.30			
$CD_{(0.05)}$ Juice (J)= 0.05 Storage conditions (C)= NS Storage intervals (I)= NS J x I= NS J x C= NS C x I= NS J x C x I= NS							

AT= Ambient temperature (13-27^{o}C) RT= Refrigerated temperature (0-4^{o}C)

4.6.2.4 Total sugars

It is evident from the Table 4.137 that blending of juice resulted in increase of total sugars in all the blends except kinnow: papaya: aonla blend. The mean maximum total sugars content was recorded in kinnow: aonla: red grapes juice blends as 9.28% whereas it was minimum in kinnow: papaya: aonla blend (7.28%). An increasing trend was recorded in total sugars content of all the blends with the advancement of storage period. It was recorded to increase from an average initial value of 8.29 to 8.34% after six month of storage. Temperature did not show any significant effect on the total sugars of different blends however, it resulted in an increase from average initial value of 8.29 to 8.32 at ambient temperature as against 8.31% at refrigerated conditions. Besides, interaction of various factors revealed the non-significant results for change in total sugars.

4.6.2.5 Ascorbic acid

The perusal of data in Table 4.138 indicates that ascorbic acid in juice blends improved significantly by blending of kinnow juice with aonla and papaya juice/pulp however, in kinnow: red grapes: papaya blend it was found to decrease significantly. Average ascorbic acid content was recorded to be in the range of 11.65-59.12 mg/100 mL. The mean maximum ascorbic acid content was recorded in kinnow: papaya: aonla blend (59.12 mg/100 mL) while it was minimum in kinnow: red grapes: papaya (11.65 mg/100 mL). A decreasing trend was recorded for ascorbic acid content of all the blends during the storage, irrespective of storage conditions. Average ascorbic acid content was recorded to decrease significantly from an initial value of 30.71 to 22.46 mg/100 mL after six month of storage, irrespective of storage conditions. The decrease was higher at ambient storage where the decrease was from 30.71 to 25.21 as against 27.79 mg/100 mL at refrigerated storage.

4.6.2.6 Total phenolics

Data showing the effect of storage intervals and storage conditions on kinnow based (three fruit) juice/pulp blends are presented in Table 4.139. Total phenolics content (TPC) was found to be in the range from 8.45 to 92.61 mg/100 mL. A significant difference in the mean TPC was recorded in all the blends. It was highest in kinnow: aonla: red grapes (92.61 mg/100 mL) while lowest in control (8.45 mg/100 mL). A gradual decrease in the TPC was recorded from a mean initial value of 45.07 to 36.20 mg/100 mL with the advancement of storage. TPC was found to be affected significantly by storage condition. It decreased from an average initial value of 45.07 to 39.72 at ambient storage against 41.42 mg/100 mL at refrigerated storage. A significant effect of various interaction factors on total phenolics was also recorded for all the blends.

Table 4.137 Effect of storage on total sugars (%) of Kinnow based (three fruit) juice blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Kinnow (Control)	7.65	7.68	7.66	7.70	7.68	7.67	8.32
Kinnow: Aonla: Red grapes (5.7: 0.3: 4)	9.28	9.34	9.32	9.36	9.33	9.32	8.31
Kinnow: Papaya: Aonla (7.2: 1.8: 1)	7.28	7.31	7.30	7.33	7.32	7.30	
Kinnow: Red grapes: Papaya (4.4: 3.6: 2)	8.94	8.98	8.97	9.01	8.98	8.97	
Mean	8.23	8.33	8.31	8.35	8.33		
Grand Mean (I)	8.29	8.32		8.34			

$CD_{(0.05)}$ Juice (J)= 0.07 Storage conditions (C)= NS Storage intervals (I)= NS J x I= NS
J x C= NS C x I = NS J x C x I= NS

AT= Ambient temperature (13-27^{o}C) RT= Refrigerated temperature (0-4^{o}C)

Table 4.138 Effect of storage on ascorbic acid (mg/100 mL) of Kinnow based (three fruit) juice blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Kinnow (Control)	25.50	22.76	23.82	20.14	21.77	23.25	25.21
Kinnow: Aonla: Red grapes (5.7: 0.3: 4)	26.58	24.59	25.20	21.68	23.67	24.72	27.79
Kinnow: Papaya: Aonla (7.2: 1.8: 1)	59.12	42.19	51.87	30.26	44.29	47.81	
Kinnow: Red grapes: Papaya (4.4: 3.6: 2)	11.65	9.87	10.32	8.21	9.66	10.23	
Mean	30.71	24.85	27.80	20.07	24.85		
Grand Mean (I)	30.71	26.33		22.46			

$CD_{(0.05)}$ Juice (J)= 0.33 Storage conditions (C)= 0.23 Storage intervals (I)= 0.29 J x I= 0.57
J x C= 0.47 C x I= 0.40 J x C x I= 0.81

AT= Ambient temperature (13-27^{o}C) RT= Refrigerated temperature (0-4^{o}C)

Table 4.139 Effect of storage on total phenolics (mg/100 mL) of Kinnow based (three fruit) juice blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Kinnow (Control)	8.45	7.34	7.78	5.10	6.68	7.30	39.72
Kinnow: Aonla: Red grapes (5.7: 0.3: 4)	92.61	85.62	87.39	76.31	82.35	86.15	41.42
Kinnow: Papaya: Aonla (7.2: 1.8: 1)	43.33	35.36	37.65	28.59	33.46	36.95	
Kinnow: Red grapes: Papaya (4.4: 3.6: 2)	35.87	30.42	32.13	27.69	29.39	31.90	
Mean	45.07	39.69	41.24	34.42	37.97		
Grand Mean (I)	45.07	40.46		36.20			

$CD_{(0.05)}$ Juice (J)= 6.32 Storage conditions (C)= 1.23 Storage intervals (I)= 4.28 J x I= 2.46
J x C= 4.56 C x I= 7.40 J x C x I= 4.79

AT= Ambient temperature (13-27^{o}C) RT= Refrigerated temperature (0-4^{o}C)

4.6.2.7 Total carotenoids

Total carotenoids content of different blends are given in Table 4.140 which varied from 1.40 to 4.41 mg/100 mL. The mean maximum total carotenoids content was recorded in kinnow: papaya: aonla (4.41 mg/100 mL). A marginal decrease in total carotenoids of all the blends was recorded during storage where decrease was from 2.61 to 2.57 mg/100 mL however, losses were insignificant. An insignificant effect of various interaction factors was recorded for total carotenoids content of all the blends.

Table 4.140 Effect of storage on total carotenoids (mg/100 mL) of Kinnow based (three fruit) juice blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Kinnow (Control)	2.39	2.36	2.37	2.34	2.36	2.37	2.58
Kinnow: Aonla: Red grapes (5.7: 0.3: 4)	1.40	1.36	1.38	1.34	1.38	1.38	2.59
Kinnow: Papaya: Aonla (7.2: 1.8: 1)	4.41	4.38	4.40	4.37	4.39	4.39	
Kinnow: Red grapes: Papaya (4.4: 3.6: 2)	2.23	2.21	2.22	2.20	2.20	2.22	
Mean	2.61	2.58	2.59	2.56	2.58		
Grand Mean (I)	2.61	2.59		2.57			
$CD_{(0.05)}$ Juice (J)= 0.14 Storage conditions (C)= NS Storage intervals (I)= NS J x I= NS J x C= NS C x I= NS J x C x I= NS							

AT= Ambient temperature (13-27°C) RT= Refrigerated temperature (0-4°C)

4.6.2.8 Antioxidant activity

Data on the effect of storage on the antioxidant activity (AA) of blends are presented in Table 4.141. The antioxidant activity ranged from 24.00 to 65.48% in different blends. Significant differences were observed in the AA of all the juice blends. Storage intervals imposed a significant effect on the antioxidant activity of all the blends. The AA was observed to decrease from an average mean value of 52.74 (0 day) to 48.77 (6 month) during storage. Changes were lower at ambient temperature as compared to refrigerated temperature in case of all blends where AA reduced from 52.74 to 51.13 at ambient temperature and from 52.74 to 50.37 at refrigerated temperature. Similar trends were recorded in all the juice blends. Besides, the interaction of various factors revealed the non-significant results for change in antioxidant activity.

Table 4.141 Effect of storage on antioxidant activity (%) of Kinnow based (three fruit) juice blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Kinnow (Control)	24.00	23.81	22.43	21.22	20.91	22.73	51.13
Kinnow: Aonla: Red grapes (5.7: 0.3: 4)	59.09	57.81	56.34	56.10	55.25	57.28	50.37
Kinnow: Papaya: Aonla (7.2: 1.8: 1)	62.40	60.08	59.41	58.14	56.17	59.77	
Kinnow: Red grapes: Papaya (4.4: 3.6: 2)	65.48	63.34	62.67	62.09	60.29	63.23	
Mean	52.74	51.26	50.21	49.39	48.16		
Grand Mean (I)	52.74	50.74		48.77			
$CD_{(0.05)}$ Juice (J)= 1.50 Storage conditions (C)= 2.35 Storage intervals (I)= 1.43 J x I= 1.86 J x C= NS C x I= 1.61 J x C x I= NS							

AT= Ambient temperature (13-27^{o}C) RT= Refrigerated temperature (0-4^{o}C)

4.6.2.9 Non-enzymatic browning

It is clear from the data given in Table 4.142 that the mean non-enzymatic browning (NEB) increased with the advancement of storage period. A marginal decrease was recorded in NEB of kinnow: red grapes: papaya and kinnow: aonla: red grapes blends. The NEB of all the blends varied significantly with highest value for kinnow: aonla: red grapes blend (1.560) and the lowest for kinnow (0.754). No significant effect of storage period and storage conditions was recorded on NEB of juices. It increased from a mean initial value of 1.214 to 1.217. Besides, interaction of various factors did not impose significant changes in NEB.

Table 4.142 Effect of storage on non-enzymatic browning of Kinnow based (three fruit) juice blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Kinnow (Control)	0.754	0.767	0.759	0.774	0.766	0.764	1.216
Kinnow: Aonla: Red grapes (5.7: 0.3: 4)	1.560	1.555	1.558	1.548	1.554	1.555	1.215
Kinnow: Papaya: Aonla (7.2: 1.8: 1)	1.104	1.112	1.109	1.121	1.114	1.112	
Kinnow: Red grapes: Papaya (4.4: 3.6: 2)	1.436	1.432	1.435	1.429	1.433	1.433	
Mean	1.214	1.217	1.215	1.218	1.217		
Grand Mean (I)	1.214	1.215		1.217			
$CD_{(0.05)}$ Juice (J)= 0.04 Storage conditions (C)= NS Storage intervals (I)= NS J x I= NS J x C= NS C x I= NS J x C x I= NS							

AT= Ambient temperature (13-27^{o}C) RT= Refrigerated temperature (0-4^{o}C)

4.6.2.10 Sensory quality

The colour rating was found to increase by blending of juices (Table 4.143). It was highest (7.70) in kinnow: red grapes: papaya juice blend while lowest colour rating was recorded for pure kinnow juice. The colour rating of blends showed slight decrease during storage. It was found to decrease from an initial value of 7.35 to 7.16 at six month of storage however, changes were not significant. Blends stored at refrigerated temperature had better liking than those stored at ambient temperature. Colour rating decreased from an initial value of 7.35 to 7.23 and 7.29 at ambient and refrigerated storage conditions, respectively. The colour rating was not significantly affected by various interaction factors.

Data showing the effect of storage on the flavour rating of kinnow: red grapes: papaya and vegetable juice blends are presented in the Table 4.144. During storage the blends suffered losses in flavour score. However blends stored at low temperature were better than those stored at ambient temperature. During storage, the flavour rating was observed to decrease non-significantly from mean initial value of 6.63 to 5.98. Highest flavour rating was recorded as 7.60 (kinnow: red grapes: papaya blend) while it was lowest for control (6.00). Various interaction factors did not affect the flavour during the storage irrespective of storage conditions.

Perusal of the data presented in Table 4.145 indicates perceivable decrease in the body score of all the blends. The body score was recorded to increase with the blending. During storage, the body score was recorded to decrease from 7.10 at 0 day to 6.86 at 6 month. Storage conditions also affected the body score of blends as more decrease was recorded at ambient storage conditions. Besides this, changes were non-significant irrespective of various interaction factors.

Blending exhibited a significant increase in overall acceptability (OAA) rating of different blends. The OAA score of blends exhibited a gradual decrease with the advancement of storage conditions (Table 4.146). Kinnow: red grapes: papaya obtained superior rating (7.50) for OAA while control obtained lowest score on Hedonic scale (6.50) for OAA except control. The storage temperature also influenced the OAA score as it was lower (6.81) at ambient temperature as compared to low temperature storage (6.87) which decreasd from a mean initial value of 6.98. The OAA rating was found to decrease from an average initial value of 6.98 to 6.67 during six month of storage however, changes were insignificant.

Table 4.143 Effect of storage on colour of Kinnow based (three fruit) juice blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Kinnow (Control)	7.00	6.90	6.90	6.70	6.90	6.90	7.23
Kinnow: Aonla: Red grapes (5.7: 0.3: 4)	7.50	7.30	7.40	7.10	7.30	7.35	7.29
Kinnow: Papaya: Aonla (7.2: 1.8: 1)	7.20	7.10	7.17	7.06	7.10	7.14	
Kinnow: Red grapes: Papaya (4.4: 3.6: 2)	7.70	7.70	7.70	7.50	7.60	7.65	
Mean	7.35	7.25	7.29	7.09	7.23		
Grand Mean (I)	7.35	7.27		7.16			

$CD_{(0.05)}$ Juice (J)= 0.20 Storage conditions (C)= NS Storage intervals (I)= NS J x I= NS
J x C= NS C x I= NS J x C x I= NS

AT= Ambient temperature (13-27^{o}C) RT= Refrigerated temperature (0-4^{o}C)

Table 4.144 Effect of storage on flavour of Kinnow based (three fruit) juice blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Kinnow (Control)	6.00	5.00	5.00	4.00	4.30	5.05	6.27
Kinnow: Aonla: Red grapes (5.7: 0.3: 4)	6.70	6.60	6.70	6.50	6.60	6.63	6.33
Kinnow: Papaya: Aonla (7.2: 1.8: 1)	6.20	6.00	6.00	5.70	5.80	5.98	
Kinnow: Red grapes: Papaya (4.4: 3.6: 2)	7.60	7.50	7.50	7.40	7.50	7.52	
Mean	6.63	6.28	6.30	5.90	6.05		
Grand Mean (I)	6.63	6.29		5.98			

$CD_{(0.05)}$ Juice (J)= 0.35 Storage conditions (C)= NS Storage intervals (I)= NS J x I= NS
J x C= NS C x I= NS J x C x I= NS

AT= Ambient temperature (13-27^{o}C) RT= Refrigerated temperature (0-4^{o}C)

Table 4.145 Effect of storage on body of Kinnow based (three fruit) juice blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Kinnow (Control)	7.00	6.90	7.00	6.80	6.90	6.93	6.97
Kinnow: Aonla: Red grapes (5.7: 0.3: 4)	7.20	7.10	7.10	6.90	7.00	7.08	7.00
Kinnow: Papaya: Aonla (7.2: 1.8: 1)	7.00	6.90	6.80	6.80	6.70	6.87	
Kinnow: Red grapes: Papaya (4.4: 3.6: 2)	7.20	7.00	7.10	6.80	7.00	7.05	
Mean	7.10	6.98	7.00	6.83	6.90		
Grand Mean (I)	7.10	6.99		6.86			
$CD_{(0.05)}$ Juice (J) = NS Storage conditions (C) = NS Storage intervals (I)= NS J x I=NS J x C = NS C x I = NS J x C x I = NS							

AT= Ambient temperature (13-27^{o}C) RT= Refrigerated temperature (0-4^{o}C)

Table 4.146 Effect of storage on overall acceptability of Kinnow based (three fruit) juice blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Kinnow (Control)	6.50	6.30	6.30	5.80	6.03	6.24	6.81
Kinnow: Aonla: Red grapes (5.7: 0.3: 4)	7.13	7.00	7.07	6.83	6.97	7.02	6.87
Kinnow: Papaya: Aonla (7.2: 1.8: 1)	6.80	6.70	6.70	6.50	6.60	6.68	
Kinnow: Red grapes: Papaya (4.4: 3.6: 2)	7.50	7.40	7.40	7.20	7.40	7.40	
Mean	6.98	6.85	6.87	6.58	6.75		
Grand Mean (I)	6.98	6.86		6.67			
$CD_{(0.05)}$ Juice (J)= 0.22 Storage conditions (C)= NS Storage intervals (I)= NS J x I= NS J x C= NS C x I= NS J x C x I= NS							

AT= Ambient temperature (13-27^{o}C) RT= Refrigerated temperature (0-4^{o}C)

4.6.3 Kinnow: Aonla and vegetable juice blends

4.6.3.1 Total soluble solids (TSS)

Data given in Table 4.147 reveal that the total soluble solids in blends ranged from 9.30 to 11.24^{o}B. Significant difference was recorded in TSS content of all blends. Maximum TSS was recorded in kinnow: aonla: beetroot (11.24^{o}B) while minimum value was recorded as 9.30^{o}B in kinnow: aonla: cabbage blend. A gradual increase in TSS was recorded with the advancement of storage period which increased from average initial value of 10.12 to 10.47^{o}B after six month irrespective of all the factors however, changes were non-significant. Juice blends stored at ambient temperature showed more increase in TSS (from an initial value of 10.12 to 10.32^{o}B) while those stored at refrigerated temperature resulted in a minimum change (from an initial value of 10.12 to 10.24^{o}B) during storage. The interaction of various factors revealed the non-significant results for change in TSS during storage at both the temperatures.

4.6.3.2 Titratable acidity

Data obtained for the changes in titratable acidity of the kinnow: aonla and vegetable blends during storage are presented in Table 4.148. A significant difference was recorded in the titratable acidity of all the blends. It ranged from 0.66 to 1.18 per cent. The mean maximum titratable acidity (1.18%) was recorded in control while minimum was recorded as 0.66% in the kinnow: aonla: carrot blend. A gradual increase in titratable acidity was recorded from an initial mean value of 0.99 to 1.02% after six month of storage however, changes were insignificant. Changes were more at ambient storage where increase was from mean initial value of 0.99 to 1.01% as compared to refrigerated storage where the increase was from a mean initial value of 0.99 to 1.00 per cent. Insignificant effect of different interaction factors was observed for all the blends.

4.6.3.3 Reducing sugars

Perusal of data presented in Table 4.149 reveals that reducing sugars content of blends ranged from 3.82 to 5.46 per cent. Kinnow: aonla: beetroot blend contained the maximum reducing sugars content as 5.46% followed by control (4.56%). It was minimum in kinnow: aonla: cabbage (3.82%). No significant variation was recorded in reducing sugars content of all the blends. An increasing trend of reducing sugars was noticed in all the blends during the storage, irrespective of storage conditions. A gradual increase from an initial value of 4.55 (0 day) to 4.57 (3 month) and finally to 4.59% (6 month) was recorded during the storage. Storage conditions also did not affect the reducing sugars content as the increase was recorded from an average initial value of 4.55 to 4.58% in ambient storage as against 4.56% in refrigerated storage.

Table 4.147 Effect of storage on total soluble solids (^{o}B) of Kinnow: Aonla and vegetable blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Kinnow: Aonla (9.5: 0.5)	10.20	10.40	10.30	10.70	10.50	10.38	10.32
Kinnow: Aonla: Tomato (9: 0.5: 0.5)	9.86	9.98	9.92	10.23	10.11	9.99	10.24
Kinnow: Aonla: Carrot (5.2: 0.3: 4.5)	9.99	10.18	10.05	10.31	10.20	10.12	
Kinnow: Aonla: Beetroot (6.6: 0.4: 3)	11.24	11.41	11.36	11.78	11.58	11.44	
Kinnow: Aonla: Cabbage (9: 0.5: 5)	9.30	9.50	9.43	9.72	9.61	9.48	
Mean	10.12	10.29	10.21	10.55	10.40		
Grand Mean (I)	10.12	10.25		10.47			
$CD_{(0.05)}$ Juice (J)= 0.14 Storage conditions (C)= NS Storage intervals (I)= NS J x I= NS J x C= NS C x I= NS J x C x I= NS							

AT= Ambient temperature (13-27^{o}C) RT= Refrigerated temperature (0-4^{o}C)

Table 4.148 Effect of storage on titratable acidity (%) of Kinnow: Aonla and vegetable blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Kinnow: Aonla (9.5: 0.5)	1.18	1.20	1.19	1.22	1.21	1.20	1.01
Kinnow: Aonla: Tomato (9: 0.5: 0.5)	1.15	1.17	1.16	1.18	1.17	1.16	1.00
Kinnow: Aonla: Carrot (5.2: 0.3: 4.5)	0.66	0.67	0.66	0.68	0.67	0.67	
Kinnow: Aonla: Beetroot (6.6: 0.4: 3)	0.84	0.86	0.85	0.88	0.86	0.86	
Kinnow: Aonla: Cabbage (9: 0.5: 5)	1.12	1.14	1.13	1.15	1.14	1.13	
Mean	0.99	1.01	1.00	1.02	1.01		
Grand Mean (I)	0.99	1.00		1.02			
$CD_{(0.05)}$ Juice (J)= 0.05 Storage conditions (C)= NS Storage intervals (I)= NS J x I= NS J x C= NS C x I= NS J x C x I= NS							

AT= Ambient temperature (13-27^{o}C) RT= Refrigerated temperature (0-4^{o}C)

Table 4.149 Effect of storage on reducing sugars (%) of Kinnow: Aonla and vegetable blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Kinnow: Aonla (9.5: 0.5)	4.56	4.58	4.56	4.59	4.57	4.57	4.58
Kinnow: Aonla: Tomato (9: 0.5: 0.5)	4.43	4.46	4.42	4.48	4.45	4.45	4.56
Kinnow: Aonla: Carrot (5.2: 0.3: 4.5)	4.48	4.51	4.50	4.52	4.51	4.50	
Kinnow: Aonla: Beetroot (6.6: 0.4: 3)	5.46	5.49	5.48	5.52	5.51	5.49	
Kinnow: Aonla: Cabbage (9: 0.5: 5)	3.82	3.85	3.84	3.87	3.86	3.85	
Mean	4.55	4.58	4.56	4.60	4.58		
Grand Mean (I)	4.55	4.57		4.59			
$CD_{(0.05)}$ Juice (J)= 0.06 Storage conditions (C)= NS Storage intervals (I)= NS J x I= NS J x C= NS C x I= NS J x C x I= NS							

AT= Ambient temperature (13-27^{o}C) RT= Refrigerated temperature (0-4^{o}C)

4.6.3.4 Total sugars

It is evident from the Table 4.150 that total sugars content of blends ranged from 7.22 to 7.84 per cent. The mean maximum total sugars content was recorded in kinnow: aonla: beetroot juice blends as 7.84% whereas it was minimum in kinnow: aonla: cabbage blend (7.22%). An increasing trend was recorded in total sugars content of all the blends with the advancement of storage period. It was recorded to increase from an average initial value of 7.45 to 7.49% after six month of storage. Temperature did not show any significant effect on the total sugars of different blends however, it resulted in an increase from average initial value of 7.45 to 7.48 at ambient temperature as against 7.47% at refrigerated conditions. Besides, interaction of various factors revealed the non-significant results for change in total sugars.

4.6.3.5 Ascorbic acid

The perusal of data in Table 4.151 shows the effect of blending on ascorbic acid content of kinnow: aonla and vegetable blends. Average ascorbic acid content was recorded to be in the range of 20.97-40.21 mg/100 mL. The maximum ascorbic acid content was recorded in kinnow: aonla (40.21 mg/100 mL) while it was minimum in kinnow: aonla: carrot (20.97 mg/100 mL). A decreasing trend was recorded for ascorbic acid content of all the blends during the storage. Average ascorbic acid content was recorded to decrease significantly from an initial value of 32.54 to 28.67 mg/ 100 mL after six month of storage, irrespective of storage conditions. The decrease was higher at ambient storage where the mean value was 30.24 which decreased from a mean initial value of 32.54 as against 30.92 mg/100 mL at refrigerated storage.

4.6.3.6 Total phenolics

Data showing the effect of storage intervals and storage conditions on kinnow: aonla and vegetable blends are presented in Table 4.152. Total phenolics content (TPC) was found to be in the range from 13.95 to 80.21 mg/100 mL. A significant difference in the mean TPC was recorded in all the blends. It was highest in Kinnow: Aonla: Beetroot (80.21 mg/100 mL) while lowest in kinnow: aonla: carrot (13.95 mg/100 mL). A gradual decrease in the TPC was recorded from a mean initial value of 33.35 to 25.67 mg/100 mL with the advancement of storage. TPC was found to be affected significantly by storage condition. It decreased from an average initial value of 33.35 to 28.35 at ambient storage against 29.06 mg/100 mL at refrigerated storage. A significant effect of various interaction factors on total phenolics was also recorded for all the blends.

Table 4.150 Effect of storage on total sugars (%) of Kinnow: Aonla and vegetable blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Kinnow: Aonla (9.5: 0.5)	7.55	7.58	7.57	7.60	7.58	7.58	7.48
Kinnow: Aonla: Tomato (9: 0.5: 0.5)	7.26	7.28	7.27	7.30	7.29	7.28	7.47
Kinnow: Aonla: Carrot (5.2: 0.3: 4.5)	7.39	7.14	7.40	7.44	7.42	7.36	
Kinnow: Aonla: Beetroot (6.6: 0.4: 3)	7.84	7.87	7.85	7.89	7.87	7.86	
Kinnow: Aonla: Cabbage (9: 0.5: 5)	7.22	7.25	7.24	7.26	7.25	7.24	
Mean	7.45	7.48	7.47	7.50	7.48		
Grand Mean (I)	7.45	7.47		7.49			
$CD_{(0.05)}$ Juice (J)= 0.40 Storage conditions (C)= NS Storage intervals (I)= NS J x I= NS J x C= NS C x I= NS J x C x I= NS							

AT= Ambient temperature (13-27^{o}C) RT= Refrigerated 15.79 temperature (0-4^{o}C)

Table 4.151 Effect of storage on ascorbic acid (mg/100 mL) of Kinnow: Aonla and vegetable blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Kinnow: Aonla (9.5: 0.5)	40.21	37.52	38.30	34.72	36.28	37.41	30.24
Kinnow: Aonla: Tomato (9: 0.5: 0.5)	36.56	34.12	35.09	32.35	34.98	34.62	30.92
Kinnow: Aonla: Carrot (5.2: 0.3: 4.5)	20.97	18.64	19.16	17.24	18.42	18.89	
Kinnow: Aonla: Beetroot (6.6: 0.4: 3)	28.13	26.97	27.57	24.86	25.69	26.64	
Kinnow: Aonla: Cabbage (9: 0.5: 5)	36.85	33.59	34.29	30.93	31.26	33.38	
Mean	32.54	30.17	30.88	28.02	29.33		
Grand Mean (I)	32.54	30.53		28.67			
$CD_{(0.05)}$ Juice (J)= 0.88 Storage conditions (C)= 0.56 Storage intervals (I)= 0.68 J x I= NS J x C= NS C x I= NS J x C x I= NS							

AT= Ambient temperature (13-27^{o}C) RT= Refrigerated temperature (0-4^{o}C)

Table 4.152 Effect of storage on total phenolics (mg/100 mL) of Kinnow: Aonla and vegetable blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Kinnow: Aonla (9.5: 0.5)	23.05	20.37	21.52	18.16	19.68	20.56	28.35
Kinnow: Aonla: Tomato (9: 0.5: 0.5)	23.83	21.59	22.24	20.41	21.81	21.98	29.06
Kinnow: Aonla: Carrot (5.2: 0.3: 4.5)	13.95	11.36	12.40	10.54	11.27	11.90	
Kinnow: Aonla: Beetroot (6.6: 0.4: 3)	80.21	57.22	58.39	55.94	56.27	61.61	
Kinnow: Aonla: Cabbage (9: 0.5: 5)	25.71	22.39	23.45	20.46	22.15	22.83	
Mean	33.35	26.59	27.60	25.10	26.24		
Grand Mean (I)	33.35	27.09		25.67			
$CD_{(0.05)}$ Juice (J)= 1.74 Storage conditions (C)= NS Storage intervals (I)= 1.35 J x I= NS J x C= NS C x I= NS J x C x I= NS							

AT= Ambient temperature (13-27^{o}C) RT= Refrigerated temperature (0-4^{o}C)

4.6.3.7 Total carotenoids

Total carotenoids content of different blends are given in Table 4.153 which varied from 1.66 to 5.43 mg/100 mL. The mean maximum total carotenoids content was recorded in kinnow: aonla: carrot (5.43 mg/100 mL). A marginal decrease in total carotenoids of all the blends was recorded during storage where decrease was from 2.83 to 2.78 mg/100 mL however, losses were insignificant. It reduced upto a mean value of 2.80 at ambient storage as against 2.81 at refrigerated storage from a mean initial value of 2.83 mg/100 mL. An insignificant effect of various interaction factors was recorded for total carotenoids content of all the blends.

Table 4.153 Effect of storage on total carotenoids (mg/100 mL) of Kinnow: Aonla and vegetable blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Kinnow: Aonla (9.5: 0.5)	2.34	2.32	2.33	2.30	2.32	2.32	2.80
Kinnow: Aonla: Tomato (9: 0.5: 0.5)	2.49	2.47	2.48	2.46	2.47	2.47	2.81
Kinnow: Aonla: Carrot (5.2: 0.3: 4.5)	5.43	5.38	5.40	5.36	5.38	5.39	
Kinnow: Aonla: Beetroot (6.6: 0.4: 3)	1.66	1.62	1.64	1.59	1.61	1.62	
Kinnow: Aonla: Cabbage (9: 0.5: 5)	2.22	2.19	2.20	2.17	2.18	2.19	
Mean	2.83	2.80	2.81	2.78	2.79		
Grand Mean (I)	2.83	2.80		2.78			
$CD_{(0.05)}$ Juice (J)= 0.04 Storage conditions (C)= NS Storage intervals (I)= NS J x I= 18.04 J x C= NS C x I= NS J x C x I= NS							

AT= Ambient temperature (13-27^{o}C) RT= Refrigerated temperature (0-4^{o}C)

Table 4.154 Effect of storage on antioxidant activity (%) of Kinnow: Aonla and vegetable blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Kinnow: Aonla (9.5: 0.5)	50.43	48.37	47.21	46.33	45.56	47.58	51.57
Kinnow: Aonla: Tomato (9: 0.5: 0.5)	50.76	49.32	48.41	48.72	47.10	48.86	50.74
Kinnow: Aonla: Carrot (5.2: 0.3: 4.5)	56.57	55.49	54.74	53.28	52.23	54.46	
Kinnow: Aonla: Beetroot (6.6: 0.4: 3)	57.69	56.94	55.39	54.26	53.67	55.59	
Kinnow: Aonla: Cabbage (9: 0.5: 5)	50.18	47.08	46.00	46.61	45.13	47.00	
Mean	53.13	51.44	50.35	49.84	48.74		
Grand Mean (I)	53.13	50.90		49.29			

$CD_{(0.05)}$ Juice (J)= 1.38 Storage conditions (C)= NS Storage intervals (I)= 1.07 J x I= NS
J x C= NS C x I= NS J x C x I= NS

AT= Ambient temperature (13-27°C) RT= Refrigerated temperature (0-4°C)

Table 4.155 Effect of storage on non-enzymatic browning of Kinnow: Aonla and vegetable blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Kinnow: Aonla (9.5: 0.5)	0.787	0.794	0.790	0.798	0.794	0.793	1.456
Kinnow: Aonla: Tomato (9: 0.5: 0.5)	0.793	0.798	0.795	0.805	0.802	0.799	1.454
Kinnow: Aonla: Carrot (5.2: 0.3: 4.5)	0.813	0.824	0.817	0.829	0.823	0.821	
Kinnow: Aonla: Beetroot (6.6: 0.4: 3)	4.106	4.102	4.104	4.099	4.101	4.102	
Kinnow: Aonla: Cabbage (9: 0.5: 5)	0.759	0.765	0.763	0.769	0.765	0.764	
Mean	1.452	1.457	1.454	1.460	1.457		
Grand Mean (I)	1.452	1.455		1.459			

$CD_{(0.05)}$ Juice (J)= 0.01 Storage conditions (C)= NS Storage intervals (I)= NS J x I= NS
J x C= NS C x I= NS J x C x I= NS

AT= Ambient temperature (13-27°C) RT= Refrigerated temperature (0-4°C)

4.6.3.8 Antioxidant activity

Data on the effect of storage on the antioxidant activity (AA) of blends are presented in Table 4.154. The antioxidant activity ranged from 50.18 to 57.69% in different blends. Significant differences were observed in the AA of all the juice blends. Storage intervals imposed a significant effect on the antioxidant activity of all the blends. The AA was observed to decrease from an average mean value of 53.13 (0 day) to 49.29% (6 month) during storage. Changes were lower at ambient temperature as compared to refrigerated temperature in case of all blends where AA reduced from 53.13 to 51.57% at ambient temperature as against 50.74% at refrigerated temperature. Similar trend was recorded in all the juice blends. Besides, interaction of various factors revealed the non-significant results for change in antioxidant activity.

4.6.3.9 Non-enzymatic browning

It is clear from the data given in Table 4.155 that the mean non-enzymatic browning (NEB) increased with the advancement of storage period for all the blends except kinnow: aonla: Beetroot blend where it decreased marginally with the advancement of storage period. The highest NEB value was recorded for kinnow: aonla: beetroot blend (4.106) and the lowest for kinnow: aonla: cabbage (0.759). No significant effect of storage period and storage conditions was recorded on NEB of juices. Besides, interaction of various factors did not impose significant changes in NEB. Overall mean NEB increased from an average initial value of 1.452 to 1.450.

4.6.3.10 Sensory quality

The colour rating was found to increase significantly by blending of juices (Table 4.156). It was highest (7.80) in kinnow: aonla: carrot juice blend while lowest colour rating was recorded for kinnow: aonla: tomato blend (6.80). The colour rating of blends showed slight decrease during storage. It was found to decrease from an initial value of 7.24 to 7.04 at six month of storage however, changes were not significant. Blends stored at refrigerated temperature showed better ranking than those stored at ambient temperature. The colour rating decreased from an initial value of 7.24 to 7.09 and 7.16 at ambient and refrigerated storage conditions, respectively. The colour rating was not significantly affected by various interaction factors.

Data showing the effect of storage on the flavour rating of juice blends are presented in the Table 4.157. During storage the blends experienced decrease in flavour score. However, blends stored at low temperature were better than those stored at ambient temperature. During storage, the flavour rating was observed to decrease non-significantly from mean initial value of 7.20 to 6.96. Highest flavour rating was recorded as 8.00 (Kinnow: Aonla: Carrot blend) while it was lowest for kinnow: aonla: tomato (6.50). Various interaction factors did not affect the flavour during the storage irrespective of storage conditions.

Perusal of the data presented in Table 4.158 indicates marginal decrease in the body score of all the blends. During storage, the body score was recorded to decrease from 7.46 at 0 day to 7.26 at 6 month irrespective of storage conditions. Storage conditions also affected the body score of blends as more decrease was recorded at ambient storage conditions. Besides, changes were non-significant irrespective of various interaction factors.

Blending exhibited a significant increase in overall acceptability (OAA) rating of different blends (Table 4.159). The OAA score of blends exhibited a gradual decrease with the advancement of storage conditions. kinnow: aonla: carrot blend obtained superior rating (8.10) for OAA while Kinnow: Aonla: Tomato obtained lowest score on Hedonic scale (7.00) for OAA. The storage temperature also influenced the OAA score as it was lower (7.25) at ambient temperature as compared to low temperature storage (7.32). OAA rating was found to decrease from an average initial value of 7.40 to 7.29 during six month of storage however, changes were insignificant.

Table 4.156 Effect of storage on colour of Kinnow: Aonla and vegetable blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Kinnow: Aonla (9.5: 0.5)	7.00	6.80	6.90	6.75	6.84	6.86	7.09
Kinnow: Aonla: Tomato (9: 0.5: 0.5)	6.80	6.65	6.72	6.60	6.68	6.69	7.16
Kinnow: Aonla: Carrot (5.2: 0.3: 4.5)	7.80	7.60	7.70	7.57	7.67	7.67	
Kinnow: Aonla: Beetroot (6.6: 0.4: 3)	7.50	7.34	7.40	7.25	7.30	7.36	
Kinnow: Aonla: Cabbage (9: 0.5: 5)	7.10	6.93	7.02	6.80	6.90	6.95	
Mean	7.24	7.06	7.15	6.99	7.08		
Grand Mean (I)	7.24	7.11		7.04			
$CD_{(0.05)}$ Juice (J)= 0.39 Storage conditions (C)= NS Storage intervals (I)= NS J x I= NS J x C= NS C x I= NS J x C x I= NS							

AT= Ambient temperature (13-27^{o}C) RT= Refrigerated temperature (0-4^{o}C)

Table 4.157 Effect of storage on flavour of Kinnow: Aonla and vegetable blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Kinnow: Aonla (9.5: 0.5)	6.80	6.60	6.70	6.52	6.60	6.64	7.04
Kinnow: Aonla: Tomato (9: 0.5: 0.5)	6.50	6.30	6.40	6.20	6.33	6.35	7.10
Kinnow: Aonla: Carrot (5.2: 0.3: 4.5)	8.00	7.80	7.90	7.70	7.80	7.84	
Kinnow: Aonla: Beetroot (6.6: 0.4: 3)	7.50	7.30	7.40	7.20	7.30	7.34	
Kinnow: Aonla: Cabbage (9: 0.5: 5)	7.20	7.00	7.12	6.90	7.00	7.04	
Mean	7.20	7.00	7.10	6.90	7.01		
Grand Mean (I)	7.20	7.05		6.96			
$CD_{(0.05)}$ Juice (J)= 0.64 Storage conditions (C)= NS Storage intervals (I)= NS J x I= NS J x C= NS C x I= NS J x C x I= NS							

AT= Ambient temperature (13-27^{o}C) RT= Refrigerated temperature (0-4^{o}C)

Table 4.158 Effect of storage on body of Kinnow: Aonla and vegetable blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Kinnow: Aonla (9.5: 0.5)	7.50	7.40	7.50	7.30	7.40	7.42	7.32
Kinnow: Aonla: Tomato (9: 0.5: 0.5)	7.20	7.00	7.10	6.90	7.00	7.04	7.38
Kinnow: Aonla: Carrot (5.2: 0.3: 4.5)	7.80	7.65	7.70	7.60	7.70	7.69	
Kinnow: Aonla: Beetroot (6.6: 0.4: 3)	7.60	7.44	7.50	7.30	7.40	7.45	
Kinnow: Aonla: Cabbage (9: 0.5: 5)	7.20	6.95	7.10	6.90	7.05	7.04	
Mean	7.46	7.29	7.38	7.20	7.31		
Grand Mean (I)	7.46	7.33		7.26			
$CD_{(0.05)}$ Juice (J)= 0.42 Storage conditions (C)= NS Storage intervals (I)= NS J x I= NS J x C= NS C x I= NS J x C x I= NS							

AT= Ambient temperature (13-27^{o}C) RT= Refrigerated temperature (0-4^{o}C)

Table 4.159 Effect of storage on overall acceptability of Kinnow: Aonla and vegetable blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Kinnow: Aonla (9.5: 0.5)	7.10	7.00	7.10	6.90	7.00	7.02	7.25
Kinnow: Aonla: Tomato (9: 0.5: 0.5)	7.00	6.80	6.90	6.70	6.80	6.84	7.32
Kinnow: Aonla: Carrot (5.2: 0.3: 4.5)	8.10	7.90	8.00	7.87	8.00	7.97	
Kinnow: Aonla: Beetroot (6.6: 0.4: 3)	7.60	7.40	7.50	7.30	7.40	7.44	
Kinnow: Aonla: Cabbage (9: 0.5: 5)	7.20	7.00	7.10	6.90	7.00	7.04	
Mean	7.40	7.22	7.32	7.13	7.24		
Grand Mean (I)	7.40	7.27		7.29			
$CD_{(0.05)}$ Juice (J)= 0.57 Storage conditions (C)= NS Storage intervals (I)= NS J x I= 18.04 J x C= NS C x I= NS J x C x I= NS							

AT= Ambient temperature (13-27^{o}C) RT= Refrigerated temperature (0-4^{o}C)

4.6.4 Kinnow: Papaya and vegetable juice blends

4.6.4.1 Total soluble solids (TSS)

Data given in Table 4.160 reveal that the total soluble solids in blends ranged from 9.67 to 11.48^{o}B. Significant difference was recorded in TSS content of all blends. The mean maximum TSS was recorded in kinnow: papaya: beetroot (11.48^{o}B) while minimum value was recorded as 9.67^{o}B in kinnow: papaya: carrot blend. A gradual increase in TSS was recorded with the advancement of storage period which increased from average initial value of 10.26 to 10.58^{o}B after six month irrespective of all the factors. Juice blends stored at ambient temperature showed more increase in TSS (from an initial value of 10.26 to 10.45^{o}B) while those stored at refrigerated temperature resulted in a minimum change (from an initial value of 10.26 to 10.38^{o}B) during storage. The interaction of various factors revealed the non-significant results for change in TSS during storage at both the temperatures.

4.6.4.2 Titratable acidity

Data obtained for the changes in titratable acidity of the kinnow: papaya and vegetable blends during storage are presented in Table 4.161. A significant difference was recorded in the titratable acidity of all the blends. The mean maximum titratable acidity (0.90%) was recorded in control while minimum was recorded as 0.63% in the kinnow: papaya: carrot blend. A gradual increase in titratable acidity was recorded from an initial mean value of 0.81 to 0.83% after six month of storage however, changes were not significant. Changes were more at ambient storage where increase was from mean initial value of 0.81 to 0.83% as compared to refrigerated storage where the increase was from a mean initial value of 0.81 to 0.82 per cent. Insignificant effect of different interaction factors was observed for all the blends.

4.6.4.3 Reducing sugars

Perusal of data presented in Table 4.162 reveals that reducing sugars content ranged from 4.32 to 5.45% in different blends. Kinnow:

Table 4.160 Effect of storage on total soluble solids (^oB) of Kinnow: Papaya and vegetable blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Kinnow: Papaya (Control)	10.30	10.71	10.52	10.90	10.75	10.58	10.45
Kinnow: Papaya: Tomato (7.2: 1.8: 1)	9.88	9.98	9.95	10.20	10.10	10.00	10.38
Kinnow: Papaya: Carrot (5.6: 1.4: 3)	9.67	9.80	9.75	10.10	9.90	9.82	
Kinnow: Papaya: Beetroot (6.4: 1.6: 2)	11.48	11.60	11.56	11.80	11.72	11.61	
Kinnow: Papaya: Cabbage (7.6: 1.9: 0.5)	9.97	10.10	10.02	10.20	10.14	10.07	
Mean	10.26	10.43	10.36	10.64	10.52		
Grand Mean (I)	10.26	10.40		10.58			

$CD_{(0.05)}$ Juice (J)= 0.18 Storage conditions (C)= NS Storage intervals (I)= 0.14 J x I= NS
J x C= NS C x I= NS J x C x I= NS

AT= Ambient temperature (13-27^{o}C) RT= Refrigerated temperature (0-4^{o}C)

Table 4.161 Effect of storage on titratable acidity (%) of Kinnow: Papaya and vegetable blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Kinnow: Papaya (Control)	0.90	0.92	0.91	0.93	0.92	0.91	0.83
Kinnow: Papaya: Tomato (7.2: 1.8: 1)	0.88	0.90	0.89	0.91	0.90	0.89	0.82
Kinnow: Papaya: Carrot (5.6: 1.4: 3)	0.63	0.65	0.64	0.66	0.65	0.64	
Kinnow: Papaya: Beetroot (6.4: 1.6: 2)	0.77	0.78	0.77	0.79	0.78	0.78	
Kinnow: Papaya: Cabbage (7.6: 1.9: 0.5)	0.88	0.89	0.89	0.90	0.89	0.89	
Mean	0.81	0.83	0.82	0.84	0.83		
Grand Mean (I)	0.81	0.82		0.83			

$CD_{(0.05)}$ Juice (J)= 0.03 Storage conditions (C)= NS Storage intervals (I)= NS J x I= NS
J x C= NS C x I= NS J x C x I= NS

AT= Ambient temperature (13-27^{o}C) RT= Refrigerated temperature (0-4^{o}C)

Table 4.162 Effect of storage on reducing sugars (%) of Kinnow: Papaya and vegetable blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Kinnow: Papaya (Control)	4.90	4.94	4.92	4.98	4.95	4.93	4.86
Kinnow: Papaya: Tomato (7.2: 1.8: 1)	4.32	4.36	4.34	4.39	4.36	4.35	4.84
Kinnow: Papaya: Carrot (5.6: 1.4: 3)	4.69	4.72	4.71	4.75	4.73	4.72	
Kinnow: Papaya: Beetroot (6.4: 1.6: 2)	5.45	5.49	5.47	5.51	5.49	5.48	
Kinnow: Papaya: Cabbage (7.6: 1.9: 0.5)	4.76	4.79	4.78	4.82	4.79	4.78	
Mean	4.82	4.86	4.84	4.89	4.86		
Grand Mean (I)	4.82	4.85		4.88			

$CD_{(0.05)}$ Juice (J)= 0.03 Storage conditions (C)= NS Storage intervals (I)= NS J x I= NS
J x C= NS C x I= NS J x C x I= NS

AT= Ambient temperature (13-27^{o}C) RT= Refrigerated temperature (0-4^{o}C)

papaya: beetroot blend contained maximum reducing sugars content as 5.45% followed by control (4.90%). It was minimum in kinnow: papaya: tomato (4.32%). A significant variation was recorded in reducing sugars content of all the treatments. An increasing trend in reducing sugars content was noticed in all the blends during the storage irrespective of storage conditions. A gradual increase from an initial value of 4.82 (0 day) to 4.85 (3 month) and finally to 4.88% (6 month) was recorded during the storage. Storage conditions affected the reducing sugars content insignificantly as the increase was recorded from an average initial value of 4.82 to 4.86% in ambient storage as against 4.84% in refrigerated storage.

4.6.4.4 Total sugars

Table 4.163 shows the effect of blending and storage on total sugars content of juice blends. The mean maximum total sugars content was recorded in kinnow: papaya: beetroot blends as 8.10% whereas it was minimum in kinnow: papaya: tomato blend (7.00%). An increasing trend was recorded in total sugars content of all the blends with the advancement of storage period. It was recorded to increase from an average initial value of 7.50 to 7.61% after six month of storage. Temperature did not show any significant effect on the total sugars of different blends however, it resulted in an increase from average initial value of 7.50 to 7.57 at ambient temperature as against 7.55% at refrigerated conditions. Besides, interaction of various factors revealed the non-significant results for change in total sugars.

4.6.4.5 Ascorbic acid

The perusal of data in Table 4.164 indicates that ascorbic acid content decreased significantly by blending of kinnow: papaya blend with vegetable juice/pulp. Average ascorbic acid content was recorded to be in the range of 13.14-18.55 mg/100 mL. The maximum ascorbic acid content was recorded in control (18.55 mg/100 mL) followed by kinnow: papaya: cabbage blend (16.42 mg/100 mL) while it was minimum in kinnow: papaya: carrot blend (13.14 mg/100 mL). A significant loss in

Table 4.163 Effect of storage on total sugars (%) of Kinnow: Papaya and vegetable blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Kinnow: Papaya (Control)	7.42	7.46	7.44	7.49	7.47	7.45	7.57
Kinnow: Papaya: Tomato (7.2: 1.8: 1)	7.00	7.20	7.20	7.50	7.30	7.20	7.55
Kinnow: Papaya: Carrot (5.6: 1.4: 3)	7.22	7.25	7.24	7.27	7.25	7.24	
Kinnow: Papaya: Beetroot (6.4: 1.6: 2)	8.10	8.12	8.11	8.15	8.13	8.12	
Kinnow: Papaya: Cabbage (7.6: 1.9: 0.5)	7.75	7.78	7.77	7.79	7.78	7.77	
Kinnow: Papaya (Control)	7.50	7.56	7.55	7.64	7.59		
Grand Mean (I)	7.50	7.56		7.61			
$CD_{(0.05)}$ Juice (J)= 0.12 Storage conditions (C)= NS Storage intervals (I)= NS J x I= NS J x C= NS C x I= NS J x C x I= NS							

AT= Ambient temperature (13-27°C) RT= Refrigerated 15.79 temperature (0-4°C)

Table 4.164 Effect of storage on ascorbic acid (mg/100 mL) of Kinnow: Papaya and vegetable blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Kinnow: Papaya (Control)	18.55	16.26	17.16	14.46	15.82	16.80	13.32
Kinnow: Papaya: Tomato (7.2: 1.8: 1)	14.82	12.65	13.21	10.26	12.10	12.98	14.12
Kinnow: Papaya: Carrot (5.6: 1.4: 3)	13.14	11.26	12.21	9.64	10.86	11.71	
Kinnow: Papaya: Beetroot (6.4: 1.6: 2)	14.49	12.29	13.11	10.58	11.86	12.80	
Kinnow: Papaya: Cabbage (7.6: 1.9: 0.5)	16.42	13.54	14.66	11.37	13.41	14.30	
Mean	15.48	13.20	14.07	11.26	12.81		
Grand Mean (I)	15.48	13.64		12.04			
$CD_{(0.05)}$ Juice (J)= 0.89 Storage conditions (C)= 0.57 Storage intervals (I)= 0.69 J x I= NS J x C= NS C x I= NS J x C x I= NS							

AT= Ambient temperature (13-27°C) RT= Refrigerated temperature (0-4°C)

Table 4.165 Effect of storage on total phenolics (mg/100 mL) of Kinnow: Papaya and vegetable blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Kinnow: Papaya (Control)	18.56	17.09	17.82	15.48	16.71	17.37	25.49
Kinnow: Papaya: Tomato (7.2: 1.8: 1)	17.50	15.64	16.14	14.29	15.69	16.13	26.25
Kinnow: Papaya: Carrot (5.6: 1.4: 3)	13.96	12.60	13.21	10.34	12.47	12.76	
Kinnow: Papaya: Beetroot (6.4: 1.6: 2)	70.46	66.32	67.94	64.21	65.30	67.45	
Kinnow: Papaya: Cabbage (7.6: 1.9: 0.5)	17.64	14.28	15.84	13.91	14.57	15.65	
Mean	27.62	25.19	26.19	23.65	24.95		
Grand Mean (I)	27.62	25.69		24.30			
$CD_{(0.05)}$ Juice (J)= 1.45 Storage conditions (C)= NS Storage intervals (I)= 1.13 J x I= 18.04 J x C= NS C x I= NS J x C x I= NS							

AT= Ambient temperature (13-27°C) RT= Refrigerated temperature (0-4°C)

ascorbic acid content was recorded for all the blends during the storage, irrespective of storage conditions. Average ascorbic acid content was recorded to decrease significantly from an initial value of 15.48 to 12.04 mg/ 100 mL after six month of storage, irrespective of storage conditions. The decrease was higher at ambient storage where the decrease was from 15.48 to 13.32 as against 14.12 mg/100 mL at refrigerated storage.

4.6.4.6 Total phenolics

Data showing the effect of storage intervals and storage conditions on Kinnow: Papaya and vegetable juice/pulp blends are presented in Table 4.165. Total phenolics content (TPC) was found to be in the range of 13.96 to 70.46 mg/100 mL. A significant difference in the mean TPC was recorded in all the blends. It was highest in kinnow: papaya: beetroot (70.46 mg/100 mL) while lowest in kinnow: papaya: carrot (13.96 mg/100 mL). A gradual decrease in the TPC was recorded from a mean initial value of 27.62 to 24.30 mg/100 mL with the advancement of storage. TPC was found to be affected significantly by storage condition. It decreased from an average initial value of 27.62 to 25.49 at ambient storage against 26.25 mg/100 mL at refrigerated storage. A significant effect of various interaction factors on total phenolics was also recorded for all the blends.

4.6.4.7 Total carotenoids

Total carotenoids content of different blends are given in Table 4.166. It varied from 3.21 to 5.76 mg/100 mL. The mean maximum total carotenoids content was recorded in kinnow: papaya: carrot (5.76 mg/100 mL). A marginal decrease in total carotenoids of all the blends was recorded during storage where decrease was from 4.34 to 4.30 mg/100 mL however, losses were insignificant. Reduction was more at ambient storage where mean value was 4.31 as against 4.33 mg/100 mL which decreased from a mean initial value of 4.34 mg/100 mL. An insignificant effect of various interaction factors was recorded for total carotenoids content of all the blends.

Table 4.166 Effect of storage on total carotenoids (mg/100 mL) of Kinnow: Papaya and vegetable blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Kinnow: Papaya (Control)	3.21	3.19	3.20	3.18	3.20	3.20	4.31
Kinnow: Papaya: Tomato (7.2: 1.8: 1)	5.09	5.07	5.08	5.05	5.07	5.08	4.33
Kinnow: Papaya: Carrot (5.6: 1.4: 3)	5.76	5.74	5.75	5.71	5.73	5.74	
Kinnow: Papaya: Beetroot (6.4: 1.6: 2)	3.49	3.46	3.47	3.42	3.44	3.46	
Kinnow: Papaya: Cabbage (7.6: 1.9: 0.5)	4.14	4.12	4.13	4.09	4.11	4.12	
Mean	4.34	4.32	4.32	4.29	4.31		
Grand Mean (I)	4.34	4.32		4.30			

$CD_{(0.05)}$ Juice (J)= 0.15 Storage conditions (C)= NS Storage intervals (I)= NS J x I= NS
J x C= NS C x I= NS J x C x I= NS

AT= Ambient temperature (13-27^oC) RT= Refrigerated temperature (0-4^oC)

Table 4.167 Effect of storage on antioxidant activity (%) of Kinnow: Papaya and vegetable blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Kinnow: Papaya (Control)	59.56	57.60	56.38	55.41	54.82	57.22	55.93
Kinnow: Papaya: Tomato (7.2: 1.8: 1)	58.44	56.35	55.83	55.29	54.22	56.43	55.26
Kinnow: Papaya: Carrot (5.6: 1.4: 3)	60.31	58.49	57.14	57.72	55.69	58.28	
Kinnow: Papaya: Beetroot (6.4: 1.6: 2)	58.40	56.10	55.49	54.32	53.12	55.97	
Kinnow: Papaya: Cabbage (7.6: 1.9: 0.5)	52.49	50.16	49.60	48.23	47.33	50.05	
Mean	57.84	55.74	54.89	54.19	53.04		
Grand Mean (I)	57.84	55.31		53.62			

$CD_{(0.05)}$ Juice (J)= 1.03 Storage conditions (C)= NS Storage intervals (I)= 0.80 J x I= 18.04
J x C= NS C x I= NS J x C x I= NS

AT= Ambient temperature (13-27^oC) RT= Refrigerated temperature (0-4^oC)

Table 4.168 Effect of storage on non-enzymatic browning of Kinnow: Papaya and vegetable blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Kinnow: Papaya (Control)	0.893	0.901	0.897	0.908	0.902	0.899	1.360
Kinnow: Papaya: Tomato (7.2: 1.8: 1)	0.973	0.978	0.975	0.980	0.978	0.976	1.356
Kinnow: Papaya: Carrot (5.6: 1.4: 3)	1.060	1.100	1.080	1.130	1.110	1.090	
Kinnow: Papaya: Beetroot (6.4: 1.6: 2)	3.061	3.054	3.057	3.051	3.054	3.056	
Kinnow: Papaya: Cabbage (7.6: 1.9: 0.5)	0.763	0.769	0.765	0.775	0.771	0.768	
Mean	1.350	1.360	1.355	1.369	1.363		
Grand Mean (I)	1.350	1.358		1.366			

$CD_{(0.05)}$ Juice (J)= 0.02 Storage conditions (C)= NS Storage intervals (I)= NS J x I= NS
J x C= NS C x I= NS J x C x I= NS

AT= Ambient temperature (13-27^oC) RT= Refrigerated temperature (0-4^oC)

4.6.4.8 Antioxidant activity

Data on the effect of storage on the antioxidant activity (AA) of blends are presented in Table 4.167. The antioxidant activity ranged from 52.49 to 60.31% in different blends. Significant differences were observed in the AA of all the juice blends. Storage intervals imposed a significant effect on the antioxidant activity of all the blends. The AA was observed to decrease from an average mean value of 57.84 (0 day) to 53.62% (6 month) during storage. Changes were lower at ambient temperature as compared to refrigerated temperature in case of all blends where AA reduced from 57.84 to 55.93% at ambient temperature and to 55.26% at refrigerated temperature. Similar trends were recorded in all the juice blends. Besides, the interaction of various factors revealed the non-significant results for change in antioxidant activity.

4.6.4.9 Non-enzymatic browning

It is clear from the data given in Table 4.168 that the mean non-enzymatic browning (NEB) increased with the advancement of storage period. The NEB of all the blends varied significantly with highest value for kinnow: papaya: beetroot blend (3.061) and the lowest for kinnow: papaya: cabbage (0.763). The mean NEB of blends increased from a mean initial value of 1.350 to 1.366 after six month of storage. No significant effect of storage period and storage conditions was recorded on NEB of juices. Besides, the interaction of various factors did not impose significant changes in NEB.

4.6.4.10 Sensory quality

The colour rating of kinnow: papaya and vegetable blends are presented in Table 4.169. It was highest (8.00) in kinnow: papaya: carrot juice blend while lowest colour rating was recorded for kinnow: papaya: cabbage blend (7.20) which was statistically at par with kinnow: papaya: tomato blend (7.22). The colour rating of blends showed slight decrease during storage. It was found to decrease from an initial value of 7.46 to 7.22 at six month of storage however, changes were not significant. Blends stored at refrigerated temperature had better rating than those stored at ambient temperature. Colour rating decreased from an initial value of 7.46 to 7.30 and 7.38 at ambient and refrigerated storage conditions, respectively. The colour rating was not significantly affected by various interaction factors.

Data showing the effect of storage on the flavour rating of juice blends are presented in the Table 4.170. During storage the blends exhibited a marginal decrease in flavour score was recorded. However, blends stored at low temperature were better than those stored at ambient temperature. During storage, the flavour rating was observed to decrease non-significantly from mean initial value of 7.46 to 7.20. Highest flavour rating was recorded as 8.20 (kinnow: papaya: carrot blend) while it was lowest for control (7.00). Various interaction factors did not affect the flavour during the storage irrespective of storage conditions.

Perusal of the data presented in Table 4.171 indicates perceivable decrease in the body score of all the blends during storage. The body score was recorded to increase with the blending. During storage, the body score was recorded to decrease from a mean initial score of 7.82 at 0 day to 7.53 at 6 month. Storage conditions also affected the body score of blends as more decrease was recorded at ambient storage conditions. Besides, changes were non-significant irrespective of various interaction factors.

Blending exhibited a significant increase in overall acceptability (OAA) rating of different blends (Table 4.172). The OAA score of blends exhibited a gradual decrease with the advancement of storage conditions. kinnow: papaya: carrot obtained highest rating (8.40) for OAA while kinnow: papaya: tomato blend obtained lowest score on Hedonic scale (7.30) for OAA followed by control (7.50). The storage temperature also influenced the OAA score as it was lower (7.63) at ambient temperature as compared to low temperature storage (7.70) after six month of storage. OAA rating was found to decrease from an average initial value of 7.80 to 7.53 during six month of storage however, changes were insignificant.

Table 4.169 Effect of storage on colour of Kinnow: Papaya and vegetable blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Kinnow: Papaya (Control)	7.40	7.20	7.34	7.12	7.27	7.27	7.30
Kinnow: Papaya: Tomato (7.2: 1.8: 1)	7.22	7.08	7.10	6.90	7.00	7.06	7.38
Kinnow: Papaya: Carrot (5.6: 1.4: 3)	8.00	7.80	7.90	7.65	7.70	7.81	
Kinnow: Papaya: Beetroot (6.4: 1.6: 2)	7.50	7.32	7.45	7.20	7.34	7.36	
Kinnow: Papaya: Cabbage (7.6: 1.9: 0.5)	7.20	7.00	7.14	6.90	7.07	7.06	
Mean	7.46	7.28	7.39	7.15	7.28		
Grand Mean (I)	7.46	7.33		7.22			
$CD_{(0.05)}$ Juice (J)= 0.37 Storage conditions (C)= NS Storage intervals (I)= NS J x I= NS J x C= NS C x I= NS J x C x I= NS							

AT= Ambient temperature (13-27°C) RT= Refrigerated temperature (0-4°C)

Table 4.170 Effect of storage on flavour of Kinnow: Papaya and vegetable blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Kinnow: Papaya (Control)	7.00	6.80	6.90	6.72	6.80	6.84	7.29
Kinnow: Papaya: Tomato (7.2: 1.8: 1)	7.20	7.00	7.10	6.80	7.00	7.02	7.38
Kinnow: Papaya: Carrot (5.6: 1.4: 3)	8.20	8.00	8.10	7.90	8.00	8.04	
Kinnow: Papaya: Beetroot (6.4: 1.6: 2)	7.60	7.40	7.80	7.30	7.42	7.50	
Kinnow: Papaya: Cabbage (7.6: 1.9: 0.5)	7.30	7.10	7.20	7.00	7.10	7.14	
Mean	7.46	7.26	7.42	7.14	7.26		
Grand Mean (I)	7.46	7.34		7.20			
$CD_{(0.05)}$ Juice (J)= 0.57 Storage conditions (C)= NS Storage intervals (I)= NS J x I= NS J x C= NS C x I= NS J x C x I= NS							

AT= Ambient temperature (13-27°C) RT= Refrigerated temperature (0-4°C)

Table 4.171 Effect of storage on body of Kinnow: Papaya and vegetable blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Kinnow: Papaya (Control)	7.80	7.70	7.75	7.50	7.60	7.67	7.64
Kinnow: Papaya: Tomato (7.2: 1.8: 1)	7.90	7.70	7.80	7.50	7.60	7.70	7.72
Kinnow: Papaya: Carrot (5.6: 1.4: 3)	8.00	7.70	7.90	7.50	7.70	7.76	
Kinnow: Papaya: Beetroot (6.4: 1.6: 2)	7.80	7.60	7.77	7.60	7.70	7.69	
Kinnow: Papaya: Cabbage (7.6: 1.9: 0.5)	7.60	7.40	7.50	7.24	7.37	7.42	
Mean	7.82	7.62	7.74	7.47	7.59		
Grand Mean (I)	7.82	7.68		7.53			
$CD_{(0.05)}$ Juice (J)= 0.47 Storage conditions (C)= NS Storage intervals (I)= NS J x I= NS J x C= NS C x I= NS J x C x I= NS							

Table 4.172 Effect of storage on overall acceptability of Kinnow: Papaya and vegetable blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Kinnow: Papaya (Control)	7.50	7.30	7.40	7.27	7.30	7.35	7.63
Kinnow: Papaya: Tomato (7.2: 1.8: 1)	7.30	7.10	7.20	7.00	7.10	7.14	7.70
Kinnow: Papaya: Carrot (5.6: 1.4: 3)	8.40	8.20	8.30	8.00	8.22	8.22	
Kinnow: Papaya: Beetroot (6.4: 1.6: 2)	8.00	7.83	7.90	7.60	7.75	7.82	
Kinnow: Papaya: Cabbage (7.6: 1.9: 0.5)	7.80	7.65	7.70	7.50	7.60	7.65	
Mean	7.80	7.62	7.70	7.47	7.59		
Grand Mean (I)	7.80	7.66		7.53			
$CD_{(0.05)}$ Juice (J)= 0.58 Storage conditions (C)= NS Storage intervals (I)= NS J x I= NS J x C= NS C x I= NS J x C x I= NS							

4.6.5 Kinnow: Red grapes and vegetable juice blends

4.6.5.1 Total soluble solids (TSS)

Data given in Table 4.173 reveals that the total soluble solids in blends ranged from 10.98 to 12.88^{o}B. A significant difference was recorded in TSS content of all blends. The maximum TSS was recorded in kinnow: red grapes: beetroot (12.88^{o}B) while minimum value was recorded as 10.98^{o}B in kinnow: red grapes: carrot juice blend. An insignificant increase in TSS was recorded with the advancement of storage period which increased from average initial value of 12.05 to 12.27^{o}B after six month, irrespective of other factors. Juice blends stored at ambient temperature showed more increase in TSS (from an initial value of 12.05 to 12.24^{o}B) as compared to those stored at refrigerated temperature (from an initial value of 12.05 to 12.11^{o}B) during storage. The interaction of various factors revealed the non-significant results for change in TSS during storage at both the temperatures.

4.6.5.2 Titratable acidity

Data presented in Table 4.174 show the changes in titratable acidity of the juice blends during storage. Titratable acidity of blends ranged from 0.61 to 1.02 per cent. The mean maximum titratable acidity (1.02%) was recorded in control while minimum was recorded as 0.61% in the kinnow: red grapes: carrot blend. A gradual increase in titratable acidity was recorded from an initial mean value of 0.88 to 0.90% after six month of storage however, changes were not significant. Changes were same at ambient storage as well as refrigerated storage where increase was from mean initial value of 0.88 to 0.89% in both the conditions. Insignificant effect of different interaction factors was observed for all the blends.

4.6.5.3 Reducing sugars

Perusal of data presented in Table 4.175 reveals that reducing sugars content ranged from 3.85 to 6.46% in kinnow: red grapes and vegetable blends. Kinnow: red grapes blend (control) contained maximum reducing sugars content as 6.46% followed by kinnow: red grapes: beetroot blend (4.83%). It was minimum in kinnow: red grapes: carrot blend (3.85%). No significant variation was recorded in reducing sugars content of all the treatments. An increasing trend of reducing sugars was noticed in all the blends during the storage irrespective of storage conditions. A gradual increase from an initial value of 4.70 (0 day) to 4.73 (3 month) and finally to 4.75% (6 month) was recorded during the storage. Storage conditions also did not affect the reducing sugars content as the increase was recorded from an average initial value of 4.70 to 4.73% at ambient storage as against 4.72% in refrigerated storage.

Table 4.173 Effect of storage on total soluble solids (°B) of Kinnow: Red grapes and vegetable blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Kinnow: Red grapes (Control)	12.80	13.15	13.00	13.54	13.25	13.09	12.24
Kinnow: Red grapes: Tomato (4.7: 3.8: 1.5)	11.79	11.85	11.82	11.91	11.87	11.84	12.11
Kinnow: Red grapes: Carrot (3.3: 2.7: 4)	10.98	11.12	11.10	11.28	11.22	11.11	
Kinnow: Red grapes: Beetroot (5: 4: 1)	12.88	12.96	12.92	13.14	12.11	12.82	
Kinnow: Red grapes: Cabbage (5: 4: 1)	11.82	12.11	11.90	12.24	12.15	12.01	
Mean	12.05	12.24	12.15	12.42	12.12		
Grand Mean (I)	12.05	12.19		12.27			
$CD_{(0.05)}$ Juice (J)= 0.20 Storage conditions (C)= NS Storage intervals (I)= NS J x I= NS J x C= NS C x I= NS J x C x I= NS							

AT= Ambient temperature (13-27°C) RT= Refrigerated temperature (0-4°C)

Table 4.174 Effect of storage on titratable acidity (%) of Kinnow: Red grapes and vegetable blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Kinnow: Red grapes (Control)	1.02	1.03	1.03	1.05	1.04	1.03	0.89
Kinnow: Red grapes: Tomato (4.7: 3.8: 1.5)	0.93	0.94	0.94	0.96	0.95	0.94	0.89
Kinnow: Red grapes: Carrot (3.3: 2.7: 4)	0.61	0.63	0.62	0.65	0.64	0.63	
Kinnow: Red grapes: Beetroot (5: 4: 1)	0.92	0.95	0.93	0.96	0.94	0.94	
Kinnow: Red grapes: Cabbage (5: 4: 1)	0.90	0.92	0.91	0.93	0.92	0.91	
Mean	0.88	0.89	0.89	0.91	0.90		
Grand Mean (I)	0.88	0.89		0.90			
$CD_{(0.05)}$ Juice (J)= 0.0.02 Storage conditions (C)= NS Storage intervals (I)= NS J x I= NS J x C= NS C x I= NS J x C x I= NS							

AT= Ambient temperature (13-27°C) RT= Refrigerated temperature (0-4°C)

Table 4.175 Effect of storage on reducing sugars (%) of Kinnow: Red grapes and vegetable blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Kinnow: Red grapes (Control)	6.46	6.49	6.48	6.52	6.50	6.49	4.73
Kinnow: Red grapes: Tomato (4.7: 3.8: 1.5)	4.17	4.20	4.19	4.23	4.21	4.20	4.72
Kinnow: Red grapes: Carrot (3.3: 2.7: 4)	3.85	3.87	3.86	3.88	3.87	3.86	
Kinnow: Red grapes: Beetroot (5: 4: 1)	4.83	4.87	4.86	4.89	4.87	4.86	
Kinnow: Red grapes: Cabbage (5: 4: 1)	4.21	4.23	4.22	4.26	4.24	4.23	
Mean	4.70	4.73	4.72	4.76	4.74		
Grand Mean (I)	4.70	4.73		4.75			
$CD_{(0.05)}$ Juice (J)= 0.67 Storage conditions (C)= NS Storage intervals (I)= NS J x I= NS J x C= NS C x I= NS J x C x I= NS							

AT= Ambient temperature (13-27°C) RT= Refrigerated temperature (0-4°C)

4.6.5.4 Total sugars

It is evident from the Table 4.176 that blending of juice resulted in decrease of total sugars in all the blends. The mean maximum total sugars content was recorded in control (9.62%) followed by kinnow: red grapes: beetroot (9.56%) whereas it was minimum in kinnow: red grapes: carrot blend (8.42%). An insignificant increase was recorded in total sugars content of all the blends with the advancement of storage period, irrespective of other factors. It was recorded to increase from an average initial value of 9.01 to 9.05% after six month of storage. No significant effect of storage conditions was recorded on the total sugars of different blends however, it resulted in an increase from average initial value of

9.01 to 9.04% at ambient temperature as against 9.03% at refrigerated conditions. Besides, interaction of various factors revealed the non-significant results for change in total sugars.

4.6.5.5 Ascorbic acid

Data presented in Table 4.177 exhibit the effect of storage intervals and storage conditions on ascorbic acid content of juice blends. Average ascorbic acid content was recorded to vary from 10.58 to 15.20 mg/100 mL. The maximum ascorbic acid content was recorded in control (15.20%) followed by kinnow: red grapes: cabbage blend (14.33 mg/100 mL) while it was minimum in kinnow: red grapes: carrot (10.58 mg/100 mL). A significant decrease was recorded in ascorbic acid content of all the blends during the storage, irrespective of storage conditions. Average ascorbic acid content was recorded to decrease significantly from an initial value of 13.43 to 10.41 mg/100 mL after six month of storage, irrespective of storage conditions. The decrease was higher at ambient storage where the decrease was from 13.43 to 11.56 as against 12.33 mg/100 mL at refrigerated storage.

4.6.5.6 Total phenolics

Data showing the effect of storage intervals and storage conditions on kinnow: red grapes and vegetable blends are presented in Table 4.178. Total phenolics content (TPC) was found to be in the range of 19.50 to 49.07 mg/100 mL. A significant difference in the mean TPC was recorded in all the blends. It was highest in kinnow: red grapes: beetroot (49.07 mg/100 mL) while lowest in kinnow: red grapes: carrot (19.50 mg/100 mL). A gradual decrease in the TPC was recorded from a mean initial value of 32.96 to 28.22 mg/100 mL after six month of storage. TPC was found to be affected significantly by storage condition as it decreased from an average initial value of 32.96 to 30.34 at ambient storage against 30.65 mg/100 mL at refrigerated storage. A significant effect of various interaction factors on total phenolics was also recorded for all the blends.

Table 4.176 Effect of storage on total sugars (%) of Kinnow: Red grapes and vegetable blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Kinnow: Red grapes (Control)	9.62	9.65	9.64	9. 69	9.67	9.65	9.04
Kinnow: Red grapes: Tomato (4.7: 3.8: 1.5)	8.60	8.63	8.62	8.65	8.64	8.62	9.03
Kinnow: Red grapes: Carrot (3.3: 2.7: 4)	8.42	8. 44	8.43	8.45	8.44	8.43	
Kinnow: Red grapes: Beetroot (5: 4: 1)	9.56	9.58	9.59	9.61	9.60	9.58	
Kinnow: Red grapes: Cabbage (5: 4: 1)	8.85	8.88	8.87	8.90	8.88	8.88	
Mean	9.01	9.04	9.03	9.06	9.05		
Grand Mean (I)	9.01	9.03		9.05			
$CD_{(0.05)}$ Juice (J)= 0.04 Storage conditions (C)= NS Storage intervals (I)= NS J x I= NS J x C= NS C x I= NS J x C x I= NS							

AT= Ambient temperature (13-27^{o}C) RT= Refrigerated 15.79 temperature (0-4^{o}C)

Table 4.177 Effect of storage on ascorbic acid (mg/100 mL) of Kinnow: Red grapes and vegetable blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Kinnow: Red grapes (Control)	15.20	12.63	13.86	10.51	11.72	13.19	11.56
Kinnow: Red grapes: Tomato (4.7: 3.8: 1.5)	13.00	11.22	12.69	9.68	10.83	11.74	12.33
Kinnow: Red grapes: Carrot (3.3: 2.7: 4)	10.58	8.61	9.74	6.57	7.45	8.92	
Kinnow: Red grapes: Beetroot (5: 4: 1)	14.02	12.32	13.63	11.95	12.88	13.14	
Kinnow: Red grapes: Cabbage (5: 4: 1)	14.33	12.11	13.24	10.65	11.83	12.75	
Mean	13.43	11.38	12.63	9.87	10.94		
Grand Mean (I)	13.43	12.01		10.41			
$CD_{(0.05)}$ Juice (J)= 1.06 Storage conditions (C)= 0.67 Storage intervals (I)= 0.82 J x I= NS J x C= NS C x I= NS J x C x I= NS							

AT= Ambient temperature (13-27^{o}C) RT= Refrigerated temperature (0-4^{o}C)

Table 4.178 Effect of storage on total phenolics (mg/100 mL) of Kinnow: Red grapes and vegetable blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Kinnow: Red grapes (Control)	30.25	28.51	27.47	26.24	25.35	28.01	30.34
Kinnow: Red grapes: Tomato (4.7: 3.8: 1.5)	31.18	29.31	30.89	27.86	28.37	29.80	30.65
Kinnow: Red grapes: Carrot (3.3: 2.7: 4)	19.50	17.29	18.68	15.72	16.47	17.86	
Kinnow: Red grapes: Beetroot (5: 4: 1)	49.07	44.52	46.39	42.43	44.27	45.96	
Kinnow: Red grapes: Cabbage (5: 4: 1)	34.82	30.29	29.68	28.14	27.36	30.85	
Mean	32.96	29.98	30.62	28.08	28.36		
Grand Mean (I)	32.96	30.30		28.22			
$CD_{(0.05)}$ Juice (J)= 1.25 Storage conditions (C)= NS Storage intervals (I)= 0.97 J x I= NS J x C= NS C x I= NS J x C x I= NS							

AT= Ambient temperature (13-27^{o}C) RT= Refrigerated temperature (0-4^{o}C)

4.6.5.7 Total carotenoids

Total carotenoids content of different blends are given in Table 4.179. It varied from 1.22 to 4.81 mg/100 mL. The mean maximum total carotenoids content was recorded in kinnow: red grapes: carrot (4.81 mg/100 mL) while it was minimum in kinnow: red grapes: beetroot (1.22 mg/100 mL). An insignificant decrease in total carotenoids of all the blends was recorded during storage where decrease was from 2.11 to 2.07 mg/100 mL. An insignificant effect of various interaction factors was recorded for total carotenoids content of all the blends.

Table 4.179 Effect of storage on total carotenoids (mg/100 mL) of Kinnow: Red grapes and vegetable blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Kinnow: Red grapes (Control)	1.34	1.32	1.33	1.30	1.32	1.33	2.09
Kinnow: Red grapes: Tomato (4.7: 3.8: 1.5)	1.95	1.92	1.93	1.89	1.91	1.93	2.10
Kinnow: Red grapes: Carrot (3.3: 2.7: 4)	4.81	4.78	4.79	4.76	4.78	4.79	
Kinnow: Red grapes: Beetroot (5: 4: 1)	1.22	1.20	1.21	1.17	1.19	1.20	
Kinnow: Red grapes: Cabbage (5: 4: 1)	1.25	1.22	1.23	1.19	1.20	1.23	
Mean	2.11	2.09	2.10	2.06	2.08		
Grand Mean (I)	2.11	2.09		2.07			

$CD_{(0.05)}$ Juice (J)= 0.02 Storage conditions (C)= NS Storage intervals (I)= 0.02 J x I= NS J x C= NS C x I= NS J x C x I= NS

AT= Ambient temperature (13-27^{o}C) RT= Refrigerated temperature (0-4^{o}C)

4.6.5.8 Total Anthocyanins

Data presented in Table 4.180 reveal that total anthocyanins of kinnow: red grapes and vegetable blends ranged from 19.43 to 33.75 mg/100 mL. The mean maximum total anthocyanins content was recorded as 33.75 mg/100 mL (control) followed by 31.35 mg/100 mL (kinnow: red grapes: beetroot). The mean minimum total anthocyanins content was recorded in kinnow: red grapes: carrot (19.43 mg/100 mL). A significant reduction in total anthocyanins was recorded during storage. It decreased from a mean initial value of 28.24 to 24.05 mg/100 mL after six month of storage, irrespective of storage factors. Storage conditions also exhibited a significant effect on total anthocyanins of juice blends. Interaction factors did not affect the total anthocyanins content significantly.

Table 4.180 Effect of storage on total anthocyanins (mg/100 mL) of Kinnow: Red grapes and vegetable blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Kinnow: Red grapes (Control)	33.75	30.54	31.84	28.13	29.68	31.28	25.51
Kinnow: Red grapes: Tomato (4.7: 3.8: 1.5)	26.88	23.49	24.68	21.52	22.37	24.30	26.62
Kinnow: Red grapes: Carrot (3.3: 2.7: 4)	19.43	17.39	18.53	14.61	20.53	18.32	
Kinnow: Red grapes: Beetroot (5: 4: 1)	31.35	27.69	28.94	25.91	26.78	28.67	
Kinnow: Red grapes: Cabbage (5: 4: 1)	29.81	27.54	28.31	24.59	26.37	27.74	
Mean	28.24	25.33	26.46	22.95	25.15		
Grand Mean (I)	28.24	25.90		24.05			
$CD_{(0.05)}$ Juice (J)= 1.68 Storage conditions (C)= 1.06 Storage intervals (I)= 1.30 J x I= NS J x C= NS C x I= NS J x C x I= NS							

AT= Ambient temperature (13-27^{o}C) RT= Refrigerated temperature (0-4^{o}C)

4.6.5.9 Antioxidant activity

Data on the effect of storage on the antioxidant activity (AA) of blends are presented in Table 4.181. The antioxidant activity ranged from 63.51 to 66.81% in different blends. It was maximum in kinnow: red grapes: beetroot (66.81 per cent). The minimum AA was recorded in kinnow: red grapes: cabbage (63.51%) followed by kinnow: red grapes: tomato (63.56%) however, both were statistically at par. A Significant difference was observed in the AA of all the juice blends. Storage intervals imposed a significant effect on the antioxidant activity of all the blends. The AA was observed to decrease from an average mean value of 64.81 (0 day) to 59.45% (6 month) during storage. Changes were lower at ambient temperature as compared to refrigerated temperature in case of all blends where AA reduced from 64.81 to 62.48 at ambient temperature as against 61.39% at refrigerated temperature. Besides, interaction of various factors revealed the non-significant results for change in antioxidant activity.

Table 4.181 Effect of storage on antioxidant activity (%) of Kinnow: Red grapes and vegetable blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Kinnow: Red grapes (Control)	65.62	62.19	60.70	61.54	59.33	61.88	62.48
Kinnow: Red grapes: Tomato (4.7: 3.8: 1.5)	63.56	60.34	59.41	58.76	55.56	59.53	61.39
Kinnow: Red grapes: Carrot (3.3: 2.7: 4)	64.57	62.51	61.33	59.34	57.40	61.03	
Kinnow: Red grapes: Beetroot (5: 4: 1)	66.81	64.54	63.25	62.82	61.37	63.76	
Kinnow: Red grapes: Cabbage (5: 4: 1)	63.51	61.33	59.84	59.75	58.62	60.61	
Mean	64.81	62.18	60.91	60.44	58.46		
Grand Mean (I)	64.81	61.54		59.45			
$CD_{(0.05)}$ Juice (J)= 1.18 Storage conditions (C)= 0.75 Storage intervals (I)= 0.92 J x I= 18.04 J x C= NS C x I= NS J x C x I= NS							

AT= Ambient temperature (13-27^{o}C) RT= Refrigerated temperature (0-4^{o}C)

4.6.5.10 Non-enzymatic browning

It is clear from the data given in Table 4.182 that the mean non-enzymatic browning (NEB) decreased with the advancement of storage period. The mean maximum NEB was recorded for kinnow: red grapes: beetroot blend (4.149) and the lowest for kinnow: red grapes: cabbage (1.239). The average NEB of blends decreased from a mean initial value of 1.877 to 1.778 after six month of storage. No significant effect of storage period and storage conditions was recorded on NEB of juices. Besides, interaction of various factors did not impose significant changes in NEB.

Table 4.182 Effect of storage on non-enzymatic browning of Kinnow: Red grapes and vegetable blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Kinnow: Red grapes (Control)	1.326	1.320	1.323	1.316	1.319	1.322	1.820
Kinnow: Red grapes: Tomato (4.7: 3.8: 1.5)	1.412	1.398	1.402	1.392	1.396	1.402	1.835
Kinnow: Red grapes: Carrot (3.3: 2.7: 4)	1.257	1.119	1.126	0.982	0.996	1.123	
Kinnow: Red grapes: Beetroot (5: 4: 1)	4.149	4.144	4.146	4.139	4.142	4.145	
Kinnow: Red grapes: Cabbage (5: 4: 1)	1.239	1.115	1.186	0.991	1.106	1.146	
Mean	1.877	1.819	1.837	1.764	1.792		
Grand Mean (I)	1.877	1.828		1.778			
$CD_{(0.05)}$ Juice (J)= NS Storage conditions (C)= NS Storage intervals (I)= NS J x I= NS J x C= NS C x I= NS J x C x I= NS							

AT= Ambient temperature (13-27^{o}C) RT= Refrigerated temperature (0-4^{o}C)

4.6.5.11 Sensory quality

The colour rating was found to decrease by blending of kinnow: red grapes blend with vegetable juices/pulps (Table 4.183). It was highest (7.85) in kinnow: red grapes blend (control) while lowest colour rating was recorded for kinnow: red grapes: beetroot juice blend (7.52). The colour rating of blends showed insignificant decrease during storage. It was found to decrease from an initial value of 7.67 to 7.26 at six month of storage however, changes were insignificant. Blends stored at refrigerated temperature had better liking than those stored at ambient temperature. Colour rating decreased from an initial value of 7.67 to 7.42 and 7.50 at ambient and refrigerated storage conditions, respectively. The colour rating was not significantly affected by various interaction factors.

Data showing the effect of storage on the flavour rating of blends are presented in the Table 4.184. During storage the blends showed decrease in flavour score. However, blends stored at low temperature were better than those stored at ambient temperature. During storage, the flavour rating was observed to decrease non-significantly from mean initial value of 7.43 to 7.16. Highest flavour rating was recorded as 7.80 for control followed by kinnow: red grapes: carrot blend (7.70) while it was lowest for kinnow: red grapes: cabbage (6.50). Various interaction factors did not affect the flavour during the storage irrespective of storage conditions.

Perusal of the data presented in Table 4.185 indicates perceivable increase in the body score of all the blends. The body score was recorded to increase with the blending. During storage, the body score was recorded to decrease from 7.98 at 0 day to 7.64 at 6 month. Storage conditions also affected the body score of blends as more decrease was recorded at ambient storage conditions. Besides, changes were non-significant irrespective of various interaction factors.

Blending exhibited a significant increase in overall acceptability (OAA) rating of different blends (Table 4.186). The OAA score of blends exhibited a gradual decrease with the advancement of storage conditions.

kinnow: red grapes: carrot obtained superior rating (8.20) for OAA while kinnow: red grapes: tomato obtained lowest score on Hedonic scale (7.30) for OAA. The storage temperature also influenced the OAA score as it was lower (7.56) at ambient temperature as compared to low temperature storage (7.63). OAA rating was found to decrease from an average initial value of 7.76 to 7.42 during six month of storage however, changes were insignificant.

Table 4.183 Effect of storage on colour of Kinnow: Red grapes and vegetable blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Kinnow: Red grapes (Control)	7.85	7.60	7.70	7.45	7.53	7.63	7.42
Kinnow: Red grapes: Tomato (4.7: 3.8: 1.5)	7.60	7.40	7.50	7.20	7.35	7.41	7.50
Kinnow: Red grapes: Carrot (3.3: 2.7: 4)	7.72	7.40	7.50	7.20	7.30	7.42	
Kinnow: Red grapes: Beetroot (5: 4: 1)	7.52	7.25	7.40	7.00	7.20	7.27	
Kinnow: Red grapes: Cabbage (5: 4: 1)	7.65	7.30	7.40	7.13	7.25	7.35	
Mean	7.67	7.39	7.50	7.20	7.33		
Grand Mean (I)	7.67	7.45		7.26			

$CD_{(0.05)}$ Juice (J) = NS Storage conditions (C) = NS Storage intervals (I)=0.19 J x I=NS
J x C = NS C x I = NS J x C x I =NS

AT= Ambient temperature (13-27^{o}C) RT= Refrigerated temperature (0-4^{o}C)

Table 4.184 Effect of storage on flavour of Kinnow: Red grapes and vegetable blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Kinnow: Red grapes (Control)	7.80	7.60	7.70	7.50	7.60	7.67	7.27
Kinnow: Red grapes: Tomato (4.7: 3.8: 1.5)	7.50	7.30	7.40	7.20	7.30	7.37	7.33
Kinnow: Red grapes: Carrot (3.3: 2.7: 4)	7.70	7.50	7.50	7.30	7.37	7.48	
Kinnow: Red grapes: Beetroot (5: 4: 1)	7.65	7.50	7.60	7.30	7.50	7.51	
Kinnow: Red grapes: Cabbage (5: 4: 1)	6.50	6.33	6.40	6.25	6.30	6.38	
Mean	7.43	7.25	7.32	7.11	7.21		
Grand Mean (I)	7.43	7.28		7.16			

$CD_{(0.05)}$ Juice (J) = 0.15 Storage conditions (C) = NS Storage intervals (I)= NS J x I=NS
J x C = NS C x I = NS J x C x I =NS

AT= Ambient temperature (13-27^{o}C) RT= Refrigerated temperature (0-4^{o}C)

Table 4.185 Effect of storage on body of Kinnow: Red grapes and vegetable blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Kinnow: Red grapes (Control)	7.90	7.70	7.81	7.50	7.70	7.72	7.76
Kinnow: Red grapes: Tomato (4.7: 3.8: 1.5)	7.80	7.78	7.71	7.30	7.60	7.60	7.86
Kinnow: Red grapes: Carrot (3.3: 2.7: 4)	8.15	7.90	8.05	7.73	7.81	7.93	
Kinnow: Red grapes: Beetroot (5: 4: 1)	8.03	7.78	7.90	7.64	7.73	7.82	
Kinnow: Red grapes: Cabbage (5: 4: 1)	8.00	7.80	7.90	7.60	7.80	7.82	
Mean	7.98	7.75	7.87	7.55	7.73		
Grand Mean (I)	7.98	7.81		7.64			
$CD_{(0.05)}$ Juice (J)= 0.28 Storage conditions (C)= NS Storage intervals (I)= NS J x I= NS J x C= NS C x I= NS J x C x I= NS							

AT= Ambient temperature (13-27°C) RT= Refrigerated temperature (0-4°C)

Table 4.186 Effect of storage on overall acceptability of Kinnow: Red grapes and vegetable blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Kinnow: Red grapes (Control)	8.00	7.80	7.90	7.63	7.75	7.82	7.56
Kinnow: Red grapes: Tomato (4.7: 3.8: 1.5)	7.30	7.10	7.22	6.90	7.00	7.10	7.63
Kinnow: Red grapes: Carrot (3.3: 2.7: 4)	8.20	7.95	8.07	7.78	7.80	7.96	
Kinnow: Red grapes: Beetroot (5: 4: 1)	7.80	7.63	7.70	7.45	7.61	7.64	
Kinnow: Red grapes: Cabbage (5: 4: 1)	7.50	7.30	7.40	7.10	7.20	7.30	
Mean	7.76	7.56	7.66	7.37	7.47		
Grand Mean (I)	7.76	7.61		7.42			
$CD_{(0.05)}$ Juice (J)= 0.31 Storage conditions (C)= NS Storage intervals (I)= NS J x I= NS J x C= NS C x I= NS J x C x I= NS							

AT= Ambient temperature (13-27°C) RT= Refrigerated temperature (0-4°C

4.6.6 Kinnow: Aonla: Red grapes and vegetable juice blends

4.6.6.1 Total soluble solids (TSS)

Data given in Table 4.187 reveal that the total soluble solids in blends ranged from 10.87 to 12.60°B. Significant difference was recorded in TSS content of all blends. Maximum TSS was recorded in kinnow: aonla: red grapes blend (control) (12.60°B) while minimum value was recorded as 10.87°B in kinnow: aonla: red grapes: carrot blend. A gradual increase in TSS was recorded with the advancement of storage period which increased from average initial value of 11.85 to 12.01°B after six month irrespective of all the factors however, changes were non-significant. Juice blends stored at ambient temperature showed more increase in TSS (from an initial value of 11.85 to 12.06^{o}B) while those stored at refrigerated temperature resulted in a minimum change (from an initial value of 11.85 to 11.92^{o}B) during storage. The interaction of various factors reveals the non-significant results for change in TSS during storage at both the temperatures.

4.6.6.2 Titratable acidity

Data obtained for the changes in titratable acidity of the kinnow: aonla: red grapes and vegetable blends during storage are presented in Table 4.188. A significant difference was recorded in the titratable acidity of all the blends. The mean maximum titratable acidity (1.11%) was recorded in kinnow: aonla: red grapes: beetroot while minimum was recorded as 0.65% in the kinnow: aonla: red grapes: carrot blend. A gradual increase in titratable acidity was recorded from an initial mean value of 0.95 to 0.98 after six month of storage however, changes were not significant. Changes were more at ambient storage where increase was from mean initial value of 0.95 to 0.97% as against 0.96% at refrigerated storage. Insignificant effect of different interaction factors was observed for all the blends.

4.6.6.3 Reducing sugars

Perusal of data presented in Table 4.189 indicates that reducing sugars content ranged from 5.20 to 6.77% in juice blends. Kinnow: aonla: red grapes: beetroot blend contained maximum reducing sugars content as 6.77% followed by control (6.71%). It was minimum in kinnow: aonla: red grapes: carrot (5.20%). A significant variation was recorded in reducing sugars content of all the treatments. An increasing trend was noticed in reducing sugars of all the blends during the storage irrespective of storage conditions. A gradual increase from an initial value of 6.19 (0 day) to 6.22 (3 month) and finally to 6.25% (6 month) was recorded during the storage. Storage conditions also did not affect the reducing sugars content as the increase was recorded from an average initial value of 6.19 to 6.23% in ambient storage as against 6.22% in refrigerated storage.

Table 4.187 Effect of storage on total soluble solids (°B) of Kinnow: Aonla: Red grapes and vegetable blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Kinnow: Aonla: Red grapes (Control)	12.60	12.80	12.70	13.10	12.90	12.82	12.06
Kinnow:Aonla: Red grapes: Tomato (4.8: 0.3:3.4: 1.5)	11.64	11.79	11.74	11.92	11.85	11.79	11.92
Kinnow: Aonla: Red grapes: Carrot (3.4: 0.2: 2.4: 4)	10.87	11.12	10.95	11.38	10.26	10.92	
Kinnow:Aonla:Red grapes:Beetroot (5.4: 0.3:3.8:0.5)	12.47	12.68	12.61	12.91	12.83	12.70	
Kinnow:Aonla: Red grapes: Cabbage (5.1: 0.3: 3.6: 1)	11.66	11.82	11.78	12.12	11.96	11.87	
Mean	11.85	12.04	11.96	12.29	11.96		
Grand Mean (I)	11.85	12.00		12.01			
$CD_{(0.05)}$ Juice (J)= 0.12 Storage conditions (C)= NS Storage intervals (I)= NS J x I= NS J x C= NS C x I= NS J x C x I= NS							

AT= Ambient temperature (13-27°C) RT= Refrigerated temperature (0-4°C)

Table 4.188 Effect of storage on titratable acidity (%) of Kinnow: Aonla: Red grapes and vegetable blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Kinnow: Aonla: Red grapes (Control)	1.05	1.07	1.06	1.08	1.07	1.07	0.97
Kinnow: Aonla: Red grapes:Tomato (4.8: 0.3: 3.4: 1.5)	0.98	1.00	0.99	1.02	1.01	1.00	0.96
Kinnow: Aonla: Red grapes: Carrot (3.4: 0.2: 2.4: 4)	0.65	0.66	0.65	0.67	0.66	0.66	
Kinnow: Aonla: Red grapes:Beetroot (5.4: 0.3: 3.8:0.5)	1.11	1.13	1.12	1.15	1.14	1.13	
Kinnow: Aonla: Red grapes: Cabbage (5.1: 0.3: 3.6: 1)	0.97	0.98	0.98	1.00	0.99	0.98	
Mean	0.95	0.97	0.96	0.98	0.97		
Grand Mean (I)	0.95	0.96		0.98			
$CD_{(0.05)}$ Juice (J)= 0.13 Storage conditions (C)= NS Storage intervals (I)= NS J x I= NS J x C= NS C x I= NS J x C x I= NS							

AT= Ambient temperature (13-27°C) RT= Refrigerated temperature (0-4°C)

Table 4.189 Effect of storage on reducing sugars (%) of Kinnow: Aonla: Red grapes and vegetable blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Kinnow: Aonla: Red grapes (Control)	6.71	6.75	6.73	6.77	6.75	6.74	6.23
Kinnow: Aonla: Red grapes: Tomato (4.8: 0.3: 3.4: 1.5)	6.08	6.11	6.10	6.16	6.13	6.12	6.22
Kinnow: Aonla: Red grapes: Carrot (3.4: 0.2: 2.4: 4)	5.20	5.24	5.22	5.27	5.25	5.24	
Kinnow: Aonla: Red grapes: Beetroot (5.4: 0.3: 3.8: 0.5)	6.77	6.81	6.79	6.84	6.82	6.81	
Kinnow: Aonla: Red grapes: Cabbage (5.1: 0.3: 3.6: 1)	6.21	6.25	6.23	6.28	6.26	6.25	
Mean	6.19	6.23	6.21	6.26	6.24		
Grand Mean (I)	6.19	6.22		6.25			
$CD_{(0.05)}$ Juice (J)= 0.23 Storage conditions (C)= NS Storage intervals (I)= NS J x I= NS J x C= NS C x I= NS J x C x I= NS							

AT= Ambient temperature (13-27°C) RT= Refrigerated temperature (0-4°C)

4.6.6.4 Total sugars

Table 4.190 shows the total sugars of kinnow: aonla: red grapes and vegetable blends. The mean maximum total sugars content was recorded in kinnow: aonla: red grapes: beetroot juice blends as 9.30% whereas it was minimum in kinnow: aonla: red grapes: tomato blend (8.15 per cent). An increasing trend was recorded in total sugars content of all the blends with the advancement of storage period. It was recorded to increase from an average initial value of 8.72 to 8.77% after six month of storage. Temperature did not show any significant effect on the total sugars of different blends however, it resulted in an increase from average initial value of 8.72 to 8.75 at ambient temperature as against 8.74% at refrigerated conditions. Besides, interaction of various factors revealed the non-significant results for change in total sugars.

4.6.6.5 Ascorbic acid

The perusal of data in Table 4.191 shows the effect of storage on ascorbic acid content of juice blends. Average ascorbic acid content was recorded in the range of 15.72 to 26.58 mg/100 mL. The maximum ascorbic acid content was recorded in control (26.58 mg/100 mL) which was statistically at par with kinnow: aonla: red grapes: tomato blend (25.64 mg/100 mL). The minimum ascorbic acid content was recorded in kinnow: aonla: red grapes: carrot (15.72 mg/100 mL). A significant reduction was recorded in ascorbic acid content of all the blends during the storage, irrespective of storage conditions. Average ascorbic acid content was recorded to decrease significantly from an initial value of 22.88 to 18.85 mg/ 100 mL after six month of storage, irrespective of storage conditions. The decrease was higher at ambient storage where the decrease was from 22.88 to 20.35 as against 21.22 mg/100 mL at refrigerated storage.

4.6.6.6 Total phenolics

Data showing the effect of storage intervals and storage conditions on kinnow: aonla: red grapes and vegetable blends are presented in Table 4.192. Total phenolics content (TPC) was found to be in the range from 56.65 to 98.52 mg/100 mL. A significant difference in the mean TPC was recorded in all the blends. It was highest in kinnow: aonla: red grapes: beetroot blend (98.52 mg/100 mL) while lowest in kinnow: aonla: red grapes: carrot (56.65 mg/100 mL). A gradual decrease in the TPC was recorded from a mean initial value of 84.82 to 77.16 mg/100 mL with the advancement of storage. TPC was found to be affected significantly by storage condition. It decreased from an average initial value of 84.82 to 80.17 at ambient storage against 81.63 mg/100 mL at refrigerated storage. An insignificant effect of various interaction factors on total phenolics was also recorded for all the blends.

Table 4.190 Effect of storage on total sugars (%) of Kinnow: Aonla: Red grapes and vegetable blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Kinnow: Aonla: Red grapes (Control)	9.28	9.34	9.32	9.36	9.33	9.33	8.75
Kinnow: Aonla: Red grapes: Tomato (4.8: 0.3: 3.4: 1.5)	8.15	8.17	8.16	8.19	8.18	8.17	8.74
Kinnow: Aonla: Red grapes: Carrot (3.4: 0.2: 2.4: 4)	8.26	8.29	8.28	8.31	8.29	8.29	
Kinnow: Aonla: Red grapes: Beetroot (5.4: 0.3: 3.8: 0.5)	9.30	9.33	9.32	9.37	9.35	9.33	
Kinnow: Aonla: Red grapes: Cabbage (5.1: 0.3: 3.6: 1)	8.59	8.62	8.61	8.64	8.64	8.62	
Mean	8.72	8.75	8.74	8.77	8.76		
Grand Mean (I)	8.72	8.74		8.77			
$CD_{(0.05)}$ Juice (J)= 0.28 Storage conditions (C)= NS Storage intervals (I)= NS J x I= NS J x C= NS C x I= NS J x C x I= NS							

AT= Ambient temperature (13-27°C) RT= Refrigerated 15.79 temperature (0-4°C)

Table 4.191 Effect of storage on ascorbic acid (mg/100 mL) of Kinnow: Aonla: Red grapes and vegetable blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Kinnow: Aonla: Red grapes (Control)	26.58	24.59	25.20	21.68	23.67	24.34	20.35
Kinnow:Aonla:Red grapes:Tomato (4.8: 0.3: 3.4: 1.5)	25.64	22.69	23.64	20.40	21.59	22.79	21.22
Kinnow: Aonla: Red grapes:Carrot (3.4: 0.2: 2.4: 4)	15.72	12.68	13.97	10.94	11.69	13.00	
Kinnow:Aonla:Red grapes:Beetroot (5.4:0.3: 3.8: 0.5)	23.68	20.36	21.82	18.24	20.67	20.95	
Kinnow: Aonla: Red grapes: Cabbage (5.1: 0.3: 3.6:1)	22.78	20.13	21.29	19.20	20.40	20.76	
Mean	22.88	20.09	21.18	18.09	19.60		
Grand Mean (I)	22.88	20.64		18.85			
$CD_{(0.05)}$ Juice (J)= 1.50 Storage conditions (C)= 0.82 Storage intervals (I)= 1.16 J x I= NS J x C= NS C x I= NS J x C x I= NS							

AT= Ambient temperature (13-27°C) RT= Refrigerated temperature (0-4°C)

Table 4.192 Effect of storage on total phenolics (mg/100 mL) of Kinnow: Aonla: Red grapes and vegetable blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Kinnow: Aonla: Red grapes (Control)	92.61	85.62	87.39	76.31	82.35	84.86	80.17
Kinnow:Aonla:Red grapes:Tomato (4.8:0.3:3.4: 1.5)	83.49	79.35	81.54	76.95	78.63	79.99	81.63
Kinnow: Aonla: Red grapes: Carrot (3.4: 0.2: 2.4: 4)	56.65	50.95	53.67	48.26	51.13	52.13	
Kinnow:Aonla:Red grapes:Beetroot (5.4: 0.3: 3.8: 0.5)	98.52	94.52	95.82	91.69	92.66	94.64	
Kinnow: Aonla: Red grapes: Cabbage (5.1: 0.3: 3.6:1)	92.85	88.46	89.80	86.33	87.29	88.95	
Mean	84.82	79.78	81.64	75.91	78.41		
Grand Mean (I)	84.82	80.71		77.16			
$CD_{(0.05)}$ Juice (J)= 2.96 Storage conditions (C)= NS Storage intervals (I)= 2.29 J x I= NS J x C= NS C x I= NS J x C x I= NS							

AT= Ambient temperature (13-27^{o}C) RT= Refrigerated temperature (0-4^{o}C)

4.6.6.7 Total carotenoids

Total carotenoids content of different blends are given in Table 4.193. Total carotenoids varied from 1.37 to 4.91 mg/100 mL. The mean maximum total carotenoids content was recorded in kinnow: aonla: red grapes: carrot (4.91 mg/100 mL) while it was minimum in kinnow: aonla: red grapes: cabbage (1.37 mg/100 mL). An insignificant decrease in total carotenoids of all the blends was recorded during storage where decrease was from a mean initial value of 2.24 to 2.19 mg/100 mL. An insignificant effect of various interaction factors was recorded for total carotenoids content of all the blends.

Table 4.193 Effect of storage on total carotenoids (mg/100 mL) of Kinnow: Aonla: Red grapes and vegetable blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Kinnow: Aonla: Red grapes (Control)	1.40	1.36	1.38	1.34	1.38	1.37	2.21
Kinnow: Aonla: Red grapes: Tomato (4.8: 0.3: 3.4: 1.5)	2.04	2.01	2.02	1.98	2.00	2.01	2.22
Kinnow: Aonla: Red grapes: Carrot (3.4: 0.2: 2.4: 4)	4.91	4.87	4.89	4.83	4.86	4.87	
Kinnow:Aonla:Red grapes:Beetroot (5.4: 0.3: 3.8: 0.5)	1.49	1.46	1.47	1.44	1.45	1.46	
Kinnow: Aonla: Red grapes: Cabbage (5.1: 0.3: 3.6: 1)	1.37	1.34	1.35	1.32	1.34	1.34	
Mean	2.24	2.21	2.22	2.18	2.21		
Grand Mean (I)	2.24	2.22		2.19			
$CD_{(0.05)}$ Juice (J)= 0.24 Storage conditions (C)= NS Storage intervals (I)= NS J x I= NS J x C= NS C x I= NS J x C x I= NS							

AT= Ambient temperature (13-27^{o}C) RT= Refrigerated temperature (0-4^{o}C)

Table 4.194 Effect of storage on total anthocyanins (mg/100 mL) of Kinnow: Aonla: Red grapes and vegetable blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Kinnow: Aonla: Red grapes (Control)	30.73	27.83	28.65	25.44	26.12	27.75	23.13
Kinnow:Aonla:Red grapes:Tomato (4.8: 0.3: 3.4: 1.5)	25.64	23.19	24.15	21.98	22.48	23.49	23.84
Kinnow: Aonla: Red grapes: Carrot (3.4: 0.2: 2.4: 4)	17.53	15.21	16.86	12.69	14.54	15.37	
Kinnow:Aonla:Red grapes:Beetroot (5.4:0.3: 3.8: 0.5)	27.71	25.34	25.69	22.58	24.14	25.09	
Kinnow: Aonla: Red grapes: Cabbage (5.1: 0.3: 3.6:1)	26.34	23.21	24.59	21.48	22.42	23.61	
Mean	25.59	22.96	23.99	20.83	21.94		
Grand Mean (I)	25.59	23.47		21.39			

$CD_{(0.05)}$ Juice (J)= 1.50 Storage conditions (C)= 0.78 Storage intervals (I)= 1.16 J x I= NS
J x C= NS C x I= NS J x C x I= NS

AT= Ambient temperature (13-27^{o}C) RT= Refrigerated temperature (0-4^{o}C)

4.6.6.8 Total anthocyanins

Data presented in Table 4.194 reveal that total anthocyanins of kinnow: aonla: red grapes and vegetable blends ranged from 17.53 to 30.73 mg/100 mL. The mean maximum total anthocyanins content was recorded as 30.73 mg/100 mL (control) followed by 27.71 mg/100 mL (kinnow: aonla: red grapes: beetroot). The mean minimum total anthocyanins content was recorded in kinnow: aonla: red grapes: carrot (17.53 mg/100 mL). A significant decrease in total anthocyanins was recorded during storage. It decreased from a mean initial value of 25.59 to 21.39 mg/100 mL after six month of storage, irrespective of storage factors. Storage conditions also exhibited a significant effect on total anthocyanins of juice blends as mean value of 23.31 was recorded at ambient storage as against 23.84 mg/100 mL which decreased from a mean initial value of 25.59 mg/100 mL. Interaction factors affected the total anthocyanins content insignificantly.

4.6.6.9 Antioxidant activity

Data on the effect of storage on the antioxidant activity (AA) of blends are presented in Table 4.195. The antioxidant activity ranged from 51.66 to 59.09% in different blends. Significant differences were observed in the AA of all the juice blends. Storage intervals imposed a significant effect on the antioxidant activity of all the blends. The AA was observed to decrease from an average mean value of 56.74 (0 day) to 51.97% (6 month) during storage. Changes were lower at ambient temperature as compared to refrigerated temperature in case of all blends where AA reduced from 56.74 to 54.66 at ambient temperature and from 56.74 to 53.67% at refrigerated temperature. Similar trends were recorded in all the juice blends. Besides, interaction of various factors revealed the non-significant results for change in antioxidant activity.

Table 4.195 Effect of storage on antioxidant activity (%) of Kinnow: Aonla: Red grapes and vegetable blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Kinnow: Aonla: Red grapes (Control)	59.09	57.81	56.34	56.10	55.25	56.92	54.66
Kinnow:Aonla:Red grapes:Tomato (4.8: 0.3: 3.4: 1.5)	56.05	54.25	53.61	52.48	51.09	53.50	53.67
Kinnow: Aonla: Red grapes: Carrot (3.4: 0.2: 2.4: 4)	58.48	55.41	53.24	53.62	51.73	54.50	
Kinnow:Aonla:Red grapes:Beetroot (5.4:0.3: 3.8: 0.5)	51.66	49.11	48.28	46.34	46.36	48.35	
Kinnow: Aonla: Red grapes: Cabbage (5.1: 0.3: 3.6:1)	58.43	56.59	53.26	54.54	52.15	54.99	
Mean	56.74	54.63	52.95	52.62	51.32		
Grand Mean (I)	56.74	53.79		51.97			
$CD_{(0.05)}$ Juice (J)= 1.77 Storage conditions (C)= NS Storage intervals (I)= 1.37 J x I= NS J x C= NS C x I= NS J x C x I= NS							

AT= Ambient temperature (13-27^{o}C) RT= Refrigerated temperature (0-4^{o}C)

4.6.6.10 Non-enzymatic browning

It is clear from the data given in Table 4.196 that the mean non-enzymatic browning (NEB) decreased with the advancement of storage period. The NEB of all the blends varied significantly with highest value for Kinnow: Aonla: Red grapes: Beetroot blend (4.263) and the lowest for Kinnow: Aonla: Red grapes: Carrot (1.362). Average NEB decreased from a mean initial value of 2.042 to 1.830 after six month of storage. No significant effect of storage period and storage conditions was recorded on NEB of juices. Besides, the interaction of various factors did not impose significant changes in NEB.

Table 4.196 Effect of storage on non-enzymatic browning of Kinnow: Aonla: Red grapes and vegetable blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Kinnow: Aonla: Red grapes (Control)	1.560	1.500	1.530	1.470	1.490	1.510	1.910
Kinnow: Aonla:Red grapes:Tomato (4.8:0.3: 3.4: 1.5)	1.589	1.367	1.471	1.291	1.384	1.420	1.950
Kinnow: Aonla: Red grapes: Carrot (3.4: 0.2: 2.4: 4)	1.362	1.169	1.209	0.985	1.105	1.166	
Kinnow:Aonla:Red grapes:Beetroot (5.4: 0.3: 3.8:0.5)	4.263	4.248	4.251	4.239	4.243	4.249	
Kinnow: Aonla: Red grapes: Cabbage (5.1: 0.3: 3.6:1)	1.437	1.156	1.286	0.998	1.113	1.198	
Mean	2.042	1.888	1.949	1.797	1.867		
Grand Mean (I)	2.042	1.920		1.830			
$CD_{(0.05)}$ Juice (J)= 0.02 Storage conditions (C)= NS Storage intervals (I)= NS J x I= NS J x C= NS C x I= NS J x C x I= NS							

AT= Ambient temperature (13-27^{o}C) RT= Refrigerated temperature (0-4^{o}C)

4.6.6.11 Sensory quality

The effect of storage on colour rating of kinnow: aonla: red grapes and vegetable blends are presented in Table 4.197. It was highest (8.00) in kinnow: aonla: red grapes: carrot blend while lowest colour rating was recorded for pure kinnow: aonla: red grapes: cabbage blend (7.50). The colour rating of blends showed slight decrease during storage. It was found to decrease from an initial value of 7.78 to 7.54 at six month of storage however, changes were not significant. Blends stored at refrigerated temperature had better liking than those stored at ambient temperature. Colour rating decreased from an initial value of 7.78 to 7.62 and 7.70 at ambient and refrigerated storage conditions, respectively. The colour rating was not significantly affected by various interaction factors.

Data showing the effect of storage on the flavour rating juice blends are presented in the Table 4.198. The maximum flavour score was recorded for kinnow: aonla: red grapes: carrot blend (8.70). During storage the blends suffered losses in flavour score. However flavour score of blends stored at low temperature were better than those stored at ambient temperature. During storage, the flavour rating was observed to decrease non-significantly from mean initial value of 7.61 to 7.30. Various interaction factors did not affect the flavour during the storage irrespective of storage conditions.

Perusal of the data presented in Table 4.199 indicates insignificant decrease in the body score of all the blends. The body score was recorded to increase with the blending. During storage, the body score was recorded to decrease from 8.12 at 0 day to 7.86 at 6 month. Storage conditions also affected the body score of blends as more decrease was recorded at ambient storage conditions. Besides, changes were non-significant irrespective of various interaction factors.

Blending exhibited a significant increase in overall acceptability (OAA) rating of different blends (Table 4.200). The OAA score of blends exhibited a gradual decrease with the advancement of storage conditions. kinnow: aonla: red grapes: carrot obtained superior rating (8.20) while kinnow: aonala: red grapes: Tomato blend obtained lowest score (7.50) on Hedonic scale for OAA. The storage temperature also influenced the OAA score as it was lower (7.66) at ambient temperature as compared to low temperature storage (7.73) which decreased from a mean initial value of 7.81. The OAA rating was found to decrease from an average initial value of 7.81 to 7.59 during six month of storage however, changes were insignificant.

Table 4.197 Effect of storage on colour of Kinnow: Aonla: Red grapes and vegetable blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Kinnow: Aonla: Red grapes (Control)	7.80	7.60	7.70	7.40	7.60	7.62	7.62
Kinnow: Aonla:Red grapes:Tomato (4.8: 0.3: 3.4: 1.5)	7.70	7.50	7.60	7.30	7.50	7.52	7.70
Kinnow: Aonla: Red grapes: Carrot (3.4: 0.2: 2.4: 4)	8.00	7.85	7.90	7.70	7.80	7.85	
Kinnow:Aonla:Red grapes:Beetroot (5.4:0.3: 3.8: 0.5)	7.90	7.80	7.90	7.70	7.80	7.82	
Kinnow: Aonla: Red grapes: Cabbage (5.1: 0.3: 3.6:1)	7.50	7.30	7.40	7.20	7.40	7.36	
Mean	7.78	7.61	7.70	7.46	7.62		
Grand Mean (I)	7.78	7.66		7.54			

$CD_{(0.05)}$ Juice (J)= 0.39 Storage conditions (C)= NS Storage intervals (I)= NS J x I= NS
J x C= NS C x I= NS J x C x I= NS

AT= Ambient temperature (13-27^{o}C) RT= Refrigerated temperature (0-4^{o}C)

Table 4.198 Effect of storage on flavour of Kinnow: Aonla: Red grapes and vegetable blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Kinnow: Aonla: Red grapes (Control)	7.35	7.18	7.25	7.00	7.11	7.18	7.42
Kinnow:Aonla:Red grapes:Tomato (4.8:0.3:3.4:1.5)	7.30	7.10	7.20	7.00	7.10	7.14	7.49
Kinnow: Aonla: Red grapes: Carrot (3.4: 0.2: 2.4: 4)	8.70	8.50	8.60	8.30	8.4	8.50	
Kinnow:Aonla:Red grapes:Beetroot (5.4:0.3:3.8:0.5)	7.50	7.30	7.40	7.05	7.20	7.29	
Kinnow:Aonla:Red grapes:Cabbage (5.1:0.3: 3.6:1)	7.20	7.00	7.10	6.85	6.95	7.02	
Mean	7.61	7.42	7.51	7.24	7.35		
Grand Mean (I)	7.61	7.46		7.30			

$CD_{(0.05)}$ Juice (J)= 0.54 Storage conditions (C)= NS Storage intervals (I)= NS J x I= NS
J x C= NS C x I= NS J x C x I= NS

AT= Ambient temperature (13-27^{o}C) RT= Refrigerated temperature (0-4^{o}C)

Table 4.199 Effect of storage on body of Kinnow: Aonla: Red grapes and vegetable blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Kinnow: Aonla: Red grapes (Control)	8.00	7.80	7.90	7.70	7.80	7.84	7.96
Kinnow:Aonla:Red grapes:Tomato (4.8:0.3:3.4:1.5)	8.10	8.00	8.05	7.80	7.90	7.97	8.02
Kinnow: Aonla: Red grapes: Carrot (3.4: 0.2: 2.4: 4)	8.40	8.22	8.30	8.10	8.20	8.24	
Kinnow:Aonla:Red grapes:Beetroot (5.4:0.3:3.8:0.5)	8.20	8.00	8.10	7.90	8.00	8.04	
Kinnow:Aonla:Red grapes:Cabbage (5.1: 0.3: 3.6:1)	7.90	7.70	7.80	7.50	7.70	7.72	
Mean	8.12	7.94	8.03	7.80	7.92		
Grand Mean (I)	8.12	7.99		7.86			

$CD_{(0.05)}$ Juice (J)= 0.48 Storage conditions (C)= NS Storage intervals (I)= NS J x I= NS
J x C= NS C x I= NS J x C x I= NS

AT= Ambient temperature (13-27^{o}C) RT= Refrigerated temperature (0-4^{o}C)

Table 4.200 Effect of storage on overall acceptability of Kinnow: Aonla: Red grapes and vegetable blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Kinnow: Aonla: Red grapes (Control)	7.70	7.50	7.60	7.40	7.50	7.54	7.66
Kinnow:Aonla:Red grapes:Tomato (4.8:0.3:3.4:1.5)	7.50	7.40	7.45	7.30	7.40	7.41	7.73
Kinnow: Aonla: Red grapes: Carrot (3.4: 0.2: 2.4: 4)	8.20	8.00	8.10	7.90	8.00	8.04	
Kinnow:Aonla:Red grapes:Beetroot (5.4:0.3:3.8:0.5)	7.80	7.60	7.70	7.50	7.60	7.64	
Kinnow: Aonla: Red grapes: Cabbage (5.1: 0.3: 3.6:1)	7.86	7.70	7.80	7.60	7.70	7.73	
Mean	7.81	7.64	7.73	7.54	7.64		
Grand Mean (I)	7.81	7.69		7.59			

$CD_{(0.05)}$ Juice (J)= 0.33 Storage conditions (C)= NS Storage intervals (I)= NS J x I= NS
J x C= NS C x I= NS J x C x I= NS

AT= Ambient temperature (13-27^{o}C) RT= Refrigerated temperature (0-4^{o}C)

4.6.7 Kinnow: Papaya: Aonla and vegetable juice blends

4.6.7.1 Total soluble solids (TSS)

Data given in Table 4.201 reveal that the total soluble solids in blends ranged from 9.52 to 11.05^{o}B. Significant difference was recorded in TSS content of all blends. Maximum TSS was recorded in kinnow: papaya: aonla: beetroot (11.05^{o}B) while minimum value was recorded as 9.52^{o}B in kinnow: papaya: aonla: carrot blend. A gradual increase in TSS was recorded with the advancement of storage period which increased from average initial value of 10.12 to 10.52^{o}B after six month irrespective of all the factors however, changes were insignificant. Juice blends stored at ambient temperature showed more increase in TSS (from an initial value of 10.12 to 10.38^{o}B) while those stored at refrigerated temperature resulted in a minimum change (from an initial value of 10.12 to 10.32^{o}B) during storage. The interaction of various factors revealed the non-significant results for change in TSS during storage at both the temperatures.

4.6.7.2 Titratable acidity

Data obtained for the changes in titratable acidity of the juice blends during storage are presented in Table 4.202. A significant difference was recorded in the titratable acidity of all the blends. The mean maximum titratable acidity (1.06%) was recorded in control while minimum was recorded in the kinnow: papaya: aonla: carrot blend (0.65%). A gradual increase in titratable acidity was recorded from an initial mean value of 0.92 to 0.93% after six month of storage however, changes were not significant. Changes were more at ambient

Table 4.201 Effect of storage on total soluble solids (^{o}B) of Kinnow: Papaya: Aonla and vegetable blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Kinnow: Papaya: Aonla (Control)	10.38	10.55	10.43	10.70	10.60	10.53	10.38
Kinnow: Papaya: Aonla: Tomato (6.5: 1.6: 0.9: 1)	9.96	10.30	10.20	10.45	10.42	10.27	10.32
Kinnow: Papaya: Aonla: Carrot (4.3: 1.1: 0.6: 4)	9.52	9.92	9.85	10.20	10.12	9.92	
Kinnow:Papaya:Aonla:Beetroot (5.8: 1.4: 0.8: 2)	11.05	11.32	11.22	11.54	11.40	11.31	
Kinnow:Papaya:Aonla:Cabbage (6.5: 1.6: 0.9: 1)	9.67	9.92	9.85	10.20	10.05	9.94	
Mean	10.12	10.40	10.31	10.62	10.52		
Grand Mean (I)	10.12	10.36		10.52			
$CD_{(0.05)}$ Juice (J)= 0.15 Storage conditions (C)= NS Storage intervals (I)= 0.12 J x I= NS J x C= NS C x I= NS J x C x I= NS							

AT= Ambient temperature (13-27^{o}C) RT= Refrigerated temperature (0-4^{o}C)

Table 4.202 Effect of storage on titratable acidity (%) of Kinnow: Papaya: Aonla and vegetable blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Kinnow: Papaya: Aonla (Control)	1.06	1.07	1.07	1.09	1.08	1.07	0.93
Kinnow: Papaya: Aonla: Tomato (6.5: 1.6: 0.9: 1)	1.02	1.04	1.03	1.06	1.04	1.04	0.92
Kinnow: Papaya: Aonla: Carrot (4.3: 1.1: 0.6: 4)	0.65	0.67	0.66	0.69	0.67	0.67	
Kinnow: Papaya:Aonla:Beetroot (5.8: 1.4: 0.8: 2)	0.87	0. 89	0.88	0.90	0.89	0.89	
Kinnow: Papaya:Aonla:Cabbage (6.5: 1.6: 0.9: 1)	0.98	0.99	0.98	1.01	0.99	0.99	
Mean	0.92	0.94	0.92	0.95	0.93		
Grand Mean (I)	0.92	0.92		0.94			
$CD_{(0.05)}$ Juice (J)= 0.03 Storage conditions (C)= NS Storage intervals (I)= NS J x I= NS J x C= NS C x I= NS J x C x I= NS							

AT= Ambient temperature (13-27^{o}C) RT= Refrigerated temperature (0-4^{o}C)

storage where increase was from mean initial value of 0.92 to 0.94% as compared to refrigerated storage where there was no apparent increase in acidity. Insignificant effect of different interaction factors was observed for all the blends.

4.6.7.3 Reducing sugars

Perusal of data presented in Table 4.203 reveals that reducing sugars content ranged from 4.08 to 5.42% in different kinnow: papaya: aonla and vegetable blends. Kinnow: papaya: aonla: beetroot blend contained maximum reducing sugars content as 5.42% followed by control (4.92%). It was minimum in kinnow: papaya: aonla: carrot (4.08%). No significant variation was recorded in reducing sugars content of all the treatments. An increasing trend of reducing sugars was noticed in all the blends during the storage irrespective of storage conditions. A gradual increase from an initial value of 4.71 (0 day) to 4.74 (3 month) and finally to 4.77% (6 month) was recorded during the storage. Storage conditions also did not affect the reducing sugars content as the increase was recorded from an average initial value of 4.71 to 4.75% in ambient storage as against 4.74% in refrigerated storage.

Table 4.203 Effect of storage on reducing sugars (%) of Kinnow: Papaya: Aonla and vegetable blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Kinnow: Papaya: Aonla (Control)	4.92	4.94	4.93	4.97	4.95	4.94	4.75
Kinnow: Papaya: Aonla: Tomato (6.5: 1.6: 0.9: 1)	4.61	4.64	4.63	4.68	4.66	4.64	4.74
Kinnow: Papaya: Aonla: Carrot (4.3: 1.1: 0.6: 4)	4.08	4.11	4.10	4.16	4.13	4.12	
Kinnow: Papaya: Aonla: Beetroot (5.8: 1.4: 0.8: 2)	5.42	5.47	5.46	5.52	5.49	5.47	
Kinnow: Papaya: Aonla: Cabbage (6.5: 1.6: 0.9: 1)	4.53	4.56	4.55	4.58	4.57	4.56	
Mean	4.71	4.74	4.73	4.78	4.76		
Grand Mean (I)	4.71	4.74		4.77			
$CD_{(0.05)}$ Juice (J)= 0.49 Storage conditions (C)= NS Storage intervals (I)= NS J x I= NS J x C= NS C x I= NS J x C x I= NS							

AT= Ambient temperature (13-27^{o}C) RT= Refrigerated temperature (0-4^{o}C)

4.6.7.4 Total sugars

It is evident from the Table 4.204 total sugars content of kinnow: papaya: aonla and vegetable blends ranged from 7.28 to 8.92 per cent. The mean maximum total sugars content was recorded in kinnow: papaya: aonla: beetroot juice blends as 8.92% whereas it was minimum in kinnow: papaya: aonla blend (7.28%). An increasing trend was recorded in total sugars content of all the blends with the advancement of storage period. It was recorded to increase from an average initial value of 8.23% to 8.27% after six month of storage. Storage conditions did not show any significant effect on the total sugars of different blends however, it resulted in an increase from average initial value of 8.23% to 8.25% at ambient temperature as against 8.24% at refrigerated conditions. Besides, interaction of various factors revealed the non-significant results for change in total sugars.

Table 4.204 Effect of storage on total sugars (%) of Kinnow: Papaya: Aonla and vegetable blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Kinnow: Papaya: Aonla (Control)	7.28	7.31	7.30	7.33	7.32	7.31	8.25
Kinnow: Papaya: Aonla: Tomato (6.5: 1.6: 0.9: 1)	8.35	8.37	8.36	8.39	8.37	8.37	8.24
Kinnow: Papaya: Aonla: Carrot (4.3: 1.1: 0.6: 4)	8.26	8.27	8.26	8.28	8.27	8.27	
Kinnow:Papaya:Aonla:Beetroot (5.8: 1.4: 0.8: 2)	8.92	8.96	8.94	9.01	8.97	8.96	
Kinnow:Papaya:Aonla:Cabbage (6.5: 1.6: 0.9: 1)	8.32	8.34	8.33	8.37	8.35	8.34	
Mean	8.23	8.25	8.24	8.28	8.26		
Grand Mean (I)	8.23	8.24		8.27			
$CD_{(0.05)}$ Juice (J)= 0.05 Storage conditions (C)= NS Storage intervals (I)= NS J x I= NS J x C= NS C x I= NS J x C x I= NS							

AT= Ambient temperature (13-27^{o}C) RT= Refrigerated 15.79 temperature (0-4^{o}C)

4.6.7.5 Ascorbic acid

The perusal of data in Table 4.205 indicates that ascorbic acid content in juice blends was reduced significantly during the storage of six month, irrespective of storage conditions. Average ascorbic acid content was recorded to be in the range of 44.82 to 59.12 mg/100 mL. The maximum ascorbic acid content was recorded in control (59.12 mg/100 mL) while it was minimum in kinnow: papaya: aonla: beetroot (44.82 mg/100 mL). Average ascorbic acid content was recorded to decrease significantly from an initial value of 51.22 to 39.06 mg/ 100 mL after six month of storage, irrespective of storage conditions. The decrease was higher at ambient storage where the decrease was from 51.22 to 43.37 as against 45.54 mg/100 mL at refrigerated storage.

Table 4.205 Effect of storage on ascorbic acid (mg/100 mL) of Kinnow: Papaya: Aonla and vegetable blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Kinnow: Papaya: Aonla (Control)	59.12	42.19	51.87	30.36	44.29	43.89	43.37
Kinnow: Papaya: Aonla: Tomato (6.5: 1.6: 0.9: 1)	50.34	47.32	48.91	43.59	55.34	47.08	45.54
Kinnow: Papaya: Aonla: Carrot (4.3: 1.1: 0.6: 4)	53.84	39.38	30.18	27.64	28.23	40.29	
Kinnow: Papaya: Aonla: Beetroot (5.8: 1.4: 0.8: 2)	44.82	41.26	41.36	39.34	38.78	41.81	
Kinnow: Papaya: Aonla: Cabbage (6.5: 1.6: 0.9: 1)	47.96	43.21	45.21	40.19	42.80	43.79	
Mean	51.22	42.67	43.51	36.22	41.89		
Grand Mean (I)	51.22	43.09		39.06			
$CD_{(0.05)}$ Juice (J)= 1.60 Storage conditions (C)= 1.01 Storage intervals (I)= 1.24 J x I= 2.77 J x C= 2.26 C x I= 1.75 J x C x I= 3.92							

AT= Ambient temperature (13-27^{o}C) RT= Refrigerated temperature (0-4^{o}C)

4.6.7.6 Total phenolics

Data showing the effect of storage intervals and storage conditions on kinnow: papaya: aonla and vegetable juice/pulp blends are presented in Table 4.206. Total phenolics content (TPC) was found to be in the range of 27.73 to 77.23 mg/100 mL. A significant difference in the mean TPC was recorded in all the blends. It was highest in kinnow: papaya: aonla: beetroot (77.23 mg/100 mL) while lowest in kinnow: papaya: aonla: carrot (27.73 mg/100 mL). A gradual decrease in the TPC was recorded from a mean initial value of 47.28 to 40.24

mg/100 mL with the advancement of storage. TPC was found to be affected significantly by storage condition. It decreased from an average initial value of 47.28 to 42.96 at ambient storage against 44.35 mg/100 mL at refrigerated storage. A significant effect of various interaction factors on total phenolics was also recorded for all the blends.

4.6.7.7 Total carotenoids

Total carotenoids content of different blends are given in Table 4.207. It varied from 1.82 to 5.17 mg/100 mL. The mean maximum total carotenoids content was recorded in kinnow: papaya: aonla: carrot (5.17 mg/100 mL) while it was minimum in kinnow: papaya: aonla: beetroot (1.82 mg/100 mL). A marginal decrease in total carotenoids of all the blends was recorded during storage where decrease was from 3.22 to 3.16 mg/100 mL however, losses were insignificant. An insignificant effect of

Table 4.206 Effect of storage on total phenolics (mg/100 mL) of Kinnow: Papaya: Aonla and vegetable blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Kinnow: Papaya: Aonla (Control)	43.33	35.36	37.65	28.59	33.46	35.68	42.96
Kinnow: Papaya: Aonla: Tomato (6.5: 1.6: 0.9: 1)	42.15	38.46	39.88	36.19	37.46	38.83	44.35
Kinnow: Papaya: Aonla: Carrot (4.3: 1.1: 0.6: 4)	27.73	24.09	25.63	21.52	22.57	24.31	
Kinnow:Papaya:Aonla:Beetroot (5.8: 1.4: 0.8: 2)	77.23	73.24	75.64	70.39	73.45	73.99	
Kinnow:Papaya:Aonla:Cabbage (6.5: 1.6: 0.9: 1)	45.94	41.55	42.97	38.64	40.11	41.84	
Mean	47.28	42.54	44.35	39.07	41.41		
Grand Mean (I)	47.28	43.45		40.24			
$CD_{(0.05)}$ Juice (J)= 1.40 Storage conditions (C)= 0.89 Storage intervals (I)= 1.09 J x I= NS J x C= NS C x I= NS J x C x I= NS							

AT= Ambient temperature (13-27^{o}C) RT= Refrigerated temperature (0-4^{o}C)

Table 4.207 Effect of storage on total carotenoids (mg/100 mL) of Kinnow: Papaya: Aonla and vegetable blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Kinnow: Papaya: Aonla (Control)	4.41	4.38	4.40	4.37	4.39	4.39	3.19
Kinnow: Papaya: Aonla: Tomato (6.5: 1.6: 0.9: 1)	2.55	2.51	2.52	2.48	2.50	2.51	3.20
Kinnow: Papaya: Aonla: Carrot (4.3: 1.1: 0.6: 4)	5.17	5.14	5.15	5.11	5.12	5.14	
Kinnow:Papaya: Aonla:Beetroot (5.8: 1.4: 0.8: 2)	1.82	1.79	1.80	1.76	1.78	1.79	
Kinnow:Papaya: Aonla:Cabbage (6.5: 1.6: 0.9: 1)	2.14	2.09	2.11	2.05	2.08	2.09	
Mean	3.22	3.18	3.20	3.15	3.17		
Grand Mean (I)	3.22	3.19		3.16			
$CD_{(0.05)}$ Juice (J)= 0.12 Storage conditions (C)= NS Storage intervals (I)= NS J x I= NS J x C= NS C x I= NS J x C x I= NS							

AT= Ambient temperature (13-27^{o}C) RT= Refrigerated temperature (0-4^{o}C)

Table 4.208 Effect of storage on antioxidant activity (%) of Kinnow: Papaya: Aonla and vegetable blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Kinnow: Papaya: Aonla (Control)	62.40	60.08	59.41	58.14	56.17	59.24	58.43
Kinnow: Papaya: Aonla: Tomato (6.5: 1.6: 0.9: 1)	59.58	56.34	55.21	54.78	53.42	55.87	57.39
Kinnow: Papaya: Aonla: Carrot (4.3: 1.1: 0.6: 4)	60.44	58.61	56.15	55.34	54.41	56.99	
Kinnow: Papaya:Aonla:Beetroot (5.8: 1.4: 0.8: 2)	63.13	60.72	58.84	59.46	57.69	59.97	
Kinnow:Papaya:Aonla:Cabbage (6.5: 1.6: 0.9: 1)	58.32	55.42	53.71	53.83	51.98	54.65	
Mean	60.77	58.23	56.66	56.31	54.73		
Grand Mean (I)	60.77	57.45		55.22			
$CD_{(0.05)}$ Juice (J)= 2.12 Storage conditions (C)= NS Storage intervals (I)= 1.63 J x I= NS J x C= NS C x I= NS J x C x I= NS							

AT= Ambient temperature (13-27^{o}C) RT= Refrigerated temperature (0-4^{o}C)

various interaction factors was recorded for total carotenoids content of all the blends.

4.6.7.8 Antioxidant activity

Data on the effect of storage on the antioxidant activity (AA) of blends are presented in Table 4.208. The antioxidant activity ranged from 58.32 to 63.13% in different blends. Significant differences were observed in the AA of all the juice blends. Storage intervals imposed a significant effect on the antioxidant activity of all the blends. The AA was observed to decrease from an average mean value of 60.77 (0 day) to 55.22% (6 month) during storage. Reduction was lower at ambient temperature as compared to refrigerated temperature in case of all blends where AA reduced from 60.77 to 58.43% at ambient temperature as against 57.39% at refrigerated temperature. Similar trends were recorded in all the juice blends. Besides, interaction of various factors revealed the non-significant results for change in antioxidant activity.

4.6.7.9 Non-enzymatic browning

It is clear from the data given in Table 4.209 that the mean non-enzymatic browning (NEB) increased with the advancement of storage period. The NEB of all the blends varied significantly with highest value for kinnow: papaya: aonla: beetroot blend (4.095) and the lowest for kinnow: papaya: aonla: cabbage (0.846). No significant effect of storage period and storage conditions was recorded on NEB of juices, however it increased marginally during storage of six month. It increased from a mean initial value of 1.558 to 1.564 after six month. Besides, the interaction of various factors did not impose significant changes in NEB.

4.6.7.10 Sensory quality

The colour rating was found to increase by blending of juices (Table 4.210). It was highest (7.80) in kinnow: papaya: aonla: carrot juice blend while lowest colour rating was recorded for kinnow: papaya: aonla: cabbage (7.49). The colour rating of blends showed slight decrease during storage. It was found to decrease from an initial value of 7.57 to 7.28 at six month of storage however, changes were not significant. Blends stored at refrigerated temperature had better liking than those stored at ambient temperature. The colour rating decreased from an initial value of 7.57 to 7.36 and 7.46 at ambient and refrigerated storage conditions, respectively. The colour rating was not significantly affected by various interaction factors.

Data showing the effect of storage on the flavour rating of kinnow: papaya: aonla and vegetable juice blends are presented in the Table 4.211. During storage the blends suffered losses in flavour score. However, blends stored at low temperature were better than those stored at ambient temperature. During storage, the flavour rating was observed to decrease non-significantly from mean initial value of 7.81 to 7.57. Highest flavour rating was recorded as 8.80 (kinnow: papaya: aonla: carrot blend) while it was lowest for control (7.30). Various interaction factors did not affect the flavour during the storage irrespective of storage conditions.

Perusal of the data presented in Table 4.212 indicates non-significant decrease in the body score of all the blends. The body score was recorded to increase with the blending. During storage, the body score was recorded to decrease from 7.43 at 0 day to 7.22 at 6 month. Storage conditions also affected the body score of blends as more decrease was recorded at ambient storage conditions. Besides, changes were non-significant irrespective of various interaction factors.

Blending exhibited a significant increase in overall acceptability (OAA) rating of different blends (Table 4.213). The OAA score of blends exhibited a gradual decrease with the advancement of storage conditions. Kinnow: papaya: aonla: carrot obtained superior rating (8.00) for OAA while kinnow: papaya: aonla: tomato obtained lowest score on Hedonic scale (7.50) for OAA except control. The storage temperature also influenced the OAA score as it was lower (7.50) at ambient temperature as compared to low temperature storage (7.54). The OAA rating was found to decrease from an average initial value of 7.69 to 7.32 during six month of storage however, changes were insignificant.

Table 4.209 Effect of storage on non-enzymatic browning of Kinnow: Papaya: Aonla and vegetable blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Kinnow: Papaya: Aonla (Control)	1.104	1.108	1.106	1.110	1.108	1.107	1.563
Kinnow: Papaya: Aonla: Tomato (6.5: 1.6: 0.9: 1)	0.869	0.878	0.873	0.886	0.878	0.877	1.560
Kinnow: Papaya: Aonla: Carrot (4.3: 1.1: 0.6: 4)	0.876	0.889	0.881	0.896	0.885	0.885	
Kinnow: Papaya: Aonla: Beetroot (5.8: 1.4: 0.8: 2)	4.095	4.086	4.091	4.072	4.079	4.085	
Kinnow: Papaya: Aonla: Cabbage (6.5: 1.6: 0.9: 1)	0.846	0.858	0.851	0.865	0.858	0.856	
Mean	1.558	1.564	1.560	1.566	1.562		
Grand Mean (I)	1.558	1.562		1.564			
$CD_{(0.05)}$ Juice (J)= 0.04 Storage conditions (C)= NS Storage intervals (I)= NS J x I= NS J x C= NS C x I= NS J x C x I= NS							

AT= Ambient temperature (13-27^{o}C) RT= Refrigerated temperature (0-4^{o}C)

Table 4.210 Effect of storage on colour of Kinnow: Papaya: Aonla and vegetable blends

Juice	Storage intervals (month)					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Kinnow: Papaya: Aonla (Control)	7.53	6.70	6.90	6.50	6.80	6.89	7.36
Kinnow: Papaya: Aonla: Tomato (6.5: 1.6: 0.9: 1)	7.53	7.70	7.80	7.60	7.70	7.67	7.46
Kinnow: Papaya: Aonla: Carrot (4.3: 1.1: 0.6: 4)	7.80	7.70	7.80	7.60	7.74	7.73	
Kinnow:Papaya:Aonla:Beetroot (5.8: 1.4: 0.8: 2)	7.50	7.30	7.40	7.20	7.30	7.34	
Kinnow: Papaya:Aonla:Cabbage (6.5: 1.6: 0.9: 1)	7.49	7.23	7.35	7.08	7.25	7.28	
Mean	7.57	7.33	7.45	7.20	7.36		
Grand Mean (I)	7.57	7.39		7.28			
$CD_{(0.05)}$ Juice (J)= 0.17 Storage conditions (C)= Storage intervals (I)= NS J x I= NS J x C= NS C x I= NS J x C x I= NS							

AT= Ambient temperature (13-27^{o}C) RT= Refrigerated temperature (0-4^{o}C)

Table 4.211 Effect of storage on flavour of Kinnow: Papaya: Aonla and vegetable blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Kinnow: Papaya: Aonla (Control)	7.30	7.00	7.20	6.90	7.10	7.10	7.65
Kinnow: Papaya: Aonla: Tomato (6.5: 1.6: 0.9: 1)	7.50	7.40	7.50	7.20	7.40	7.40	7.73
Kinnow: Papaya: Aonla: Carrot (4.3: 1.1: 0.6: 4)	8.80	8.60	8.70	8.50	8.60	8.64	
Kinnow:Papaya:Aonla:Beetroot (5.8: 1.4: 0.8: 2)	7.87	7.70	7.80	7.60	7.70	7.73	
Kinnow:Papaya: Aonla:Cabbage (6.5: 1.6: 0.9: 1)	7.60	7.40	7.50	7.30	7.40	7.44	
Mean	7.81	7.62	7.74	7.50	7.64		
Grand Mean (I)	7.81	7.68		7.57			
$CD_{(0.05)}$ Juice (J)= 0.28 Storage conditions (C)= NS Storage intervals (I)= NS J x I= NS J x C= NS C x I= NS J x C x I= NS							

AT= Ambient temperature (13-27^{o}C) RT= Refrigerated temperature (0-4^{o}C)

Table 4.212 Effect of storage on body of Kinnow: Papaya: Aonla and vegetable blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Kinnow: Papaya: Aonla (Control)	7.50	7.30	7.40	7.20	7.60	7.40	7.27
Kinnow: Papaya: Aonla: Tomato (6.5: 1.6: 0.9: 1)	7.20	7.00	7.10	6.90	7.00	7.04	7.36
Kinnow: Papaya: Aonla: Carrot (4.3: 1.1: 0.6: 4)	7.80	7.60	7.70	7.50	7.60	7.64	
Kinnow:Papaya:Aonla: Beetroot (5.8: 1.4: 0.8: 2)	7.50	7.40	7.40	7.20	7.40	7.38	
Kinnow:Papaya:Aonla: Cabbage (6.5: 1.6: 0.9: 1)	7.13	7.00	7.07	6.83	6.97	7.00	
Mean	7.43	7.26	7.33	7.13	7.31		
Grand Mean (I)	7.43	7.30		7.22			
$CD_{(0.05)}$ Juice (J)= 0.46 Storage conditions (C)= NS Storage intervals (I)= NS J x I= NS J x C= NS C x I= NS J x C x I= NS							

AT= Ambient temperature (13-27^{o}C) RT= Refrigerated temperature (0-4^{o}C)

Table 4.213 Effect of storage on overall acceptability of Kinnow: Papaya: Aonla and vegetable blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Kinnow: Papaya: Aonla (Control)	7.60	7.40	7.50	7.20	7.35	7.41	7.50
Kinnow: Papaya: Aonla: Tomato (6.5: 1.6: 0.9: 1)	7.50	7.25	7.40	7.00	7.20	7.27	7.54
Kinnow: Papaya: Aonla: Carrot (4.3: 1.1: 0.6: 4)	8.00	7.85	7.90	7.70	7.84	7.86	
Kinnow:Papaya:Aonla: Beetroot (5.8: 1.4: 0.8: 2)	7.65	7.30	7.40	7.13	7.25	7.35	
Kinnow:Papaya:Aonla: Cabbage (6.5: 1.6: 0.9: 1)	7.70	7.40	7.50	7.20	7.30	7.42	
Mean	7.69	7.44	7.54	7.25	7.39		
Grand Mean (I)	7.69	7.49		7.32			
$CD_{(0.05)}$ Juice (J)= 0.21 Storage conditions (C)= NS Storage intervals (I)= NS J x I= NS J x C= NS C x I= NS J x C x I= NS							

AT= Ambient temperature (13-27^{o}C) RT= Refrigerated temperature (0-4^{o}C

4.6.8 Kinnow: Red grapes: Papaya and vegetable juice blends

4.6.8.1 Total soluble solids (TSS)

Data given in Table 4.214 reveal that the total soluble solids in blends ranged from 10.61 to 12.57^{o}B. Significant difference was recorded in TSS content of all blends. Maximum TSS was recorded in kinnow: red grapes: papaya: beetroot (12.57^{o}B) while minimum value was recorded as 10.61^{o}B (kinnow: red grapes: papaya: cabbage). A gradual increase in TSS was recorded with the advancement of storage period which increased from average initial value of 11.81 to 12.21^{o}B after six month irrespective of all the factors. Juice blends stored at ambient temperature showed more increase in TSS (from an initial value of 11.81 to 12.04^{o}B) while those stored at refrigerated temperature resulted in a minimum change (from an initial value of 11.81 to 11.98^{o}B) during storage. The interaction of various factors revealed the non-significant results for change in TSS during storage at both the temperatures.

4.6.8.2 Titratable acidity

Data obtained for the changes in titratable acidity of the kinnow: red grapes: papaya and vegetable blends during storage are presented in Table 4.215. A significant difference was recorded in the titratable acidity of all the blends. The mean maximum titratable acidity (0.82%) was recorded in kinnow: red grapes: papaya: tomato and control while minimum was recorded as 0.55% in the kinnow: red grapes: papaya: carrot blend. A gradual increase in titratable acidity was recorded from an initial mean value of 0.73 to 0.76% after six month of storage however, changes were not significant. Changes were more at ambient storage where increase was from mean initial value of 0.73 to 0.75% as compared to refrigerated storage where the increase was from a mean initial value of 0.73 to 0.74 per cent. Insignificant effect of different interaction factors was observed for all the blends.

Table 4.214 Effect of storage on total soluble solids (°B) of Kinnow: Red grapes: Papaya and vegetable blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Kinnow: Red grapes: Papaya (Control)	12.48	12.60	12.57	12.84	12.70	12.64	12.04
Kinnow:Red grapes:Papaya: Tomato (4.2: 3.4: 1.9: 0.5)	12.19	12.50	12.45	12.72	12.62	12.50	11.98
Kinnow: Red grapes: Papaya: Carrot (2.9: 2.3: 1.3: 3.5)	11.20	11.42	11.35	11.65	11.58	11.44	
Kinnow:Red grapes:Papaya:Beetroot (4.2:3.4: 1.9: 0.5)	12.57	12.78	12.70	12.90	12.84	12.76	
Kinnow:Red grapes:Papaya:Cabbage (3.5: 2.9: 1.6: 2)	10.61	10.93	10.82	11.24	11.02	10.92	
Mean	11.81	12.05	11.98	12.27	12.15		
Grand Mean (I)	11.81	12.01		12.21			
$CD_{(0.05)}$ Juice (J)= 0.14 Storage conditions (C)= NS Storage intervals (I)= 0.11 J x I= NS J x C= NS C x I= NS J x C x I= NS							

AT= Ambient temperature (13-27°C) RT= Refrigerated temperature (0-4°C)

Table 4.215 Effect of storage on titratable acidity (%) of Kinnow: Red grapes: Papaya and vegetable blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Kinnow: Red grapes: Papaya (Control)	0.82	0.84	0.83	0.85	0.84	0.84	0.75
Kinnow:Red grapes:Papaya: Tomato (4.2: 3.4: 1.9: 0.5)	0.82	0.84	0.83	0.86	0.85	0.84	0.74
Kinnow: Red grapes: Papaya: Carrot (2.9: 2.3: 1.3: 3.5)	0.55	0.57	0.56	0.59	0.58	0.57	
Kinnow:Red grapes:Papaya:Beetroot (4.2:3.4: 1.9: 0.5)	0.79	0.80	0.79	0.82	0.80	0.80	
Kinnow:Red grapes:Papaya: Cabbage (3.5: 2.9: 1.6: 2)	0.67	0.68	0.68	0.70	0.69	0.68	
Mean	0.73	0.75	0.74	0.76	0.75		
Grand Mean (I)	0.73	0.74		0.76			
$CD_{(0.05)}$ Juice (J)= 0.03 Storage conditions (C)= NS Storage intervals (I)= 0.02 J x I= NS J x C= NS C x I= NS J x C x I= NS							

AT= Ambient temperature (13-27°C) RT= Refrigerated temperature (0-4°C)

Table 4.216 Effect of storage on reducing sugars (%) of Kinnow: Red grapes: Papaya and vegetable blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Kinnow: Red grapes: Papaya (Control)	4.82	4.86	4.84	4.88	4.86	4.85	4.67
Kinnow:Red grapes: Papaya: Tomato (4.2: 3.4: 1.9: 0.5)	4.84	4.88	4.87	4.90	4.88	4.87	4.65
Kinnow: Red grapes: Papaya: Carrot (2.9: 2.3: 1.3: 3.5)	4.27	4.31	4.29	4.34	4.32	4.31	
Kinnow:Red grapes:Papaya: Beetroot (4.2: 3.4: 1.9: 0.5)	5.09	5.12	5.10	5.13	5.12	5.11	
Kinnow: Red grapes: Papaya: Cabbage (3.5: 2.9: 1.6: 2)	4.14	4.19	4.17	4.22	4.20	4.18	
Mean	4.63	4.67	4.65	4.69	4.68		
Grand Mean (I)	4.63	4.66		4.69			
$CD_{(0.05)}$ Juice (J)= 0.05 Storage conditions (C)= NS Storage intervals (I)= 0.04 J x I= NS J x C= NS C x I= NS J x C x I= NS							

AT= Ambient temperature (13-27°C) RT= Refrigerated temperature (0-4°C)

4.6.8.3 Reducing sugars

Perusal of data presented in Table 4.216 reveals that reducing sugars content ranged from 4.14 to 5.09% in different kinnow: red grapes: papaya and vegetable blends. Kinnow: red grapes: papaya: beetroot blend contained maximum reducing sugars content as 5.09% followed by kinnow: red grapes: papaya: tomato juice/pulp blend (4.84 per cent). It was minimum in kinnow: red grapes: papaya: cabbage (4.14 per cent). No significant variation was recorded in reducing sugars content of all the treatments. An increasing trend was noticed in reducing sugars of all the blends during the storage, irrespective of storage conditions. A gradual increase from an initial value of 4.63 (0 day) to 4.66 (3 month) and finally to 4.69% (6 month) was recorded during the storage. Storage conditions also did not affect the reducing sugars content as the increase was recorded from an average initial value of 4.63 to 4.67% in ambient storage as against 4.65% in refrigerated storage.

4.6.8.4 Total sugars

It is evident from the Table 4.217 that blending of juice resulted in decrease in total sugars of all the blends. The mean maximum total sugars content was recorded in kinnow: red grapes: papaya blends (control) as 8.94% whereas it was minimum in kinnow: red grapes: papaya: cabbage blend (6.23%). An increasing trend was recorded in total sugars content of all the blends with the advancement of storage period. It was recorded to increase from an average initial value of 7.35 to 7.39% after six month of storage. Temperature did not show any significant effect on the total sugars of different blends however, it resulted in an increase from average initial value of 7.35 to 7.37% at ambient temperature as against 7.36% at refrigerated conditions. Besides, interaction of various factors revealed the non-significant results for change in total sugars.

4.6.8.5 Ascorbic acid

The perusal of data in Table 4.218 reveals the effect of storage on ascorbic acid content of juice blends. Average ascorbic acid content was recorded to be in the range of 6.78 to 11.65 mg/100 mL. The maximum ascorbic acid content was found in control (11.65 mg/100 mL) while it was minimum in kinnow: red grapes: papaya: carrot (6.78 mg/100 mL). A perceivable reduction was recorded in ascorbic acid content of all the blends during the storage, irrespective of storage conditions. Average ascorbic acid content was recorded to decrease significantly from an initial value of 9.34 to 6.50 mg/ 100 mL after six month of storage, irrespective of storage conditions. The decrease was higher at ambient storage where the decrease was from 9.34 to 7.62 as against 8.21 mg/100 mL at refrigerated storage.

Table 4.217 Effect of storage on total sugars (%) of Kinnow: Papaya and vegetable blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Kinnow: Red grapes: Papaya (Control)	8.94	8.98	8.97	9.01	8.98	8.98	7.37
Kinnow:Red grapes: Papaya:Tomato (4.2: 3.4: 1.9: 0.5)	7.10	7.13	7.11	7.15	7.13	7.12	7.36
Kinnow: Red grapes: Papaya: Carrot (2.9: 2.3: 1.3: 3.5)	7.05	7.09	7.07	7.11	7.09	7.08	
Kinnow:Red grapes:Papaya Beetroot (4.2:3.4:1.9:0.5)	7.41	7.42	7.41	7.45	7.44	7.43	
Kinnow: Red grapes: Papaya: Cabbage (3.5: 2.9: 1.6:2)	6.23	6.24	6.23	6.26	6.24	6.24	
Mean	7.35	7.37	7.36	7.40	7.38		
Grand Mean (I)	7.35	7.37		7.39			
$CD_{(0.05)}$ Juice (J)= 0.09 Storage conditions (C)= NS Storage intervals (I)= NS J x I= NS J x C= NS C x I= NS J x C x I= NS							

AT= Ambient temperature (13-27^{o}C) RT= Refrigerated 15.79 temperature (0-4^{o}C)

Table 4.218 Effect of storage on ascorbic acid (mg/100 mL) of Kinnow: Red grapes: Papaya and vegetable blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Kinnow: Red grapes: Papaya (Control)	11.65	9.87	10.32	8.21	9.66	9.94	7.62
Kinnow:Red grapes:Papaya:Tomato (4.2: 3.4: 1.9: 0.5)	9.36	7.58	8.35	5.39	6.70	7.48	8.21
Kinnow: Red grapes: Papaya: Carrot (2.9: 2.3: 1.3: 3.5)	6.78	5.42	5.64	4.16	4.82	5.36	
Kinnow:Red grapes:Papaya:Beetroot (4.2: 3.4: 1.9: 0.5)	9.47	7.62	8.34	5.72	6.55	7.54	
Kinnow: Red grapes: Papaya: Cabbage (3.5: 2.9: 1.6: 2)	9.43	7.42	8.64	6.22	7.54	7.85	
Mean	9.34	7.58	8.26	5.94	7.05		
Grand Mean (I)	9.34	7.92		6.50			
$CD_{(0.05)}$ Juice (J)= 0.85 Storage conditions (C)= 0.54 Storage intervals (I)= 0.66 J x I= NS J x C= NS C x I= NS J x C x I= NS							

AT= Ambient temperature (13-27^{o}C) RT= Refrigerated temperature (0-4^{o}C)

4.6.8.6 Total phenolics

Data presented in Table 4.219 show the effect of storage intervals and storage conditions on total phenolics content of blends. Total phenolics content (TPC) was found to be in the range from 24.19 to 42.70 mg/100 mL. A significant difference in the mean TPC was recorded in all the blends. It was highest in kinnow: red grapes: papaya: beetroot (42.70 mg/100 mL) while lowest in kinnow: red grapes: papaya: carrot blend (24.19 mg/100 mL). A gradual decrease in the TPC was recorded from a mean initial value of 34.46 to 28.85 mg/100 mL after six month of storage. TPC was found to be affected significantly by storage condition. It decreased from an average initial value of 34.46 to 31.04 at ambient storage as against 31.83 mg/100 mL at refrigerated storage. A significant effect of various interaction factors on total phenolics was also recorded for all the blends.

Table 4.219 Effect of storage on total phenolics (mg/100 mL) of Kinnow: Red grapes: Papaya and vegetable blends

Juice	Storage interval (month)/Storage conditions					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Kinnow: Red grapes: Papaya (Control)	35.87	30.42	32.13	27.69	29.39	31.10	31.04
Kinnow:Red grapes:Papaya:Tomato (4.2: 3.4: 1.9: 0.5)	35.65	32.14	33.46	29.38	31.09	32.34	31.83
Kinnow: Red grapes: Papaya: Carrot (2.9: 2.3: 1.3: 3.5)	24.19	19.33	20.34	17.64	18.53	20.01	
Kinnow:Red grapes:Papaya:Beetroot (4.2: 3.4: 1.9: 0.5)	42.70	39.50	40.11	37.58	38.65	39.71	
Kinnow: Red grapes: Papaya: Cabbage (3.5: 2.9: 1.6:2)	33.88	30.95	31.59	28.64	29.87	30.99	
Mean	34.46	30.47	31.53	28.19	29.51		
Grand Mean (I)	34.46	31.00		28.85			
$CD_{(0.05)}$ Juice (J)= 1.27 Storage conditions (C)= 0.80 Storage intervals (I)= 0.98 J x I= NS J x C= NS C x I= NS J x C x I= NS							

AT= Ambient temperature (13-27^{o}C) RT= Refrigerated temperature (0-4^{o}C)

4.6.8.7 Total carotenoids

Total carotenoids content of different blends are given in Table 4.220. It varied from 2.23 to 6.06 mg/100 mL. The mean maximum total carotenoids content was recorded in kinnow: red grapes: papaya: carrot (6.06 mg/100 mL). A marginal decrease in total carotenoids of all the blends was recorded during storage where decrease was from 4.15 to 4.08 mg/100 mL however, losses were insignificant. An insignificant effect of various interaction factors was recorded for total carotenoids content of all the blends.

4.6.8.8 Total Anthocyanins

Data presented in Table 4.221 reveal that total anthocyanins of kinnow: red grapes: papaya and vegetable blends ranged from 16.24 to 27.48 mg/100 mL. The mean maximum total anthocyanins content was recorded as 27.48 mg/100 mL (control) followed by 24.47 mg/100 mL (kinnow: red grapes: papaya: beetroot). The mean minimum total anthocyanins content was recorded in kinnow: red grapes: papaya carrot (16.24 mg/100 mL). A significant decrease in total anthocyanins was recorded during storage. It decreased from a mean initial value of 21.10 to 17.14 mg/100 mL after six month of storage, irrespective of storage factors. Storage conditions also exhibited a significant effect on total anthocyanins of juice blends. Interaction factors also affected the total anthocyanins content significantly.

Table 4.220 Effect of storage on total carotenoids (mg/100 mL) of Kinnow: Red grapes: Papaya and vegetable blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Kinnow: Red grapes: Papaya (Control)	2.23	2.21	2.22	2.20	2.20	2.21	4.11
Kinnow:Red grapes:Papaya: Tomato (4.2: 3.4: 1.9: 0.5)	4.51	4.48	4.49	4.45	4.47	4.48	4.12
Kinnow: Red grapes: Papaya: Carrot (2.9: 2.3: 1.3: 3.5)	6.06	5.98	6.01	5.92	5.93	5.98	
Kinnow:Red grapes:Papaya:Beetroot (4.2:3.4: 1.9: 0.5)	3.15	3.09	3.11	3.06	3.09	3.10	
Kinnow: Red grapes: Papaya: Cabbage (3.5: 2.9: 1.6:2)	4.80	4.75	4.78	4.73	4.75	4.76	
Mean	4.15	4.10	4.12	4.07	4.09		
Grand Mean (I)	4.15	4.11		4.08			

$CD_{(0.05)}$ Juice (J)= 0.26 Storage conditions (C)= NS Storage intervals (I)= NS J x I= NS
J x C= NS C x I= NS J x C x I= NS

AT= Ambient temperature (13-27^{o}C) RT= Refrigerated temperature (0-4^{o}C)

Table 4.221 Effect of storage on total anthocyanins (mg/100 mL) of Kinnow: Red grapes: Papaya and vegetable blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Kinnow: Red grapes: Papaya (Control)	27.48	24.18	25.64	22.53	24.62	24.89	18.51
Kinnow:Red grapes:Papaya:Tomato (4.2: 3.4: 1.9: 0.5)	20.44	18.22	19.05	15.74	17.58	18.21	19.52
Kinnow: Red grapes: Papaya: Carrot (2.9: 2.3: 1.3: 3.5)	16.24	13.61	14.79	11.25	13.36	13.85	
Kinnow:Red grapes:Papaya:Beetroot (4.2:3.4:1.9:0.5)	24.47	21.84	22.75	19.92	21.38	22.07	
Kinnow: Red grapes: Papaya: Cabbage (3.5: 2.9: 1.6:2)	16.89	13.22	14.69	11.64	13.41	13.97	
Mean	21.10	18.21	19.38	16.22	18.07		
Grand Mean (I)	21.10	18.80		17.14			

$CD_{(0.05)}$ Juice (J)= 1.08 Storage conditions (C)= 0.68 Storage intervals (I)= 0.83 J x I= NS
J x C= NS C x I= NS J x C x I= NS

AT= Ambient temperature (13-27^{o}C) RT= Refrigerated temperature (0-4^{o}C)

4.6.8.9 Antioxidant activity

Data on the effect of storage on the antioxidant activity (AA) of blends are presented in Table 4.222. The antioxidant activity ranged from 44.25 to 65.40% in different blends. Significant differences were observed in the AA of all the juice blends. Storage intervals imposed a significant effect on the antioxidant activity of all the blends. The AA was observed to decrease from an average mean value of 58.79 (0 day) to 52.69% (6 month) during storage. Changes were lower at ambient temperature as compared to refrigerated temperature in case of all blends where AA reduced from 58.79 to 55.88 at ambient temperature as aginst 54.92% at refrigerated temperature. Besides, interaction of various factors revealed the non-significant results for change in antioxidant activity.

Table 4.222 Effect of storage on antioxidant activity (%) of Kinnow: Red grapes: Papaya and vegetable blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Kinnow: Red grapes: Papaya (Control)	65.40	63.34	62.67	62.09	60.29	62.76	55.88
Kinnow:Red grapes:Papaya: Tomato (4.2: 3.4: 1.9: 0.5)	62.79	60.33	59.20	58.24	56.47	59.41	54.92
Kinnow: Red grapes: Papaya: Carrot (2.9: 2.3: 1.3: 3.5)	62.40	54.59	53.46	52.19	50.82	54.69	
Kinnow:Red grapes:Papaya:Beetroot (4.2:3.4: 1.9: 0.5)	44.25	42.19	41.09	40.37	38.86	41.35	
Kinnow: Red grapes: Papaya: Cabbage (3.5: 2.9: 1.6:2)	59.09	56.98	54.48	53.97	52.61	55.43	
Mean	58.79	55.49	54.18	53.37	51.81		
Grand Mean (I)	58.79	54.83		52.69			
$CD_{(0.05)}$ Juice (J)= 1.39 Storage conditions (C)= 0.88 Storage intervals (I)= 1.39 J x I= 2.42 J x C= NS C x I= NS J x C x I= NS							

AT= Ambient temperature (13-27^{o}C) RT= Refrigerated temperature (0-4^{o}C)

4.6.8.10 Non-enzymatic browning

It is clear from the data given in Table 4.223 that the mean non-enzymatic browning (NEB) decreased with the advancement of storage period. The NEB of all the blends varied significantly with highest value for kinnow: red grapes: papaya: beetroot blend (4.154) and the lowest for kinnow: red grapes: papaya: carrot blend (1.243). No significant effect of storage period and storage conditions was recorded on NEB of juices. Besides, interaction of various factors did not impose significant changes in NEB.

Table 4.223 Effect of storage on non-enzymatic browning of Kinnow: Red grapes: Papaya and vegetable blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Kinnow: Red grapes: Papaya (Control)	1.436	1.432	1.435	1.429	1.433	1.433	1.821
Kinnow:Red grapes:Papaya: Tomato (4.2: 3.4: 1.9: 0.5)	1.594	1.186	1.296	1.063	1.158	1.259	1.851
Kinnow: Red grapes: Papaya: Carrot (2.9: 2.3: 1.3: 3.5)	1.243	1.086	1.109	0.989	1.021	1.090	
Kinnow:Red grapes:Papaya: Beetroot (4.2:3.4:1.9: 0.5)	4.154	4.142	4.148	4.131	4.139	4.143	
Kinnow: Red grapes: Papaya: Cabbage (3.5: 2.9: 1.6:2)	1.329	1.115	1.231	0.987	1.038	1.140	
Mean	1.951	1.792	1.844	1.720	1.758		
Grand Mean (I)	1.951	1.818		1.739			

$CD_{(0.05)}$ Juice (J)= 0.02 Storage conditions (C)= 0.01 Storage intervals (I)= 0.02 J x I= 0.034
J x C= 0.03 C x I= 0.03 J x C x I= 0.06

AT= Ambient temperature (13-27°C) RT= Refrigerated temperature (0-4°C)

4.6.8.11 Sensory quality

The colour rating was found to increase by blending of juices (Table 4.224). It was highest (8.37) in kinnow: red grapes: papaya: carrot juice blend while lowest colour rating was recorded for kinnow: red grapes: papaya: beetroot (7.80). The colour rating of blends showed slight decrease during storage. It was found to decrease from an initial value of 8.06 to 7.86 at six month of storage however, changes were not significant. Blends stored at refrigerated temperature had better liking than those stored at ambient temperature. Colour rating decreased from an initial value of 8.06 to 7.94 and 7.98 at ambient and refrigerated storage conditions, respectively. The colour rating was not significantly affected by various interaction factors.

Data showing the effect of storage on the flavour rating of kinnow: red grapes: papaya and vegetable juice blends are presented in the Table 4.225. During storage the blends showed decrease in flavour score. However blends stored at low temperature were better than those stored at ambient temperature. During storage, the flavour rating was observed to decrease non-significantly from mean initial value of 7.45 to 7.22. Highest flavour rating was recorded as 8.00 (kinnow: red grapes: papaya: carrot blend) while it was lowest for kinnow: red grapes: papaya: tomato (6.80). Various interaction factors did not affect the flavour during the storage irrespective of storage conditions.

Perusal of the data presented in Table 4.226 indicated perceivable decrease in the body score of all the blends. The body score was recorded to increase with the blending. During storage, the body score was recorded to decrease from 7.23 at 0 day to 6.95 at 6 month. Storage conditions also affected the body score of blends as more decrease was recorded at ambient storage conditions. Besides this, changes were non-significant irrespective of various interaction factors.

Blending exhibited a significant increase in the overall acceptability (OAA) rating of different blends (Table 4.227). The OAA score of blends exhibited a gradual decrease with the advancement of storage conditions. Kinnow: red grapes: papaya: carrot obtained highest rating (8.20) for OAA while kinnow: red grapes: papaya: tomato obtained lowest score on Hedonic scale (6.80) for OAA except control. The storage temperature also influenced the OAA score as it was lower (7.10) at ambient temperature as compared to low temperature storage (7.18). The OAA rating was found to decrease from an average initial value of 7.26 to 7.02 during six month of storage however, changes were insignificant

Table 4.224 Effect of storage on colour of Kinnow: Red grapes: Papaya and vegetable blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Kinnow: Red grapes: Papaya (Control)	8.10	8.00	8.02	7.90	7.94	7.99	7.94
Kinnow:Red grapes: Papaya: Tomato (4.2: 3.4: 1.9: 0.5)	8.02	7.90	8.00	7.80	7.90	7.92	7.98
Kinnow: Red grapes: Papaya: Carrot (2.9: 2.3: 1.3: 3.5)	8.37	8.25	8.30	8.10	8.20	8.24	
Kinnow:Red grapes:Papaya: Beetroot (4.2: 3.4: 1.9: 0.5)	7.80	7.75	7.70	7.60	7.65	7.70	
Kinnow: Red grapes: Papaya: Cabbage (3.5: 2.9: 1.6: 2)	8.00	7.80	7.90	7.70	7.80	7.84	
Mean	8.06	7.94	7.98	7.82	7.90		
Grand Mean (I)	8.06	7.96		7.86			
$CD_{(0.05)}$ Juice (J)= 0.44 Storage conditions (C)= NS Storage intervals (I)= NS J x I= NS J x C= NS C x I= NS J x C x I= NS							

AT= Ambient temperature (13-27^{o}C) RT= Refrigerated temperature (0-4^{o}C)

Table 4.225 Effect of storage on flavour of Kinnow: Red grapes: Papaya and vegetable blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Kinnow: Red grapes: Papaya (Control)	7.65	7.52	7.60	7.45	7.50	7.54	7.30
Kinnow:Red grapes:Papaya: Tomato (4.2: 3.4: 1.9: 0.5)	6.80	6.60	6.70	6.40	6.50	6.60	7.36
Kinnow: Red grapes: Papaya: Carrot (2.9: 2.3: 1.3: 3.5)	8.00	7.80	7.90	7.70	7.80	7.84	
Kinnow:Red grapes:Papaya:Beetroot (4.2:3.4: 1.9: 0.5)	7.70	7.50	7.60	7.40	7.50	7.54	
Kinnow: Red grapes: Papaya: Cabbage (3.5: 2.9: 1.6:2)	7.10	7.00	7.06	6.90	7.00	7.01	
Mean	7.45	7.28	7.37	7.17	7.26		
Grand Mean (I)	7.45	7.33		7.22			

$CD_{(0.05)}$ Juice (J)= 0.44 Storage conditions (C)= NS Storage intervals (I)= NS J x I= NS
J x C= NS C x I= NS J x C x I= NS

AT= Ambient temperature (13-27°C) RT= Refrigerated temperature (0-4°C)

Table 4.226 Effect of storage on body of Kinnow: Red grapes: Papaya and vegetable blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Kinnow: Red grapes: Papaya (Control)	7.00	6.80	6.90	6.60	6.80	6.82	7.14
Kinnow: Red grapes: Papaya:Tomato (4.2:3.4:1.9: 0.5)	7.10	6.90	7.00	6.70	6.90	6.92	7.05
Kinnow: Red grapes:Papaya:Carrot (2.9: 2.3: 1.3: 3.5)	7.80	7.65	7.70	7.50	7.60	7.65	
Kinnow:Red grapes:Papaya:Beetroot (4.2: 3.4:1.9: 0.5)	7.20	7.00	7.10	6.80	7.00	7.02	
Kinnow: Red grapes: Papaya: Cabbage (3.5: 2.9:1.6: 2)	7.04	6.90	7.00	6.70	6.90	6.91	
Mean	7.23	7.05	7.14	6.86	7.04		
Grand Mean (I)	7.23	7.10		6.95			

$CD_{(0.05)}$ Juice (J)= 0.44 Storage conditions (C)= NS Storage intervals (I)= NS J x I= NS
J x C= NS C x I= NS J x C x I= NS

AT= Ambient temperature (13-27°C) RT= Refrigerated temperature (0-4°C)

Table 4.227 Effect of storage on overall acceptability of Kinnow: Red grapes: Papaya and vegetable blends

Juice	Storage interval (month)/Storage condition					Grand Mean (J)	Grand Mean (C)
	0	3		6			
		AT	RT	AT	RT		
Kinnow: Red grapes: Papaya (Control)	7.10	6.90	7.00	6.70	6.95	6.93	7.10
Kinnow:Red grapes:Papaya:Tomato (4.2: 3.4: 1.9: 0.5)	6.80	6.60	6.70	6.50	6.60	6.64	7.18
Kinnow:Red grapes:Papaya: Carrot (2.9: 2.3: 1.3: 3.5)	8.20	8.00	8.12	7.85	8.00	8.03	
Kinnow:Red grapes:Papaya:Beetroot (4.2: 3.4: 1.9:0.5)	7.20	7.10	7.16	7.00	7.10	7.11	
Kinnow: Red grapes: Papaya:Cabbage (3.5: 2.9: 1.6: 2)	7.00	6.80	6.90	6.70	6.80	6.84	
Mean	7.26	7.08	7.18	6.95	7.09		
Grand Mean (I)	7.26	7.13		7.02			

$CD_{(0.05)}$ Juice (J)= 0.44 Storage conditions (C)= NS Storage intervals (I)= NS J x I= NS
J x C= NS C x I= NS J x C x I= NS

AT= Ambient temperature (13-27°C) RT= Refrigerated temperature (0-4°C

4.7 Effect of storage on microbial quality of juice blends

During storage the juice blends stored under both ambient and refrigerated storage conditions were subjected for total microbial count at three and six month. All the treatments in relation to storage conditions were found to be free from microbes up to six month of storage.

4.8 Cost of production of juice blends

4.8.1 Cost of production of summer season blends

The cost incurred in preparation of juice blends was calculated by taking into consideration the cost of all inputs used and cost involved during the preparation of juice blends. The electricity and other expenses including depreciation were added to the total expenditure. The comparative cost of production of apple based (two fruit) juice blends has been given in Table 4.228. The sale price per litre of product was calculated after adding 20% profit margin. The cost of production of apple: pear, apple: jamun and apple: mango blends packed in bottles of 200 mL capacity was calculated as Rs 5.25, Rs 13.89 and Rs 6.60, respectively on laboratory scale. Cost of production of apple: pear: mango, apple: jamun: pear and apple: mango: jamun was calculated as Rs 6.65, 12.22 and 15.09/ 200 mL bottle (Table 4.229). Cost of production of apple: pear: bottlegourd, apple: pear: bittergourd, apple: pear: pumpkin and apple: pear: tomato blend was estimated as Rs 8.73, 7.20, 5.41 and 5.52, respectively for each 200 mL of glass bottle (Table 4.230). The cost of production of each 200 mL glass bottle of apple: jamun: bottlegourd, apple: jamun: bittergourd, apple: jamun: pumpkin and apple: jamun: tomato was estimated as Rs 12.02, Rs 13.00, Rs 11.20 and Rs 11.32, respectively (Table 4.231). The cost of 200 mL glass bottle of apple: mango: bottlegourd, apple: mango: bittergourd, apple: mango: pumpkin and apple: mango: tomato was found out as Rs 9.54, Rs 10.47, Rs 6.74 and Rs 6.85, respectively (Table 4.232). The cost of production of apple: pear: mango: bottlegourd, apple: pear: mango: bittergourd, apple: pear: mango: pumpkin and apple: pear: mango: tomato blend was calculated as Rs 8.82, Rs 10.05, Rs 6.29 and Rs 6.40, respectively for each 200 mL glass bottle (Table 4.233). The cost of production of 200 mL glass bottle of apple: jamun: pear: bottlegourd, apple: jamun: pear: bittergourd, apple: jamun: pear: pumpkin and apple: jamun: pear: tomato blend was estimated as Rs 12.71, Rs 11.26, Rs 9.47 and Rs 8.36 at laboratory scale (Table 2.234) while the cost of production of apple: mango: jamun: bottlegourd, apple: mango: jamun: bittergourd, apple: mango: jamun: pumkin and apple: mango: jamun: tomato for the same packing was calculated as Rs 15.98, Rs 14.83, Rs 13.28 and Rs 13.15, respectively (Table 4.235).

4.8.2 Cost of production of winter season blends

The cost of production of kinnow: aonla, kinnow: papaya and kinnow: red grape blend packed in bottles of 200 mL capacity was calculated as Rs 13.72, Rs 13.49 and Rs 18.26, respectively on laboratory scale (Table 4.236). Cost of production of kinnow: aonla: red grapes, kinnow: papaya: aonla and kinnow: red grapes: papaya was calculated as Rs 17.73, 12.69 and 17.10/200 mL bottle (Table 4.237). Cost of production of kinnow: aonla: tomato, kinnow: aonla: carrot, kinnow: aonla: beetroot and kinnow: aonla: cabbage was estimated as Rs 13.62, Rs 12.99, Rs 16.60 and Rs 13.39, respectively for each 200 mL of glass bottle (Table 4.238). The cost of production of each 200 mL glass bottle of kinnow: papaya: tomato, kinnow: papaya: carrot, kinnow: papaya: beetroot and kinnow: papaya: cabbage was estimated as Rs 13.32, Rs 13.07, Rs 15.46 and Rs 13.18, respectively (Table 4.239). The cost of 200 mL glass bottle of kinnow: red grapes: tomato, kinnow: red grapes: carrot, kinnow: red grapes: beetroot and kinnow: red grapes: cabbage was found out as Rs 16.22, Rs 15.05, Rs 17.62 and Rs 14.81, respectively (Table 4.240). The cost of production of kinnow: aonla: red grapes: tomato, kinnow: aonla: red grapes: carrot, kinnow: aonla: red grapes: beetroot and kinnow: aonla: red grapes: cabbage blend was calculated as Rs 15.90, Rs 14.60, Rs 16.65 and Rs 15.37, respectively for each 200 mL glass bottle (Table 4.241). The cost of production of 200 mL glass bottle of kinnow: papaya: aonla: tomato, kinnow: papaya: aonla: carrot, kinnow: papaya: aonla: beetroot and kinnow: papaya: aonla: cabbage blend was estimated as Rs 13.27, Rs 12.25, Rs 14.56 and Rs 12.35 at laboratory scale (Table 2.242) while the cost of production of kinnow: red grapes: papaya: tomato, kinnow: red grapes: papaya: carrot, kinnow: red grapes: papaya: beetroot and kinnow: red grapes: papaya: cabbage for the same packing was calculated as Rs 15.88, Rs 10.34, Rs 10.04 and Rs 8.87, respectively (Table 4.243).

Table 4.228 Cost of production of two fruit juice blends from summer fruits

Item	Rate (Rs)	Apple: Pear		Apple: Jamun		Apple: Mango	
		Quantity	Amount (Rs)	Quantity	Amount (Rs)	Quantity	Amount (Rs)
Apple juice	10.50/L	8.0 L	84.00	8.5 L	89.25	8.0 L	84.00
Jamun pulp	212.00/Kg			1.5 Kg	318.00		
Pear juice	11.70/L	2.0 L	23.40				
Mango pulp	35.00/Kg					2.0 Kg	70.00
Packaging cost (glass bottles 200 mL)	1.5/bottle	50	75.00	50	75.00	50	75.00
Total cost			182.40		482.25		229.00
Processing charges @20%			36.48		96.45		45.80
Cost of production			218.88		578.70		274.80
Profit @20%			43.78		115.74		54.96
Total cost			262.66		694.44		329.76
Final product	Each product 10 L						
Cost of production (per litre)			26.27		69.44		32.98
Sale price per 200 mL glass bottle			5.25		13.89		6.60

Table 4.229 Cost of production of three fruit juice blends from summer fruits

Particulars	Rate (Rs)	Apple: Pear: Mango		Apple: Jamun: Pear		Apple: Mango: Jamun	
		Quantity	Amount (Rs)	Quantity	Amount (Rs)	Quantity	Amount (Rs)
Apple juice	10.50/L	6.4 L	67.2	6.8 L	71.40	6.8 L	71.40
Jamun pulp	212.00/Kg			1.2 Kg	254.52	1.5 Kg	318.15
Pear juice	11.70/L	1.6 L	18.72	2.0 L	23.40		
Mango pulp	35.00/Kg	2.0 Kg	70			1.7 Kg	59.50
Packaging cost (glass bottles 200 mL)	1.5/bottle	50	75.00	50	75.00	50	75.00
Total cost			230.92		424.32		524.05
Processing charges @20%			46.18		84.86		104.81
Cost of production			277.10		509.18		628.86
Profit @20%			55.42		101.84		125.77
Total cost			332.52		611.02		754.63
Final product	Each product 10 L						
Cost of production (per litre)			33.25		61.10		75.46
Sale price per 200 mL glass bottle			6.65		12.22		15.09

Table 4.230 Cost of production of Apple: Pear and vegetable juice blends

Particulars	Rate (Rs)	Apple:Pear:Bottlegourd		Apple:Pear:Bittergourd		Apple:Pear:Pumpkin		Apple:Pear: Tomato	
		Quantity	Amount (Rs)	Quantity	Amount (Rs)	Quantity	Amount (Rs)	Quantity	Amount (Rs)
Apple juice	10.50/L	7.2 L	75.60	7.6 L	79.80	7.6 L	79.80	7.6 L	79.80
Pear juice	11.70/L	1.8 L	19.26	1.9 L	20.33	1.9 L	20.33	1.9 L	20.33
Bottlegourd juice	66.60/L	2 L	133.20						
Bittergourd juice	150.00/L			0.5 L	75.00				
Pumpkin pulp	25.40/L					0.5 L	12.70		
Tomato juice	33.25/Kg							0.5 Kg	16.63
Packaging cost (glass bottles 200 mL)	1.5/bottle	50	75.00	50	75.00	50	75.00		75.00
Total cost			303.06		250.13		187.83		191.76
Processing charges @20%			60.61		50.03		37.57		38.35
Cost of production			363.67		300.16		225.40		230.11
Profit @20%			72.73		60.03		45.08		46.02
Total cost			436.41		360.19		270.48		276.13
Final product	Each product 10 L								
Cost of production (per litre)			43.64		36.02		27.05		27.61
Sale price per 200 mL glass bottle			8.73		7.20		5.41		5.52

Table 4.231 Cost of production of Apple: Jamun and vegetable juice blends

Particulars	Rate (Rs)	Apple:Jamun:Bottlegourd		Apple:Jamun:Bittergourd		Apple:Jamun:Pumpkin		Apple:Jamun: Tomato	
		Quantity	Amount (Rs)	Quantity	Amount (Rs)	Quantity	Amount (Rs)	Quantity	Amount (Rs)
Apple juice	10.50/L	8.1 L	85.05	8.5 L	89.25	8.5 L	89.25	8.5 L	89.25
Jamun pulp	212.00/Kg	0.9 Kg	190.80	1.0 L	212.00	1.0 Kg	212.00	1.0 Kg	212.00
Bottlegourd juice	66.60/L	1.0 L	66.60						
Bittergourd juice	150.00/L			0.5L	75.00				
Pumpkin pulp	25.40/L					0.5L	12.70		
Tomato juice	33.25/Kg							0.5 Kg	16.63
Packaging cost (glass bottles 200 mL)		50	75.00	50	75.00	50	75.00		75.00
Total cost			417.45		451.25		388.95		392.88
Processing charges @20%			83.49		90.25		77.79		78.58
Cost of production			500.94		541.50		466.74		471.45
Profit @20%			100.19		108.30		93.35		94.29
Total cost			601.13		649.80		560.09		565.74
Final product	Each product 10 L								
Cost of production (per litre)			60.11		64.98		56.01		56.57
Sale price per 200 mL glass bottle			12.02		13.00		11.20		11.32

Table 4.232 Cost of production of Apple: Mango and vegetable juice blends

Particulars	Rate (Rs)	Apple:Mango:Bottlegourd		Apple:Mango:Bittergourd		Apple:Mango:Pumpkin		Apple:Mango: Tomato	
		Quantity	Amount (Rs)	Quantity	Amount (Rs)	Quantity	Amount (Rs)	Quantity	Amount (Rs)
Apple juice	10.50/L	6.4 L	67.20	7.2 L	75.60	7.6 L	79.80	7.6 L	79.80
Mango pulp	35.00/Kg	1.6 Kg	56.00	1.8 Kg	63.00	1.9 Kg	66.50	1.9 Kg	66.50
Bottlegourd juice	66.60/L	2.0 L	133.20						
Bittergourd juice	150.00/L			1.0 L	150.00				
Pumpkin pulp	25.40/L					0.5 L	12.70		
Tomato juice	33.25/Kg							0.5 Kg	16.63
Packaging cost (glass bottles 200 mL)		50	75.00	50	75.00	50	75.00		75.00
Total cost			331.40		363.60		234.00		237.93
Processing charges @20%			66.28		72.72		46.80		47.59
Cost of production			397.68		436.32		280.80		285.51
Profit @20%			79.54		87.26		56.16		57.10
Total cost			477.22		523.58		336.96		342.61
Final product	Each product 10 L								
Cost of production (per litre)			47.72		52.36		33.696		34.26
Sale price per 200 mL glass bottle			9.54		10.47		6.74		6.85

Table 4.233 Cost of production of Apple: Pear: Mango and vegetable juice blends

Particulars	Rate (Rs)	Apple:Pear: Mango:Bottlegourd		Apple:Pear: Mango:Bittergourd		Apple:Pear: Mango:Pumpkin		Apple:Pear: Mango: Tomato	
		Quantity	Amount (Rs)	Quantity	Amount (Rs)	Quantity	Amount (Rs)	Quantity	Amount (Rs)
Apple juice	10.50/L	5.4 L	56.70	5.8 L	60.90	6.1 L	64.05	6.1 L	64.05
Pear juice	10.70/L	1.4 L	14.98	1.4 L	14.98	1.5 L	16.05	1.5 L	16.05
Mango pulp	35.00/Kg	1.7 Kg	59.50	1.8 Kg	63.00	1.9 Kg	66.50	1.9 Kg	66.50
Bottlegourd juice	66.60/L	1.5 L	99.90						
Bittergourd juice	150.00/L			1 L	150.00				
Pumpkin pulp	25.40/L					0.5 L	12.70		
Tomato juice	33.25/Kg							0.5 Kg	16.63
Packaging cost (glass bottles 200 mL)		50	75.00	50	75.00	50	75.00		75.00
Total cost			306.08		348.90		218.25		222.18
Processing charges @20%			61.22		69.78		43.65		44.44
Cost of production			367.30		418.68		261.90		266.61
Profit @20%			73.46		83.74		52.38		53.32
Total cost			440.76		502.42		314.28		319.93
Final product	Each product 10 L								
Cost of production (per litre)			44.08		50.24		31.43		31.99
Sale price per 200 mL glass bottle			8.82		10.05		6.29		6.40

Table 4.234 Cost of production of Apple: Jamun: Pear and vegetable juice blends

Particulars	Rate (Rs)	Apple: Jamun: Pear: Bottlegourd		Apple:Jamun: Pear: Bittergourd		Apple:Jamun: Pear:Pumpkin		Apple: Jamun: Pear: Tomato	
		Quantity	Amount (Rs)	Quantity	Amount (Rs)	Quantity	Amount (Rs)	Quantity	Amount (Rs)
Apple juice	10.50/L	5.4 L	56.70	6.8 L	71.40	6.8 L	71.40	6.8 L	71.40
Pear juice	10.70/L	1.5 L	16.05	1.9 L	20.33	1.9 L	20.33	1.9 L	20.33
Jamunpulp	212.00/Kg	0.6 Kg	127.20	0.8 Kg	169.60	0.8 Kg	169.60	0.6 Kg	127.20
Bottlegourd juice	66.60/L	2.5 L	166.50						
Bittergourd juice	150.00/L			0.5 L	75.00				
Pumpkin pulp	25.40/L					0.5L	12.70		
Tomato juice	33.25/Kg							0.5 Kg	16.63
Packaging cost (glass bottles 200 mL)		50	75.00	50	75.00	50	75.00		75.00
Total cost			441.45		391.00		328.70		290.23
Processing charges @20%			88.29		78.20		65.74		58.05
Cost of production			529.74		469.20		394.44		348.27
Profit @20%			105.95		93.84		78.89		69.65
Total cost			635.69		563.04		473.33		417.92
Final product	Each product 10 L								
Cost of production (per litre)			63.57		56.30		47.33		41.79
Sale price per 200 mL glass bottle			12.71		11.26		9.47		8.36

Table 4.235 Cost of production of Apple: Mango: Jamun and vegetable juice blends

Particulars	Rate (Rs)	Apple: Mango: Jamun: Bottlegourd		Apple: Mango: Jamun: Bittergourd		Apple: Mango: Jamun: Pumpkin		Apple: Mango: Jamun: Tomato	
		Quantity	Amount (Rs)	Quantity	Amount (Rs)	Quantity	Amount (Rs)	Quantity	Amount (Rs)
Apple juice	10.50/L	6.1 L	64.05	6.5 L	68.25	6.1 L	64.05	6.5 L	68.25
Jamun pulp	212/Kg	1.5 Kg	52.50	1.7 Kg	59.50	1.5 Kg	52.50	1.7 Kg	59.50
Mango pulp	35.00/Kg	1.4 Kg	296.80	1.4 Kg	296.80	1.4 Kg	296.80	1.4 Kg	296.80
Bottlegourd juice	66.60/L	1 L	66.60						
Bittergourd juice	150.00/L			0.5 L	75.00				
Pumpkin pulp	25.40/L					1 L	25.40		
Tomato juice	33.25/Kg							0.5 Kg	16.63
Packaging cost (glass bottles 200 mL)		50	75.00	50	75.00	50	75.00		75.00
Total cost			554.95		515.05		461.25		456.68
Processing charges @20%			110.99		103.01		92.25		91.34
Cost of production			665.94		618.06		553.50		548.01
Profit @20%			133.19		123.61		110.70		109.60
Total cost			799.13		741.67		664.20		657.61
Final product	Each product 10 L								
Cost of production (per litre)			79.91		74.17		66.42		65.76
Sale price per 200 mL glass bottle			15.98		14.83		13.28s		13.15

Table 4.236 Cost of production Kinnow based (two fruit) juice blends

Particulars	Rate (Rs)	Kinnow: Aonla		Kinnow: Papapya		Kinnow: Red grapes	
		Quantity	Amount (Rs)	Quantity	Amount (Rs)	Quantity	Amount (Rs)
Kinnow juice	40.27/L	9.5 L	382.57	8.0 L	322.16	5.5 L	221.49
Papaya pulp	35.70/Kg			2.0 Kg	71.40		
Red grapes juice	65.50/L					4.5 L	337.50
Aonla juice	37.50/L	0.5 L	18.75				
Packaging cost (glass bottles 200 mL)	1.5/bottle	50	75.00	50	75.00	50	75.00
Total cost			476.32		468.56		633.99
Processing charges @20%			95.26		93.71		126.80
Cost of production			571.58		562.27		760.78
Profit @20%			114.32		112.45		152.16
Total cost			685.89		674.73		912.94
Final product	Each product 10L						
Cost of production (per litre)			68.59		67.47		91.29
Sale price per 200mL glass bottle			13.72		13.49		18.26

Table 4.237 Cost of production Kinnow based (three fruit) juice blends

Particulars	Rate (Rs)	Kiinow: Aonla: Red grapes		Kinnow: Papaya: Aonla		Kinnow: Red grapes: Papaya	
		Quantity	Amount (Rs)	Quantity	Amount (Rs)	Quantity	Amount (Rs)
Kinnow juice	40.27/L	5.7 L	229.54	7.2 L	289.94	4.4 L	177.19
Papaya pulp	35.70/Kg			1.8 Kg	64.26	2.0 Kg	71.40
Red grapes juice	65.50/L	4.0 L	300.00			3.6 L	270.00
Aonla juice	37.50/L	0.3 L	11.25	1.0 L	11.25		
Packaging cost (glass bottles 200mL)	1.5/bottle	50	75.00	50	75.00	50	75.00
Total cost			615.79		440.45		593.59
Processing charges @20%			123.16		88.09		118.72
Cost of production			738.95		528.54		712.31
Profit @20%			147.79		105.71		142.46
Total cost			886.74		634.25		854.77
Final product	Each product 10L						
Cost of production (per litre)			88.67		63.43		85.48
Sale price per 200mL glass bottle			17.73		12.69		17.10

Table 4.238 Cost of production Kinnow: Aonla and vegetable juice blends

Particulars	Rate (Rs)	Kinnow: Aonla: Tomato		Kinnow: Aonla: Carrot		Kinnow: Aonla: Beetroot		Kinnow: Aonla: Cabbage	
		Quantity	Amount (Rs)	Quantity	Amount (Rs)	Quantity	Amount (Rs)	Quantity	Amount (Rs)
Kinnow juice	40.27/L	9.0 L	362.43	5.2 L	209.40	6.6 L	265.78	9.0 L	362.43
Aonla juice	37.50/L	0.5 L	18.75	0.3 L	11.25	0.4 L	15.00	0.5 L	18.75
Tomato juice	33.25/L	0.5 L	16.63						
Carrot juice	34.50/L			4.5 L	155.25				
Beetroot juice	73.50/L					3 L	220.50		
Cabbage pulp	17.5/Kg							0.5 Kg	8.75
Packaging cost (glass bottles 200 mL)	1.5/bottle	50	75.00	50	75.00	50	75.00		75.00
Total cost			472.81		450.90		576.28		464.93
Processing charges @20%			94.56		90.18		115.26		92.99
Cost of production			567.37		541.08		691.54		557.92
Profit @20%			113.47		108.22		138.31		111.58
Total cost			680.84		649.30		829.85		669.50
Final product	Each product 10 L								
Cost of production (per litre)			68.08		64.93		82.98		66.95
Sale price per 200 mL glass bottle			13.62		12.99		16.60		13.39

Table 4.239 Cost of production Kinnow: Papaya and vegetable juice blends

Particulars	Rate (Rs)	Kinnow: Papaya: Tomato		Kinnow: Papaya: Carrot		Kinnow: Papaya: Beetroot		Kinnow: Papaya: Cabbage	
		Quantity	Amount (Rs)	Quantity	Amount (Rs)	Quantity	Amount (Rs)	Quantity	Amount (Rs)
Kinnow juice	40.27/L	7.2 L	289.94	5.6 L	225.51	6.4 L	257.73	7.6 L	306.05
Papaya pulp	35.70/Kg	1.8 Kg	64.26	1.4 Kg	49.98	1.6 Kg	57.12	1.9 L	67.83
Tomato juice	33.25/L	1.0 L	33.25						
Carrot juice	34.50/L			3.0 L	103.50				
Beetroot juice	73.50/L					2.0 L	147.00		
Cabbage pulp	17.5/Kg							0.5 L	8.75
Packaging cost (glass bottles 200 mL)	1.5/bottle	50	75.00	50	75.00	50	75.00		75.00
Total cost			462.45		453.99		536.85		457.63
Processing charges @20%			92.49		90.80		107.37		91.53
Cost of production			554.94		544.79		644.22		549.16
Profit @20%			110.99		108.96		128.84		109.83
Total cost			665.93		653.75		773.06		658.99
Final product	Each product 10 L								
Cost of production (per litre)			66.59		65.37		77.31		65.90
Sale price per 200 mL glass bottle			13.32		13.07		15.46		13.18

Table 4.240 Cost of production Kinnow: Red grapes and vegetable juice blends

Particulars	Rate (Rs)	Kinnow: Red grapes: Tomato		Kinnow: Red grapes: Carrot		Kinnow: Red grapes: Beetroot		Kinnow: Red grapes: Cabbage	
		Quantity	Amount (Rs)	Quantity	Amount (Rs)	Quantity	Amount (Rs)	Quantity	Amount (Rs)
Kinnow juice	40.27/L	4.7 L	189.27	3.3 L	132.89	5.0 L	201.35	7.6 L	306.05
Aonla juice	37.50/L	3.8 L	248.90	2.7 L	176.85	4.0 L	262.00	1.9 L	124.45
Tomato juice	33.25/L	1.5 L	49.88						
Carrot juice	34.50/L			4.0 L	138.00				
Beetroot juice	73.50/L					1.0 L	73.50		
Cabbage pulp	17.5/Kg							0.5 L	8.75
Packaging cost (glass bottles 200 mL)	1.5/bottle	50	75.00	50	75.00	50	75.00		75.00
Total cost			563.04		522.74		611.85		514.25
Processing charges @20%			112.61		104.55		122.37		102.85
Cost of production			675.65		627.29		734.22		617.10
Profit @20%			135.13		125.46		146.84		123.42
Total cost			810.78		752.75		881.06		740.52
Final product	Each product 10L								
Cost of production (per litre)			81.08		75.27		88.11		74.05
Sale price per 200 mL glass bottle			16.22		15.05		17.62		14.81

Table 4.241 Cost of production Kinnow: Aonla: Red grapes and vegetable juice blends

Particulars	Rate (Rs)	Kinnow: Aonla: Red grapes: Tomato		Kinnow: Aonla: Red grapes: Carrot		Kinnow: Aonla: Red grapes: Beetroot		Kinnow: Aonla: Red grapes: Cabbage	
		Quantity	Amount (Rs)	Quantity	Amount (Rs)	Quantity	Amount (Rs)	Quantity	Amount (Rs)
Kinnow juice	40.27/L	4.8 L	193.30	3.40 L	136.92	5.40 L	217.46	5.10 L	205.38
Aonla juice	37.50/L	0.3 L	11.25	0.20 L	7.50	0.30 L	11.25	0.30 L	11.25
Red grapes juice	65.50/L	3.4 L	222.70	2.40 L	157.20	3.80 L	248.90	3.60 L	235.80
Tomato juice	33.25/L	1.5 L	49.88						
Carrot juice	34.50/L			4.00 L	138.00				
Beetroot juice	73.50/L					0.50 L	36.75		
Cabbage pulp	17.5/Kg							1.00 Kg	17.50
Packaging cost (glass bottles 200 mL)	1.5/bottle	50	75.00	50.00	75.00	50.00	75.00		75.00
Total cost			552.12		507.12		578.11		533.68
Processing charges @20%			110.42		101.42		115.62		106.74
Cost of production			662.55		608.54		693.73		640.41
Profit @20%			132.51		121.71		138.75		128.08
Total cost			795.05		730.25		832.48		768.49
Final product	Each product 10 L								
Cost of production (per litre)			79.51		73.02		83.25		76.85
Sale price per 200 mL glass bottle			15.90		14.60		16.65		15.37

Table 4.242 Cost of production Kinnow: Papaya: Aonla and vegetable juice blends

Particulars	Rate (Rs)	Kinnow: Papaya: Aonla: Tomato		Kinnow: Papaya: Aonla: Carrot		Kinnow: Papaya: Aonla: Beetroot		Kinnow: Papaya: Aonla: Cabbage	
		Quantity	Amount (Rs)	Quantity	Amount (Rs)	Quantity	Amount (Rs)	Quantity	Amount (Rs)
Kinnow juice	40.27/L	6.5 L	261.76	4.3 L	173.16	5.8 L	233.57	6.5 L	261.76
Aonla juice	37.50/L	0.9 L	33.75	0.6 L	22.50	0.8 L	30.00	0.9 L	33.75
Papaya pulp	35.70/Kg	1.6 Kg	57.12	1.1 Kg	39.27	1.4 Kg	49.98	1.6 Kg	57.12
Tomato juice	33.25/L	1 L	33.25						
Carrot juice	34.50/L			4.00 L	138.00				
Beetroot juice	73.50/L					2.0 L	147.00		
Cabbage pulp	17.5/Kg							2.0 Kg	35.00
Packaging cost (glass bottles 200 mL)	1.5/bottle	50	75.00	50.00	75.00	50.00	75.00		75.00
Total cost			460.88		425.43		505.55		428.88
Processing charges @20%			92.18		85.09		101.11		85.78
Cost of production			553.05		510.52		606.66		514.65
Profit @20%			110.61		102.10		121.33		102.93
Total cost			663.66		612.62		727.99		617.58
Final product	Each product 10 L								
Cost of production (per litre)			66.37		61.26		72.80		61.76
Sale price per 200 mL glass bottle			13.27		12.25		14.56		12.35

Table 4.243 Cost of production of Kinnow: Red grapes: Papaya and vegetable juice blends

Particulars	Rate (Rs)	Kinnow: Red grapes: Papaya: Tomato		Kinnow: Red grapes: Papaya: Carrot		Kinnow: Red grapes: Papaya: Beetroot		Kinnow: Red grapes: Papaya: Cabbage	
		Quantity	Amount (Rs)	Quantity	Amount (Rs)	Quantity	Amount (Rs)	Quantity	Amount (Rs)
Kinnow juice	40.27/L	4.2 L	169.13	2.9 L	116.78	4.2 L	169.13	3.5 L	140.95
Red grapes juice	65.50/L	3.4 L	222.70	2.3 L	150.65	3.4 L	222.70	2.9 L	189.95
Papaya	35.70/Kg	1.9 Kg	67.83	1.3 Kg	46.41	1.9 Kg	67.83	1.6 Kg	57.12
Tomato juice	33.25/L	0.5 L	16.63						
Carrot juice	34.50/L			3.5 L	120.75				
Beetroot juice	73.50/L					0.50 L	36.75		
Cabbage pulp	17.5/Kg							2.0 Kg	35.00
Packaging cost (glass bottles 200 mL)	1.5/bottle	50	75.00	50.00	75.00	50.00	75.00		75.00
Total cost			551.29		358.94		348.71		308.07
Processing charges @20%			110.26		71.79		69.74		61.61
Cost of production			661.55		430.73		418.46		369.68
Profit @20%			132.31		86.15		83.69		73.94
Total cost			793.86		516.88		502.15		443.61
Final product	Each product 10 L								
Cost of production (per litre)			79.39		51.69		50.21		44.36
Sale price per 200 mL glass bottle			15.88		10.34		10.04		8.87

DISCUSSION

Chapter-5

DISCUSSION

The present investigations entitled "**Seasonal fruit and vegetable juice blends with high antioxidant potential**" were carried out in the Department of Food Science and Technology, Dr. Y S Parmar University of Horticulture and Forestry, Nauni, Solan (HP) during the year 2009-2011. The findings recorded in different experiments have been discussed under the following heads:

5.1 Physico-chemical analysis of fruits

5.2 Physico-chemical analysis of vegetables

5.3 Development of fruit and vegetable juice blends

5.4 Effect of storage on quality characteristics of juice blends

5.5 Effect of storage on sensory characteristics of juice blends

5.6 Effect of storage on microbial population of juice blends

5.7 Cost of production

5.1 Physico-chemical analysis of fruits

5.1.1 Apple

Average length, diameter and weight of apple fruits were recorded as 46.05 mm, 64.47 mm and 90.70 g, respectively which was lower than that reported by Raj *et al*. (2011). This variation may be attributed to the difference in weather, cultivar and maturity stage of the fruits. The fruit contained 11.23^{o}B total soluble solids (TSS), 0.32% titratable acidity (as % malic acid), 6.11 mg/100 g ascorbic acid, 6.96% reducing sugars and 10.44% total sugars. Results were closer to the findings of Hussain *et al*. (2011) who reported the TSS and titratable acidity of apple as 10^{o}B and 0.31%, respectively. Raj *et al*. (2011) reported the TSS and titratable acidity of apple fruits as 10.80^{o}B and 0.24%, respectively. The results are in accordance to Alkesh (2001). Similarly, Paul and Southgate (1978) reported that apple fruits contained 9.22 to 11.80% total sugars and 4.49 mg/100 g ascorbic acid while Hussain (2001) reported 8 mg/100 g ascorbic acid in apple. Total phenolic content of apple fruits was recorded as 365.67 mg/100 g which was higher than that reported by Raj *et al*. (2011) in apple (295 mg/100 g). Antioxidant activity of apple fruits was recorded as 74.79 per cent which was quite lower than that reported by Oszmianski and Wojdylo (2009) in juices of apple fruits cultivar Shampion (94.21%) and Idared (83.05%). This difference might be due to the difference in cultivar used or maturity stage of fruits. Similarly, Khanizadeh *et al*. (2007) reported that Spartan apple contained 153.40 µg/g total phenols and 398.0 µg/g FRAP antioxidant capacity.

5.1.2 Sand Pear

Average length, diameter and weight of sand pear fruits were recorded as 54.54 mm, 52.80 mm and 86.68 g, respectively. The fruit contained 9.06^{o}B total soluble solids, 0.49% titratable acidity (as % malic acid), 5.20 mg/100 g ascorbic acid, 2.96% reducing sugars and 3.88% total sugars. Results are in accordance to Raj *et al*. (2011). Sand pear juice has been reported to possess 10.50^{o}B total soluble solids, 0.37% acidity and 11.20 mg/100 g ascorbic acid by Attri *et al.*, 1998) contrary to which Anonymous (2004) reported that vitamin C content in sand pear ranged from 3.8-4.2 mg/100 g. The results of sand pear fruits are in agreement as reported earlier by Shrestha and Bhatia (1982), Chang *et al*. (2000) and Kumar and Ghuman (2007). The slight variation in different characteristics might be attributed to the variation in weather conditions and cultural practices that might have affected the fruit quality. Total phenolic content and antioxidant activity was recorded as 369.60 mg/100 g and 65.25 per cent, respectively which was in accordance with Raj *et al*. (2011) who reported 362 mg/100 g total phenols in sand pear.

5.1.3 Mango

Average length, diameter and weight of mango fruits were recorded as 88.64 mm, 55.72 mm and 139.14 g, respectively. The fruit contained 18.47^{o}B total soluble solids, 0.26% titratable acidity (as % citric acid), 30.38 mg/100 g ascorbic acid, 9.58% reducing sugars and 15.13% total sugars. Dashehari fruits have been reported to possess total soluble solids content as 20.04% and reducing sugar content as 3.87% (Sharma *et al.*, 1999). Total phenolic content and antioxidant activity was recorded as 84.26 mg/100 g and 63.69 per cent, respectively. Total carotenoids content in mango was recorded as 6.32 mg/100 g.

5.1.4 Jamun

Average length, diameter and weight of Jamun fruits were recorded as 26.81 mm, 20.35 mm and 7.36 g, respectively. The fruit contained 16.55^{o}B total soluble solids, 0.96% titratable acidity (as % citric acid), 22.74 mg/100 g ascorbic acid, 6.81% reducing sugars and 14.00% total sugars. Total phenolic content and antioxidant activity was recorded as 415.49 mg/100 g and 76.47 per cent, respectively. Total anthocyanins content of jamun fruits was recorded as 157.99 mg/100 g. Contrary to our results Rai *et al*. (2011) reported that jamun fruits contained 55.48 mg/100 g ascorbic acid, 1175.17 mg/100 g phenolics, 61.56% antioxidant activity and 7.25 mg total anthocyanins per 100 g of fruits.

5.1.5 Kinnow

Average length, diameter and weight of Kinnow fruits was recorded as 53.47 mm, 65.41 mm and 144.78 g, respectively. The fruit contained 10.08^{o}B total soluble solids, 1.07% titratable acidity (as % citric acid), 25.50 mg/100 g ascorbic acid, 4.55% reducing sugars and 7.66% total sugars. Results were closer to Khan *et al*. (2010) who reported that Kinnow contains 3.75 to 8.93 ^{o}B TSS, 0.88 to 1.12% titratable acidity and 1.30 to 15.97 mg/100 g ascorbic acid. Total phenolic content and antioxidant activity was recorded as 18.36 mg/100 g and 22.32 per cent, respectively. The total polyphenol content in peeled lemons, oranges and grapefruits has been reported as 164±10.3, 154±10.2 and135±10.1 mg/100 g of fresh fruits, respectively by Goristein *et al*. (2001). Mathur *et al*. (2011) reported that ripen Kinnow pulp contained 6.06 mg/100 g ascorbic acid, 76 µg/ g total phenolics and 25% superoxide anion radical scavenging activity.

5.1.6 Papaya

Average length, diameter and weight of papaya fruits was recorded as 288.82 mm, 232.48 mm and 1005.04 g, respectively. The fruit contained 11.21^{o}B total soluble solids, 0.003% titratable acidity (as % citric acid), 109.22 mg/100 g ascorbic acid, 6.16% reducing sugars and 7.73% total sugars. Total phenolics content was recorded as 55.97 mg/100 g while antioxidant activity was recorded as 64.71 per cent. Results were in the agreement of Ozkan *et al*. (2011) who reported that papaya juice showed total phenolics content and antioxidant activity in a range of 41-65 mg/100 mL and 52.10 to 78.10% of DPPH. Papaya contained 5.03 mg total carotenoids /100 g of fruits.

5.1.7 Aonla

Aonla fruits showed 38.20 mm average length, 36.35 mm average diameter and 37.71 g average weight. Results were closer to Bala *et al*. (2009) who reported the fruit length, diameter and weight of Aonla fruits as 3.38 cm, 4.21 cm and 40.99 g. The fruit contained 10.38^{o}B total soluble solids, 2.26% titratable acidity (as % citric acid), 448.40 mg/100 g ascorbic acid, 3.22% reducing sugars and 4.42% total sugars. Similar findings have been reported by Bala *et al*. (2009).Total phenolic content and antioxidant activity was recorded as 293.12 mg/100 g and 82.75 per cent, respectively. Aonla fruits have been reported to contain total phenolics content as 290 mg/100 g and antioxidant activity as 92% in β-carotene lineolate system and super-oxide anion scavenging activity as 85% (Kaur and Kapoor, 2005).

5.1.8 Red grapes

Average length, diameter and weight of grape berries were recorded as 21.51 mm, 19.07 mm and 2.84 g, respectively. Results were in agreement to Yogeeshappa (2007) who reported that grape berry weight in case of low and high yielding vineyards ranged from 2.02 to 2.72 and 2.69 to 3.03 g with an average of 2.44 and 2.86 g, respectively in Thompson Seedless grapes. Average total soluble solids, titratable acidity, ascorbic acid, reducing sugars and total sugars of berries were recorded as 16.23^{o}B, 0.84% (as % tartaric acid), 11.95 mg/100 g, 9.89% and 11.86%, respectively. The results were in accordance to Yogeeshappa (2007) who reported that TSS, titratable acidity, reducing sugars and total sugars of grape varied from 18 to 24^{o}B, 0.45 to 0.89%, 8.10 to 9.96% and 10.95 to 13.93%, respectively in cv. Thompson Seedless. Total phenolics content and antioxidant activity of the fruits was recorded as 196.14 mg/100 g and 69.56 per cent, respectively. Contrary to this Qusti *et al*. (2010) reported only

150 gallic acid equivalent (GAE)/100 g fresh weight basis total phenols in red grapes. Pakhale *et al*. (2007) reported that red grapes contained 320 mg/100 g total phenols and 1250 µg/mL free radical scavenging capacity. Average total anthocyanins content was recorded as 79.40 mg/100 g.

5.2 Physiochemical analysis of vegetables

5.2.1 Bottlegourd

Average length, diameter and weight of fruits were recorded as 276.29 mm, 82.50 mm and 790.00 g, respectively which was more than that reported by Sivaraj and Pandravada (2005). Average total soluble solids content, titratable acidity (as % citric acid), ascorbic acid content, reducing sugars, total sugars, total phenolics content and antioxidant activity was recorded as 1.71^{o}B, 0.003%, 16.43 mg/100 g, 1.32%, 1.45%, 13.85 mg/100 g and 72.13 per cent, respectively. The antioxidant activity of 20, 40, 60 mg/mL of methanolic extract of bottlegourd have been reported as about 79.12, 87.34 and 91.23%, respectively (Deore, 2009).

5.2.2 Bittergourd

Bittergourd fruits showed 117.34 mm average length, 43.61 mm average diameter and 52.17 g average weight. The fruit contained 2.89^{o}B total soluble solids, 0.05% titratable acidity (as % citric acid), 88.83 mg/100 g ascorbic acid, 0.56% reducing sugars and 1.10% total sugars. Total phenolics content and antioxidant activity was recorded as 82.90 mg/100 g and 58.55 per cent, respectively. Results were in accordance with Garg (2010) who reported that fruit length, diameter, weight, TSS, titratable acidity, ascorbic acid, reducing and total sugars of bittergourd was 11.48 cm, 2.63 cm, 51.50 g, 3.00^{o}B, 0.056%, 88.40 mg/100 g, 2.50% and 2.80%, respectively.

5.2.3 Pumpkin

Pumpkin fruits contained average weight as 2566.00 g while average length and average diameter was recorded as 104.04 mm and 353.50 mm, respectively. Average total soluble solids, titratable acidity (as % citric acid), ascorbic acid, reducing sugars and total sugars were recorded as 6.32^{o}B, 0.013%, 13.52 mg/100 g, 2.17% and 3.26 per cent, respectively which was higher than the earlier findings by Fang (2008) who reported that raw pumpkin contained 1.36% sugars, 2.67 mg/100 g carotene and 9.00 mg/100 g ascorbic acid. Wangcharoen and Morasuk (2007) reported that pumpkin contained 0.11 mg vitamin C equivalent/g DPPH antioxidant activity and 0.24 mg GAE/g total phenolics. Pumpkin contained 1.35 mg total carotenoids/100 g of fruit which was lower than Godoy and Rodriguez-Amaya (1996) who reported that pumpkin contained carotenoids as 3.9 mg/100 g of edible portion while Khachik and Beecher (1987) reported that it possessed 8.0 mg/100 g total carotenoids. The slight variation in different characteristics might be attributed to the variation in climatic conditions and type of cultivar that might have affected the fruit quality. Total phenolics content and antioxidant activity was recorded as 2.63 mg/100 g and 70.81 per cent, respectively.

5.2.4 Tomato

Tomato fruits contained average fruit length, diameter and weight as 52.88 mm, 47.63 mm and 58.49 g, respectively. Total soluble solids content was recorded as 6.07^{o}B while titratable acidity was recorded as 0.59 per cent. Fruits contained 21.55 mg/100 g ascorbic acid, 2.38% reducing sugars, 2.74% total sugars, 31.71 mg/100 g total phenols and 52.46% antioxidant activity. Total carotenoids were recorded as 4.25 mg/100 g. Tomato fruit has been reported to provide 15-30 mg/100 g ascorbic acid and 20-50 mg/100 g fruit weight of lycopene (Anonymous, 2001). It has also been reported that tomato possessed 21.21± 2.883 μg antioxidant activity /100 g of fruits (Doss and Dhanabalan, 2009).

5.2.5 Carrot

Carrot contained 8.18^{o}B total soluble solids, 0.01% titratable acidity (as % citric acid), 4.47 mg/100 g ascorbic acid, 2.84% reducing sugars and 6.58% total sugars. Similarly, Holland *et al*. (1991) reported that carrot contained 5.60% total sugars. Results were in accordance to Holland *et al*. (1991) who also reported that carrot possessed 4 mg/100 g ascorbic acid. Total phenolics content was recorded as 12.66 mg/100 g and antioxidant activity was recorded as 61.71 per cent, respectively. Results were in the range as reported by Kumar *et al*. (2010) who studied the free radical scavenging activity of different carrot cultivars and reported it in the range of 52 to 76 per cent. Raw carrots have been reported to contain total phenolic content as 78.3 and 62.0 mg GAE/100 g fresh weight by Zhang and Hamauzu (2004a) for Chibagosum and Hitomigosun carrot, respectively while Vinson *et al*. (1998) found that total phenolics content in carrots was 46.40 mg catechin equivalent/100 g fresh weight which was quite higher than our findings. The different values in the literature may be due to different extraction methods and the ways to express the results. In addition, different cultivars of carrots could cause the differences in total phenolics content of carrot.

Total carotenoids content was recorded as 8.93 mg/100 g which was higher than the findings of Holland *et al*. (1991) who reported the carotene content in carrot as 5.33 mg/100 g while according to other authors carrot possessed carotenoids content of 4.2 mg/100 g (Rodriguez-Amaya, 1997), 6.3 mg/100 g (Abdel-Kader, 1991) and 3.4 mg/100 g (Almeida and Penteado 1987). Average root length of carrot was recorded as 82.51 mm while diameter was recorded as 22.53 mm. Average weight of carrot was recorded as 49.35 g.

5.2.6 Cabbage

Average weight of cabbage heads was recorded as 286.07 g. Average length and diameter was recorded as 93.86 mm and 108.57 mm, respectively. Average total soluble solids content was recorded as 3.03^{o}B while titratable acidity was recorded as 0.001% (as % citric acid). Ascorbic acid content in cabbage was recorded as 11.60 mg/100 g while reducing sugars and total sugars content was recorded as 1.35% and 1.86 per cent, respectively. Cabbage has been reported to possess 32.1 mg/ 100 g vitamin C (Massamba and Nguyen, 2008). Total phenolics content and antioxidant activity was recorded as 70.41 mg/100 g and 44.03 per cent, respectively. According to Singh *et al.* (2009) total phenolic content and antioxidant activity of the cabbage was 18.7 mg /100g gallic acid equivalent and 2.8 μmole Trolox equivalent, respectively.

5.2.7 Beetroot

Beetroot contained 89.79 g average weight while average length and diameter were recorded as 60.01 mm and 59.05 mm, respectively. Average total soluble solids, titratable acidity (as % citric acid), ascorbic acid, reducing sugars and total sugars were recorded as 13.57^{o}B, 0.001%, 9.74 mg/100 g, 7.52% and 8.82 per cent, respectively. Contrary to our results quite high ascorbic acid content (73 mg/100 g) has been reported in beetroot by Suganyadevi (2011) which may be due to different cultivar, cultural practices or climatic conditions. It contained 212.31 mg/100 g total phenolics content and 82.55 per cent antioxidant activity. Results were in accordance to Salama *et al*. (2008) who reported that beetroot contained antioxidant activity in the range of 87.26 to 94.74 per cent. Kujala (2000) reported a total phenolics concentration of 15.5 mg GAE/g in beetroot on dry weight basis.

5.3 Standardization of recipe for preparation of juice blends

On the basis of overall acceptability, the blends of summer season fruit juice/pulp in the ratio of 8: 2, 9: 1 and 8: 2 proportions were found as the best for apple: pear, apple: jamun and apple: mango, respectively. Results were contrary to Raj *et al*. (2011) who reported 50: 50 and 60: 40 ratio as the best for apple: sand pear blend and overall acceptability (OAA) score of blends ranged from 8.0 to 8.7. The overall acceptability score of the blends was recorded to decrease with the increase in concentration on sand pear and jamun which might be due to increase in acidity for both and due to decrease in body score due to high pulp percentage in case of jamun as it was found as a rich source of acid (0.96%). For the blends containing vegetable juice/pulp also, OAA score was found to decrease with the concentration of vegetable juice/pulp in the blends. This may be attributed to the bland taste of bottlegourd and pumpkin, acidic taste of tomato juice and bitter taste of bittergourd.

In winter season fruit blends, kinnow: aonla, kinnow: papaya and kinnow: red grapes blended in the proportions of 9.5: 0.5, 8: 2 and 5.5: 4.5 achieved maximum overall acceptability score. Bhardwaj and Mukherjee (2011) reported the flavour and colour score of Kinnow: Aonla blend in 95: 5 ratio as

7.50 and 8.30, respectively. The OAA score was recorded to increase with the increase in concentration of red grapes juice which might be due to the increase in sweetness of blends as well as improved colour of blends. The OAA was found to decrease in concentration of aonla juice which may be attributed to very high titratable acidity of aonla (2.26%) as indicated by results. A reduction was recorded in the body score of blends with the increase in papaya pulp concentration which could be ascribed to the decrease in viscosity of blends due to the thickness of pulp. For winter season fruit and vegetable blends, OAA score was increased significantly with the increase in carrot juice concentration which may be attribute to the sweet and non-acidic taste of carrot juice which neutralized the high acidity of kinnow, aonla and red grapes juice/blends. A decrease in OAA was recorded with the increase in cabbage pulp and tomato juice which may be ascribed to thick consistency and high acidity of blends, respectively. A decrease in OAA with increase in beetroot juice was recorded which could be attributed to the increase in earthy-flavour in blends with increase in beetroot juice.

Similarly, Bhardwaj and Mukherjee (2011) prepared different fruit juice blends *viz.* Kinnow: Aonla: Ginger (100: 0: 0 and 95: 5: 0, 92: 5: 3 ratio) and Kinnow: Pomegranate: Ginger (90: 10: 0, 87: 10: 3 ratio) for improving flavour, palatability, nutritive and medicinal value. The colour flavour and bitterness score of blends ranged from 8.20 to 8.71, 7.50 to 8.81 and 7.81 to 8.76, respectively. Sandhu and Sindhu (1992), Saxena *et al*. (1996), Attri *et al*. (1998), Langthasa (1999), Deka (2000) and Deka and Sethi (2001) reported that two or more fruits juice/pulp may be blended in various proportions for the preparation of nectar, RTS beverages etc.

The sensory scores of blended juices were recorded to be higher than the plain juices. According to Sistrunk and Morris (1985) blending increases the taste and flavour of fruit juices. They also reported that blend of apple and grape juices were highly acceptable in quality and contained acceptable flavour and colour. Anonymous (2009) have also reported that blending could lead to the production of delightful and delicious beverages with improved organoleptic quality and a high nutritive value. Blending of fruit juices could balance the strong flavours, high acidity, astringency or bitterness, improving total soluble solids, bland flavour and improve and stabilize the colour.

Nutritional or phytochemical properties could also be improved by blending which offers to adjust sugar/acid ratios and compensate undesirable juice consistency. Blended muscadine grape beverages were prepared using 25% juice and addition of other juice namely, commercial grape juice, orange juice and pineapple juice maintaining a brix/acid ratio of 30 (Flora, 1979). Higher overall acceptability and enhanced vitamin C content was achieved by blending gooseberry juice with grape juice at 20:80 ratios (Jain and Khurdiya, 2004). Antioxidant capacity of soy-based beverages was enhanced by blending with strawberry or grape fruit juices (Almeida *et al*., 2010).

5.4 Effect of storage on quality characteristics of juice blends

5.4.1 Total soluble solids (TSS)

During storage a marginal increase in total soluble solids was recorded for all blends. Increase in TSS might be attributed to breakdown of the complex carbohydrates into simple soluble carbohydrates. The increase in TSS might also be due to the formation of pectic substances from protopectin and mono-saccharides from disaccharides i.e. degradation of sucrose into glucose and fructose. Similar results have been reported by Sarolia and Mukherjee (2002) in their studies on lime juice. The results were also in confirmation with the studies of Kaunjoso and Luh (1967) on canning and storage of oranges and in canned peaches. Similar findings have also been reported by Deka and Sethi (2001) and Hussain *et al*. (2011) in fruit juice blends. Deka (2000) found an increasing trend in total soluble solids during storage at ambient and low temperature in lime-aonla and mango-pineapple spiced RTS beverages. An increase in TSS in lime-ginger RTS/blended RTS, during storage has also been recorded by Lanjhiyana *et al*. (2010) which was attributed to the conversion of polysaccharides like pectin, cellulose, starch etc into simple sugars. Shah *et al.* (1975) studied the storage stability of guava drink and observed an increase in TSS of the product during the storage. They accredited this increase to the solubilization of fruit constituents during storage. Similar results have been reported by Das (2009) in jamun beverages and Khurdiya (1981) in phalsa juice.

5.4.2 Titratable acidity

A gradual increase in acidity of both summer season and winter season blends was recorded with the advancement of storage period. This increase in acidity may be attributed to the degradation of sugars into carboxyl acids or degradation of pectin into pectinic acid. Similarly, Nunes *et al.* (1995) reported an increase in acidity of strawberry juice during storage and attributed it to the breakdown of pectin into pectinic acid (Riaz *et al.*, 1988). A slight increase in acidity (0.25 to 0.27) of jack fruit beverage during 6 month storage at room temperature has been reported by Krishnaveni *et al*. (2001). A gradual increase in acidity of pear-apple juice blends has also been noticed by Raj *et al.* (2011) during storage period of 6 month. These results are in agreement with the findings of Kinh *et al*. (2001), who reported an increase in titratable acidity of apple pulp during storage. This increase might be due to the breakdown of pectin in to pectinic acid. The results were in confirmation to the findings of Riaz *et al.* (1988). Conn and Stumt (1976) and Priyadevi *et al.* (2002) reported that pectic substances are responsible for the increase in acidity of fruits. Das (2009) also reported a slight increase in acidity of jamun beverages and attributed it to degradation of pectic substances.

5.4.3 Reducing and total sugars

Sugars content of all the blends exhibited a steady increase during storage period. The increase in reducing sugars content can be ascribed to the inversion of sucrose to glucose and fructose by the acid of the blend while increase in total sugars may be due to the degradation of complex polysaccharides like pectin and starch into simple sugars. In case of pulp containing blends this increase may be attributed to the solubilization of pulp resulting in the hydrolysis of starch into sugars. Similar observations were also reported by Babsky *et al.* (1986) and Pruthi *et al.* (1984) that non-reducing sugars of drinks is converted in to reducing sugars during storage. Significant increase in sugars during storage intervals have been reported by Krishnaveni *et al*. (2001) in jack fruit beverage. Similarly, Sethi (1992) recorded an increase in reducing sugars of lime-ginger cocktail during storage. A gradual increase in the total sugars content of carrot juice has been reported by Madan and Dhawan (2005). They also reported that rate of increase in total sugars of carrot juice was recorded to be higher at ambient storage as compared to low temperature conditions. Sood *et al*. (2009) recorded a significant increase in total and reducing sugars content of mango squash during storage and concluded that hydrolysis of non-reducing sugars into reducing sugars resulted in increasing the reducing sugars during storage. Similar results have been reported by Lanjhiyana *et al*. (2010) in lime-ginger blended squash. They related this variation in the different fraction of sugars to the hydrolysis of complex polysaccharides like starch and pectin into monosaccharides. Ruiz-Nieto *et al.* (1997) suggested that sucrose content of the strawberry juice converted to glucose and fructose during the storage resulting in changes in total sugars. Attri *et al.* (1998) reported that total sugars in sand pear juice blends increased with increase in storage period. Similarly, Shreshtha and Bhatiya (1987) reported a significant increase in total sugars content of apple juice blends and accredited this increase to the hydrolysis of complex sugars like pectin, starch etc to sucrose and monosaccharides.

5.4.4 Ascorbic acid

A significant decrease in ascorbic acid content was observed in all the blends during storage. The loss in ascorbic acid might be due to the oxidation or irreversible conversion of L-ascorbic acid into dehydroascorbic acid caused by trapped or residual oxygen in the glass bottles (Deka *et al*,. 2004). DeMan (1980) reported that out of four important enzymes (ascorbic acid oxidase, phenolase, cytochrome oxidase and peroxidase) catalyzing the decomposition of ascorbic acid, only ascorbic acid oxidase involves a direct reaction between enzyme, substrate and molecular oxygen while other enzymes oxidize the vitamins indirectly. Similar findings have been reported by Hussain *et al.*, 2011 who reported a decrease in ascorbic acid of the processed products during the storage. Viberg *et al.* (1999) also reported a decrease in ascorbic acid during storage. They recorded that ascorbic acid content in strawberry pulp was affected by treatments *viz*., freezing, heating and accelerated storage. These losses of ascorbic acid were attributed to the effect of processing, storage time and exposure to light.

Albrecht *et al.* (1991) reported that vitamin C losses ranged from 2% to 48% for six different broccoli cultivars stored at $2^{o}C$ for 21 day. Similarly, Howard *et al*. (1999) observed vitamin C losses of 13% and 48%, respectively, after 3 weeks of storage of broccoli at $4^{o}C$. Majumdar *et al.* (2011) studied the effect of storage quality of bottlegourd-basil leaves juice. They noticed that vitamin C lost 74% after 6 month of storage. Majumdar *et al*. (2009a) also found remarkable loss of vitamin C (74%) during 6 month storage of cucumber-litchi-lemon juice at room temperature ($28\pm2^{o}C$). However, Tiwari (2000) reported 26.47% loss of vitamin C during 6 month storage of guava and papaya beverage at room temperature. Losses in vitamin C content of apple juice and pineapple juice stored for 12 month in the warehouse under ambient conditions (33°C) were 45.8 and 49.8 per cent, respectively (Ewaidah, 1992). Reduction was higher at ambient temperature as compared to low temperature storage. Results were in accordance to Cortes *et al.* (2005) who reported 4.1% loss of vitamin C during 132 day storage of orange-carrot juice at -40°C and noticed lower losses of vitamin C at low temperature storage. Losses of ascorbic acid and β-carotene during cooking and storage of tomato, aonla and carrots products have also been reported (Nagra and Khan, 1988 and Aggarwal *et al.*, 1995). Similar decreasing trend for ascorbic acid contents in different fruit beverages were also reported by Ranote and Bains (1982). These results are in agreement with the finding of Kinh *et al*. (2001), who recorded a decrease in ascorbic acid content in apple pulp. The losses in ascorbic acid were attributed to high temperature and light during storage. A significant reduction in ascorbic acid content of jamun beverages during storage has been reported by Das (2009) who attributed this decrease to the oxidation of ascorbic acid into dehyroascorbic acid by trapped oxygen.

5.4.5 Total phenolics

A significant decrease in total phenolics content of summer and winter season blends was observed during storage. Losses were higher at ambient storage as compared to low temperature storage. Results were in accordance to Zhang *et al*. (2008) who recorded no significant changes in total phenolics content of apple juice at 5th day of storage which later on decreased significantly during storage at ambient temperature. Miller *et al*. (1995) also reported the same findings for apple juice stored at 4^{o}C over 10 days. Raj *et al*. (2011) reported a significant decrease in the phenolic content of sand pear and apple juice blends during six month of storage. During the processing of food, various transformations of phenolics occur to produce yellowish to brownish pigments (Clifford, 2000). The decline in the phenol contents during storage has also been reported earlier by Duda-Chodak *et al.* (2008) and El-Sheikha *et al*. (2004).

5.4.6 Total carotenoids

A marginal decrease in total carotenoids content of all the blends was recorded during storage. Decrease was more at ambient and refrigerated temperature. Similarly, Srivastava (1998) recorded a slight decrease in total carotenoids of mango RTS beverage during six month of storage. The total carotenoids content has been found to decrease over a period of six month in peach nectar by Deka *et al.* (2005) who observed 87.53 to 90.24% retention of total carotenoids after six month of storage whereas Lavelli *et al*. (2009) observed no changes in β-carotene content of mango products. There are many previous investigations which reported no or only a minor degradation of carrot carotenoids during cold storage (Kopas-Lane and Warthesen, 1995 and Howard *et al*., 1999). Apart from isomerization and oxidation of high carotenoids containing fruits and vegetables, carotenoids level increases during processing (Chandler and Shwartz, 1988). Thermal processing has been reported to increase the amount of carotenoids in products (Edwarda and Lee, 1986).

5.4.7 Total anthocyanins

A significant reduction in total anthocyanins of all blends containing Jamun and Red grapes juice/pulp was recorded during storage. Losses were higher during ambient storage as compared to refrigerated storage. Similar results have been reported by Will and Dietrich (2006) who studied the effect of storage and temperature on the stability of the anthocyanins in plum juices and noticed that degradation of anthocyanins was less at lower temperature. They found that loss of anthocyanins was about 77-88% at 90 days as compared to freshly prepared juice which increased up to 90-95% at 180 days at ambient temperature contrary to which losses were only 41-58% even during 300 days of interval at low temperature. A significant reduction in anthocyanin content has also been reported in blood orange juice (Kirca *et al.*, 2003), strawberry juice and concentrate (Garzon and Wrolstad, 2002) and black currant juices (Eder, 1996) during storage. Spayd *et al.* (1984) determined the stability of anthocyanins in apple and pear juices blended with juices containing anthocyanins and reported that the reduction of anthocyanins in juices after three month of storage at 25^{o}C was 20% in black raspberry blend, 26% in Bing cherry blend, 31% in Concord grape blend and 42% in red raspberry blend. Total loss of anthocyanins has been reported to be 46-69% in the blend of apple juice with black currant juice and 50-56% with red currant juice, after 4 month of storage at room temperature (Nani *et al.*, 1993). Similarly, Oszmianski and Wojdylo (2009) studied the effect of storage on total anthocyanins content of blackcurrant and apple mash blends and reported the losses in the anthocyanins to be 40% and 96% in blackcurrant juice after six month of storage at 4^{o}C and 30^{o}C, respectively. They also reported that rate of anthocyanin degradation increased during storage with rise in the storage temperature.

Temperature is the main factor in the degradation of anthocyanins. However, pH, presence of enzymes, light or presence of complex compounds also plays an important role in the stability of anthocyanins (Eiro and Heinomen, 2002). Quinones play an important role in enzymatic degradation of anthocyanins. First enzymes oxidize other phenolic compounds in the media to their corresponding quinones, which then react with anthocyanins resulting in anthocyanin degradation and formation of brown condensation products (Yokotsuka and Singleton, 1997; Skrede *et al.,* 2000 and Kader *et al.*, 2002). Anthocyanins are highly sensitive to pH. The temperature rise at the pH value equal to 4 induces loss of the glycosyl moieties of the anthocyanins by hydrolysis of the glycosidic bond. This leads to a further loss of anthocyanin colour since, aglycones are less stable than their glycosidic forms. It is postulated that the formation of chalcone is the first step in thermal degradation of anthocyanins (Adams *et al.*, 1973). Eventually, thermal degradation leads to brown products especially in the presence of oxygen. Thermal degradation of anthocyanins follows the first order kinetics (Ahmed *et al.*, 2004). Morais *et al.* (2002) reported that loss of pigments was higher at an elevated temperature in presence of light and increased with increase in storage intervals. These results entirely support our findings that temperature of storage has a considerable effect on the stability of anthocyanins. It was entirely supported by the findings of Pilando *et al.* (1985) according to which the anthocyanins pigments of raspberry and other fruits degraded and polymerized with aging. Sugar and sugar degradation production increases anthocyanin breakdown. This may be due to the detrimental effect of fructose produced by hydrolysis of sucrose to fructose. According to Brouillard (1982), colouration of anthocyanins varies with the pH of the environment. In aqueous environment, four types of anthocyanins exist at equilibrium i.e. flavylium cation carbinol base, quinoidal base and chalcone. The flavylium cation form presents anthocyanins that are red in acidic environment, in which they are considered to be stable. The pseudocarbinol base and chalcone forms are colourless and prevail at neutral or slightly acidic pH.

5.4.8 Antioxidant activity

Antioxidant or free radical scavenging activity of various juice blends decreased during storage of six month. This can be attributed to the loss of ascorbic acid, carotenoids and total phenolics due to oxidation and other reactions as antioxidant activity totally depends upon pigments like carotenoids and anthocyanins (Rice-Evans *et al*., 1997), ascorbic acid (Kapasakalidis *et al*., 2006) and total phenolic content (Oszmianski and Wojdylo, 2009) in the product. It has also been reported that foods undergo numerous processing changes before consumption which may alter their nutritional profile (Goyal and Khetarpaul, 1994; Negi and Roy, 2001) including their antioxidants content (Sato *et al.,* 2006; Turkmen *et al.,* 2006). Generally, food processing procedures are recognized as one of the major factors on the destruction or changes of natural phytochemicals which may affect the natural antioxidant capacity in foods (Nicoli *et al.,* 1999).

Reduction in antioxidant activity was higher at refrigerated temperature as compared to ambient temperature storage. The reason could be that non-enzymatic browning reaction could induce the formation of Maillard reaction products (MRP) with novel antioxidant properties which could maintain or even enhance the antioxidant activity of juice blends. The MRPs developed in higher quantity at ambient storage as compared to refrigerated storage might have contributed to the antioxidant activity in addition to phenolics compounds (Anese *et al*., 1993). Nicoli *et al*. (2000) reported that although the antioxidant activity of phenolics compounds was progressively lost during storage because of their destruction/transformation, it was compensated by the formation of MRPs with a remarkable antioxidant effect. So it could be hypothesized that as the polyphenolic compounds were partially lost during the ambient storage, the MRP became the prevailing contributors to the antioxidant activity. Similar results have been reported by Oszmianski and Wojdylo (2009) in apple-blackcurrant blended juices where they attributed this to the formation of degradation products in more quantity at higher temperature as compared to refrigerated temperature during storage.

5.5.9 Non-enzymatic browning (NEB)

Slight increase in NEB was observed in all types of blends during storage. Several factors such as temperature, moisture, organic acids, water activity, oxygen and sugars have been reported to be responsible for causing non-enzymatic browning in stored products as reported by Siddiqi and Cash (2000). A slight increase in NEB has been reported by Das (2009) in ready-to-serve beverages and nectars during storage which was attributed to browning reactions which occur between nitrogenous compounds and sugars or organic acids and organic acids with sugars. Non-enzymatic browning in citrus products has been related to ascorbic acid degradation (Henshall, 1982). Further, a marginal decrease in NEB during storage was recorded in blends containing Jamun, beetroot and red grapes. This may be attributed to the loss of colour due to degradation of total anthocyanins/betalains with the advancement of storage period or formation of some metabolites which could not be absorbed at wavelength of 440 nm. In case of blends, containing jamun, decrease was significant which might be due to more reduction of colour because of higher degradation in total anthocyanins due to lower acidity of blends. Findings were supported by Adams (1973) who reported that anthocyanins are highly sensitive to pH and temperature rise at the pH value equal to 4 induces loss of the glycosyl moieties of the anthocyanins by hydrolysis of the glycosidic bond which leads to a further loss of anthocyanin colour. The results were in agreement to Buglione and Lozano (2002) who observed that colour deterioration was at a faster rate in red grape juice concentrate during storage of 3 month at 10 to 30°C. A minimal loss in colour has also been observed by Balaswamy *et al*., (2011) in purple grape-phalsa ready-to-serve beverage. Similarly, losses in colour has also been observed by Morais *et al*. (2001) in blueberry juice blends prepared with different proportions of apple juice, concord grape and venus grape juices and cranberry juice after storage of 3 month at 37°C. Oszmianski and Wojdylo (2009) also reported that lightness of blended apple and blackcurrant juices increase during storage as a consequence of coloured anthocyanin degradation. Blends containing beetroot showed less reduction in NEB which might be due to stability of betalains over a wide range of pH (Robinson *et al*., 1963) while less changes in NEB of red grape's blends in comparison to that of Jamun blends might be due the high acidity of red grape's blends than Jamun blends.

5.5 Effect of storage on sensory quality of juice blends

Sensory score of all the products exhibited an insignificant decrease with the passage of time. The decrease in score for colour, flavour, body and overall acceptability was less in low temperature storage. Minimal reduction in colour score of all the products at low temperature in comparison to ambient storage might be due to the minimum degradation of carotenoids, as well as less NEB at low temperature. The gradual loss in flavour scores over the entire storage period might be due to changes in volatile compounds of the blends due to time and temperature and duration of storage. Flavour deterioration in beverage products has also been reported by Jain *et al*. (2003) and Bezman (2001). According to Sistrunk and Morris (1985) the blend of apple and grape juices were highly acceptable in quality and retained acceptable flavour and colour during storage at 24°C for 12 month. The loss of flavour and taste may be due to the degradation of ascorbic acid into furfural during storage (Shimoda and Osajima, 1981). Balaswamy *et al*. (2011) reported that a minimal loss of visual colour was found in blended beverages with phalsa, but scored well in terms of overall acceptability after 4 month storage period. Ahmed *et al.* (1976) reported no significant effect of storage on sensory quality of orange squash stored for five month.

5.6 Effect of storage on microbial quality

During microbial examination of different juice blends, no apparent spoilage was seen in any of the blend. None of the isolates i.e. bacteria, yeasts and moulds were found in nutrient agar, potato dextrose agar and yeast extract malt agar medium which shows that all the products were safe for consumption and maintained good microbial quality during the storage period of 6 month. Similar results have been reported by Lakhanpal (2010) in honey based mango nectar.

Deka (2000) reported negligible growth of moulds and yeasts in lime-aonla and mango-pineapple spiced RTS beverages, which got further reduced during storage due to inhibitory effect and antioxidative properties of spices. Deka and Sethi (2001) reported that no bacterial growth was observed in the spiced mixed fruit juice and RTS beverages. These results were supported by Ejechi *et al*. (1998) in spiced mixed fruit juices and Dhaliwal and Hira (2001) in mixed vegetable juice. Bhardwaj and Mukherjee (2011) observed that Kinnow: Aonla: Ginger blend samples were contaminated with a large variety of bacterial, fungal and mould species but within the acceptable limit.

5.7 Cost of production

The cost incurred in preparation of juice blends was calculated by taking into consideration the cost of all inputs used and appropriate cost involved during the preparation of juice blends. The electricity and other expenses including depreciation were added to the total expenditure. The sale price per litre of product was calculated after adding 20% profit margin. The cost of production of different juice blends of summer fruits and vegetables ranged in between Rs. 5.25 (apple: pear) to Rs. 15.98 (apple: mango: jamun: bottlegourd) for 200 mL glass bottle whereas, for winter season fruits and vegetables it was in between Rs. 8.87 (kinnow: red grapes: papaya: cabbage) to Rs 18.26 (kinnow: red grapes) for 200 mL glass bottle. The cost of production of various blends was within the range of natural juices being sold in the market.

SUMMARY AND CONCLUSION

Chapter-6

SUMMARY AND CONCLUSION

The present investigations entitled **"Seasonal fruit and vegetable juice blends with high antioxidant potential"** were carried out i) to develop natural juice blends from summer and winter fruits and vegetables ii) to evaluate the quality and the antioxidant potential of the developed blends iii) to investigate the shelf-life quality of the best blends under refrigerated and ambient storage temperatures and iv) to find out the cost: benefit ratio of the developed blends. Blending could lead to the production of delightful and delicious beverages with improved organoleptic quality and a high nutritive value. Blending of fruit juices could be practiced to overcome the high cost of some exotic fruit juices, scarcity or seasonal availability, balancing of strong flavours, high acidity, astringency, or bitterness, improving total soluble solids, bland flavour, improving and stabilizing colour. Nutritional or phytochemical properties can be improved by blending which offers to adjust sugar/acid ratios and compensate undesirable juice consistency. Investigations to produce natural blends using summer and winter season fruits and vegetables have been a worthwhile attempt. It is also in consonance with the present trend of use of functional beverages which are totally natural and chemical or additive-free. Natural juice blends prepared from fruits and vegetables have potential to replace synthetic juices to add a variety in beverages market. Therefore, production of natural fruit and vegetable juice/pulp blends is one of the easy and profitable options in this direction.

To accomplish the present study, the fruits and vegetables were procured from the local market as well as purchased from the farmers of adjoining villages and were brought to the Department of Food Science and Technology where juice/pulp extraction and their preservation was carried out in the Fruit Processing Unit of the Department. Extracted juices and pulps were brought to the Quality Control Laboratory for preparation and evaluation of juice blends. After completion of the proposed research work results are summarized and concluded in the following manner:

6.1 Physico-chemical characteristics of fruits

6.1.1 Average length, diameter and weight of apple fruits were recorded as 46.05 mm, 64.47 mm and 90.70 g, respectively. The fruit contained 11.23^{o}B total soluble solids, 0.32% titratable acidity (as % malic acid), 6.11 mg/100 g ascorbic acid, 6.96% reducing sugars and 10.44% total sugars. Total phenolic content and antioxidant activity was recorded as 365.67 mg/100 g and 74.79 per cent, respectively.

6.1.2 Average length, diameter and weight of mango fruits were recorded as 88.64 mm, 55.72 mm and 139.14 g, respectively. The fruit contained 18.47^{o}B total soluble solids, 0.26% titratable acidity (as % citric acid), 30.38 mg/100 g ascorbic acid, 9.58% reducing sugars and 15.13% total sugars. Total phenolic content and antioxidant activity was recorded as 84.26 mg/100 g and 63.69 per cent, respectively. Total carotenoids content in mango was recorded as 6.32 mg/100 g.

6.1.3 Average length, diameter and weight of jamun fruits were recorded as 26.81 mm, 20.35 mm and 7.36 g, respectively. The fruit contained 16.55^{o}B total soluble solids, 0.96% titratable acidity (as % citric acid), 22.74 mg/100 g ascorbic acid, 6.81% reducing sugars and 14.00% total sugars. Total phenolic content and antioxidant activity was recorded as 415.49 mg/100 g and 76.47 per cent, respectively. Total anthocyanins content of jamun fruits was recorded as 157.99 mg/100 g.

6.1.4 Average length, diameter and weight of sand pear fruits were recorded as 54.54 mm, 52.80 mm and 86.68 g, respectively. The fruit contained 9.06^{o}B total soluble solids, 0.49% titratable acidity (as % malic acid), 5.20 mg/100 g ascorbic acid, 2.96% reducing sugars and 3.88% total sugars. Total phenolic content and antioxidant activity was recorded as 369.60 mg/100 g and 65.25 per cent, respectively.

6.1.5 Average length, diameter and weight of Kinnow fruits was recorded as 53.47 mm, 65.41 mm and 144.78 g, respectively. The fruit contained 10.08^{o}B total soluble solids, 1.07% titratable acidity (as % citric acid), 25.50 mg/100 g ascorbic acid, 4.55% reducing sugars and 7.66% total sugars. Total phenolic content and antioxidant activity was recorded as 18.36 mg/100 g and 22.32 per cent, respectively.

6.1.6 Average length, diameter and weight of papaya fruits was recorded as 288.82 mm, 232.42 mm and 1005.04 g, respectively. The fruit contained 11.21^{o}B total soluble solids, 0.003% titratable acidity (as % citric acid), 109.22 mg/100 g ascorbic acid, 6.16% reducing sugars and 7.73% total sugars. Total phenolics content was recorded as 55.97 mg/100 g while antioxidant activity was recorded as 64.71 per cent. Papaya contained 5.03 mg/100 g total carotenoids.

6.1.7 Aonla fruits had 38.20 mm average length, 36.35 mm average diameter and 37.71 g average weight. The fruit contained 10.38^{o}B total soluble solids, 2.26% titratable acidity (as % citric acid), 448.4 mg/100 g ascorbic acid, 3.22% reducing sugars and 4.42% total sugars. Total phenolic content and antioxidant activity was recorded as 293.12 mg/100 g and 82.75 per cent, respectively.

6.1.8 Average length, diameter and weight of grape berries were recorded as 21.51 mm, 19.07 mm and 2.84 g, respectively. Average total soluble solids, titratable acidity, ascorbic acid, reducing sugars and total sugars of berries were recorded as 16.23^{o}B, 0.84% (as % tartaric acid), 11.95 mg/100 g, 9.89% and 11.86%, respectively. Total phenolics content and antioxidant activity of the fruits was recorded as 196.14 mg/100 g and 69.56 per cent, respectively. Average total anthocyanins content was recorded as 79.40 mg/100 g.

6.2 Physico-chemical characteristics of vegetables

6.2.1 Tomato fruits contained average fruit length, diameter and weight as 52.88 mm, 47.63 mm and 58.49 g, respectively. Total soluble solids content was recorded as 6.07^{o}B while titratable acidity was recorded as 0.59 per cent. Fruits contained 21.55 mg/100 g ascorbic acid, 2.38% reducing sugars, 2.74% total sugars, 31.71 mg/100 g total phenols and

52.46% antioxidant activity. Total carotenoids were recorded as 4.25 mg/100 g.

6.2.2 Average length, diameter and weight of bottlegourd fruits were recorded as 276.29 mm, 82.50 mm and 790.00 g, respectively. Average total soluble solids content, titratable acidity (as % citric acid), ascorbic acid content, reducing sugars, total sugars, total phenolics content and antioxidant activity was recorded as 1.71^{o}B, 0.003%, 16.43 mg/100 g, 1.32%, 1.45%, 13.85 mg/100 g and 72.13 per cent, respectively.

6.2.3 Bittergourd fruits showed 117.34 mm average length, 43.61 mm average diameter and 52.17 g average weight. The fruit contained 2.89^{o}B total soluble solids, 0.05% titratable acidity (as % citric acid), 88.83 mg/100 g ascorbic acid, 0.56% reducing sugars and 1.10% total sugars. Total phenolic content and antioxidant activity was recorded as 82.90 mg/100 g and 58.55 per cent, respectively.

6.2.4 Pumpkin fruits contained average weight as 2566.76 g while average length and average diameter was recorded as 104.04 mm and 353.50 mm, respectively. Average total soluble solids, titratable acidity (as % citric acid), ascorbic acid, reducing sugars and total sugars were recorded as 6.32^{o}B, 0.013%, 13.52 mg/100 g, 2.17% and 3.26%, respectively. Total phenolics content and antioxidant activity was recorded as 2.63 mg/100 g and 70.81 per cent, respectively.

6.2.5 Carrot contained 8.18^{o}B total soluble solids, 0.01% titratable acidity (as % citric acid), 4.47 mg/100 g ascorbic acid, 2.84% reducing sugars and 6.58% total sugars. Total phenolics content was recorded as 12.66 mg/100 g and antioxidant activity was recorded as 61.71 per cent, respectively. Total carotenoids content was recorded as 8.93 mg/100 g. Average root length of carrot was recorded as 82.51 mm while diameter was recorded as 22.53 mm. Average weight of carrot was recorded as 49.35 g.

6.2.6 Average weight of cabbage heads was recorded as 286.07 g. Average length and diameter of cabbage head was recorded as 93.86 mm and 108.57 mm, respectively. Average total soluble solids content was recorded as 3.03^{o}B while titratable acidity was recorded as 0.001% (as % citric acid). Ascorbic acid content in cabbage was recorded as 11.60 mg/100 g while reducing sugars and total sugars content was recorded as 1.35% and 1.86%, respectively. Total phenolics content and antioxidant activity was recorded as 70.41 mg/100 g and 44.03%, respectively.

6.2.7 Beetroot contained 89.79 g average weight while average length and diameter were recorded as 60.01 mm and 59.05 mm, respectively. Average total soluble solids, titratable acidity (as % citric acid), ascorbic acid, reducing sugars and total sugars were recorded as 13.57^{o}B, 0.001%, 9.74 mg/100 g, 7.52% and 8.82%, respectively. It contained 212.31 mg/100 g total phenolics content and 82.55 per cent antioxidant activity.

6.3 Development of juice blends from summer season fruits and vegetables

6.3.1 Among different proportions used for the preparation of apple based (two fruit) juice blends, the proportion of 8: 2, 9: 1 and 8: 2 were found best for apple: pear, apple: jamun and apple: mango juice/pulp blends, respectively.

6.3.2 In apple based (three fruit) juice blends, proportions of 6.4: 1.6: 2, 7.2: 0.8: 2 and 6.8: 1.7: 1.5 were adjudged best for apple: pear: mango, apple: jamun: pear and apple: mango: jamun blends, respectively.

6.3.3 In apple: pear based vegetable blends, proportion of 7.2: 1.8: 1 was rated best among all the proportions used for apple: pear: bottlegourd while proportion of 7.6: 1.9: 0.5 was ranked best for each among apple: pear: bittergourd, apple: pear: pumpkin and apple: pear: tomato blends.

6.3.4 Among apple: jamun and vegetable blends, proportion of 8.1: 0.9: 1 was found best for apple: jamun: bottlegourd blend while proportion of 8.5: 1: 0.5 was adjudged best for apple: jamun: bittergourd, apple: jamun: tomato and apple: jamun: pumpkin.

6.3.5 In apple: mango and vegetable blends, proportions of 6.4: 1.6: 2, 7.2: 1.8: 1, 7.6: 1.9: 0.5 and 7.6: 1.9: 0.5 were found best for apple: mango: bottlegourd, apple: mango: bittergourd, apple: mango: tomato and apple: mango: pumpkin blends.

6.3.6 In apple: pear: mango and vegetable blends, standardized proportions were calculated as 5.4: 1.4: 1.7: 1.5, 5.8: 1.4: 1.8: 1, 6.1: 1.5: 1.9: 0.5 and 6.1: 1.5: 1.9: 0.5 for apple: pear: mango: bottlegourd, apple: pear: mango: bittergourd, apple: pear: mango: tomato and apple: pear: mango: pumpkin blends, respectively

6.3.7 Among different proportions used for the development of apple: jamun: pear and vegetable blends, the proportion of 5.4: 0.6: 1.5: 2.5 was found best for apple: jamun: pear: bottegourd blend while 6.8: 0.8: 1.9: 0.5 was adjudged best for each among apple: jamun: pear: bittergourd, apple: jamun: pear: tomato and apple: jamun: pear: pumpkin.

6.3.8 In apple: mango: jamun and vegetable blends, the proportions of 6.1: 1.5: 1.4: 1, 6.5: 1.6: 1.4: 0.5, 6.1: 1.5: 1.4: 1 and 6.5: 1.6: 1.4: 0.5 were adjudged best for apple: mango: jamun: bottlegourd, apple: mango: jamun: bittergourd, apple: mango: jamun: tomato and apple: mango: jamun: pumpkin, respectively.

6.4 Effect of blending on quality characteristics of summer season blends

6.4.1 Blending improved the functional components in apple based (two fruit) juice blends. Maximum total soluble solids (12.74^{o}B), reducing sugars (8.84%) and total sugars (11.91%) was recorded in apple: mango blends while the maximum titratable acidity (0.40%), ascorbic acid content (10.59 mg/100 mL), total phenolics (238.45 mg/100 mL) and antioxidant sactivity (75.15%) was recorded in apple: jamun blend. Apple: mango blend was adjudged best with overall acceptability score of 8.50.

6.4.2 Among apple based (three fruit) juice blends, apple: mango: jamun blend contained maximum total soluble solids (12.93°B), titratable acidity (0.43%), reducing sugars (6.43%), total sugars (11.48%), ascorbic acid (22.15 mg/100 mL) and non-enzymatic browning (1.839) while maximum total phenolics (282.18 mg/100 mL) was recorded in apple: jamun: pear blend. Maximum antioxidant activity was recorded as 82.28% in apple: jamun: pear blend.

6.4.3 In apple: pear and vegetable blends, the maximum TSS (10.49°B), titratable acidity (0.35%), reducing sugars (5.95%) and total sugars (10.49%) was recorded in apple: pear: tomato blend. Apple: pear: bittergourd showed the maximum ascorbic acid (7.18 mg/100 mL) and total phenolics (195.32 mg/100 mL) while maximum antioxidant activity (71.65%) and non-enzymatic browning (1.184) was recorded in apple: pear: pumpkin blend. Apple: pear: tomato achieved maximum overall acceptability among all the blends with maximum score of 7.30.

6.4.4 In apple: jamun and vegetable blends, the maximum TSS content (11.43°B), titratable acidity (0.38%), total sugars (9.62%), total phenolics (235.69 mg/100 mL), antioxidant activity (74.37%), total anthocyanins (12.57 mg/100 mL) and NEB (1.764) was recorded in apple: jamun: tomato blend. Reducing sugars content was maximum (6.69%) in apple: jamun: pumpkin blend while maximum ascorbic acid content was recorded as 13.41 mg/100 mL in apple: jamun: bittergourd blend. Apple: jamun: bottlegourd was adjudged best with the maximum sensory ranking of 8.20.

6.4.5 In apple: mango and vegetable blends, apple: mango: pumpkin showed maximum TSS (12.20°), reducing sugars (6.10%), total sugars (11.08%) and NEB (1.445). Maximum titratable acidity (0.32%), total phenolics content (196.63 mg/100 mL) and total carotenoids (1.87 mg/100 mL) was recorded in apple: mango: tomato blend. The maximum ascorbic acid content (11.85 mg/100 mL) and antioxidant activity (73.43%) was recorded in apple: mango: bittergourd blend. On the basis of sensory evaluation apple: mango: pumpkin was adjudged best with maximum overall acceptability score of 8.00.

6.4.6 In apple: pear: mango and vegetable blends, apple: pear: mango: pumpkin blend showed maximum TSS (12.22°B), reducing sugars (6.52%), total sugars (10.67) and NEB (0.879). Maximum titratable acidity (0.36%), total phenolics (189.32 mg/100 mL) and total carotenoids (1.47 mg/100 mL) was recorded in apple: pear: mango: tomato blend. Ascorbic acid content was maximum (15.79 mg/100 mL) in apple: pear: mango: bittergourd blend. Maximum overall acceptability score (8.50) was achieved by apple: pear: mango: bottlegourd blend

6.4.7 Among different apple: jamun: pear and vegetable blends, apple: jamun: pear: tomato blend contained maximum TSS (11.22°B), titratable acidity (0.43%), reducing sugars (6.10%), total sugars (8.47%), total phenolics (237.43 mg/100 mL), total anthocyanins (11.78 mg/100 mL), antioxidant activity (71.61%) and NEB (1.486). Apple: jamun: pear: bittergourd blend was found to possess maximum ascorbic acid content (10.65 mg/100 mL). Maximum overall acceptability score was achieved by apple: jamun: Pear: bottlegourd blend.

6.4.8 Among vegetable blends prepared by blending vegetable pulp/juices with apple: mango: jamun blend, maximum TSS (12.49°B) was recorded in apple: mango: jamun: Pumpkin blend while maximum titratable acidity (0.43%), total phenolics (284.22 mg/100 mL), total carotenoids (1.46 mg/100 mL), total anthocyanins (21.62 mg/100 mL) and non-enzymatic browning (1.321) was recorded in apple: mango: jamun: tomato blend. Apple: mango: jamun: bittergourd contained the maximum reducing sugars (6.25%), total sugars (10.89%) and ascorbic acid content (20.87 mg/100 mL). Antioxidant activity was maximum in apple: mango: jamun: bottlegourd blend (72.47%). On the basis of overall acceptability apple: mango: jamun: bottlegourd blend achieved maximum overall acceptability.

6.4.9 Among summer season blends maximum antioxidant activity was recorded for apple: jamun: pear blend as 82.82 per cent.

6.5 Development of juice blends from winter season fruits and vegetables

6.5.1 The best proportions for kinnow based (two fruits) juice blend were found as 9.5: 0.5, 8: 2 and 5.5: 4.5 for kinnow: aonla, kinnow: papaya and kinnow: red grapes, respectively.

6.5.2 In kinnow based (three fruit) juice blends, the proportions of 5.7: 0.3: 4, 7.2: 1.8: 1 and 4.4: 3.6: 2 were adjudged best on the basis of overall acceptability score for kinnow: aonla: red grapes, kinnow: papaya: aonla and kinnow: red grapes: papaya, respectively.

6.5.3 In different kinnow: aonla and vegetable blends, kinnow: aonla: tomato, kinnow: aonla: carrot, kinnow: aonla: beetroot and kinnow: aonla: cabbage blends prepared in proportions of 9: 0.5: 0.5, 5.2: 0.3: 4.5, 6.6: 0.4: 3 and 9: 0.5: 0.5, respectively achieved maximum overall acceptability score among different proportions used.

6.5.4 In kinnow: papaya and vegetable blends, the standardized proportion of kinnow: papaya: tomato, kinnow: papaya: carrot, kinnow: papaya: beetroot and kinnow: papaya: cabbage were recorded as 7.2: 1.8: 1, 5.6: 1.4: 3, 6.4: 1.6: 2 and 7.6: 1.9: 0.5, respectively.

6.5.5 In kinnow: red grapes and vegetable blends, the proportions of 4.7: 3.8: 1.5, 3.3: 2.7: 4, 5: 4: 1 and 5: 4: 1 were adjudged best for kinnow: red grapes: tomato, kinnow: red grapes: carrot, kinnow: red grapes: beetroot and kinnow: red grapes: cabbage, respectively.

6.5.6 Among different proportions used for preparation of kinnow: aonla: red grapes and vegetable blends, ratio of 4.8: 0.3: 3.4: 1.5, 3.4: 0.2: 2.4: 4, 5.4: 0.3: 3.8: 0.5 and 5.1: 0.3: 3.6: 1 achieved maximum overall acceptability score for kinnow: aonla: red grapes: tomato, kinnow: aonla: red grapes: carrot, kinnow: aonla: red grapes: beetroot and kinnow: aonla: red grapes: cabbage blends, respectively.

6.5.7 In kinnow: papaya: aonla and vegetable blends, the proportions of 6.5: 1.6: 0.9: 1, 4.3: 1.1: 0.6: 4, 5.8: 1.4: 0.8: 2 and 6.5: 1.6: 0.9: 1 ranked best on the basis of overall acceptability score for kinnow: papaya: aonla: tomato, kinnow: papaya: aonla: red grapes: carrot, kinnow: papaya: aonla: beetroot and kinnow: papaya: aonla: cabbage, respectively.

6.5.8 In kinnow: red grapes: papaya and vegetable blends, proportions of 4.2: 3.4: 1.9: 0.5, 2.9: 2.3: 1.3: 3.5, 4.2: 3.4: 1.9: 0.5 and 3.5: 2.9: 1.6: 2 were adjudged best for the preparation of kinnow: red grapes: papaya: tomato, kinnow: red grapes: papaya: carrot, kinnow: red grapes: papaya: beetroot and kinnow: red grapes: papaya: cabbage blends, respectively.

6.6 Effect of blending on quality of winter season juice blends

6.6.1 Among kinnow based (two fruits) juice blends, the highest total soluble solids (12.80°), total sugars (9.62%), total phenolics (30.25 mg/100 mL), antioxidant activity (65.62%) and NEB (1.326) was recorded in kinnow: red grapes blend while maximum titratable acidity (1.18%) and ascorbic acid content (40.21 mg/100 mL) was recorded in kinnow: aonla blend. Maximum reducing sugars (4.90) and total carotenoids content (3.21 mg/100 mL) was recorded in kinnow: papaya blend. Maximum overall acceptability score was recorded for kinnow: red grapes (7.50).

6.6.2 In kinnow based (three fruit) juice blends, kinnow: aonla: red grapes blend showed highest TSS (12.60°B), reducing sugars (6.71%), total sugars (9.28%), total phenolics (92.61 mg/100 mL) and NEB (1.560). Maximum titratable acidity (1.06%), ascorbic acid (59.12 mg/100 mL)) and total carotenoids content (4.41 mg/100 mL) was recorded in kinnow: papaya: aonla blend. Antioxidant activity (65.48%) was maximum in kinnow: red grapes: papaya blend. The maximum overall acceptability score (7.50) was achieved by kinnow: red grapes: papaya blend.

6.6.3 Among different kinnow: aonla and vegetable blends, kinnow: aonla: beetroot blend showed highest TSS (11.24°B), reducing sugars (5.46%), total sugars (7.84%), total phenolics (80.21 mg/100 mL), antioxidant activity (57.69%) and NEB (4.106). Maximum titratable acidity (1.15%) was recorded in kinnow: aonla: tomato. Maximum ascorbic acid (36.85 mg/100 mL)) was recorded in kinnow: aonla: cabbage and total carotenoids (5.43 mg/100 mL) content was recorded in kinnow: aonla: carrot blend. The maximum overall acceptability score (8.10) was achieved by kinnow: aonla: carrot blend.

6.6.4 Among kinnow: papaya and vegetable blends, kinnow: papaya: beetroot blend showed highest TSS (11.48°B), reducing sugars (5.45%), total sugars (8.10%), total phenolics (70.46 mg/100 mL) and NEB (3.061). Maximum titratable acidity (0.88%) was recorded in kinnow: papaya: tomato and kinnow: papaya: cabbage. Maximum ascorbic acid (16.42 mg/100 mL)) was recorded in kinnow: papaya: cabbage and total carotenoids (5.76 mg/100 mL) content was recorded in kinnow: papaya: carrot blend. The maximum overall acceptability score (8.40) was achieved by kinnow: papaya: carrot blend.

6.6.5 In Kinnow: Red grapes and vegetable blends, kinnow: red grapes: beetroot blend showed highest TSS (12.88°B), reducing sugars (4.83%), total sugars (9.56%), total phenolics (49.07 mg/100 mL), total anthocyanins (31.35 mg/100 mL), antioxidant activity (66.81%) and NEB (4.149). Maximum titratable acidity (0.93%) was recorded in kinnow: red grapes: tomato. Maximum ascorbic acid (14.33 mg/100 mL)) was recorded in kinnow: red grapes: cabbage and total carotenoids (4.81 mg/100 mL) content was recorded in kinnow: red grapes: carrot blend. The maximum overall acceptability score (8.20) was achieved by kinnow: red grapes: carrot blend.

6.6.6 Among kinnow: aonla: red grapes and vegetable blends, kinnow: aonla: red grapes: beetroot blend showed highest TSS (12.47°B), titratable acidity (1.11%), reducing sugars (6.77%), total sugars

(9.30%), total anthocyanins (27.71 mg/100 mL), total phenolics (98.52 mg/100 mL) and NEB (4.263). Maximum ascorbic acid (25.64 mg/100 mL)) was recorded in kinnow: aonla: red grapes: tomato. Maximum antioxidant activity (58.48%) and total carotenoids (4.91 mg/100 mL) content was recorded in kinnow: aonla: red grapes: carrot blend. The maximum overall acceptability score (8.20) was achieved by kinnow: aonla: red grapes: carrot blend.

6.6.7 In kinnow: papaya: aonla and vegetable blends, kinnow: papaya: aonla: red grapes: beetroot blend showed highest TSS (11.05°B), reducing sugars (5.42%), total sugars (8.92%), total phenolics (77.23 mg/100 mL), antioxidant activity (63.13%) and NEB (4.095). Maximum ascorbic acid (53.84 mg/100 mL) and total carotenoids (5.17 mg/100 mL) content was recorded in kinnow: papaya: aonla: carrot blend. The maximum overall acceptability score (8.20) was achieved by kinnow: papaya: aonla: carrot blend.

6.6.8 Among kinnow: red grapes: papaya and vegetable blends, kinnow: red grapes: papaya: beetroot blend showed highest TSS (12.57°B), reducing sugars (5.09%), total sugars (7.41%), total phenolics (42.70 mg/100 mL), total anthocyanins (24.47 mg/100 mL), ascorbic acid (9.47 mg/100 mL) and NEB (4.154). Maximum total carotenoids (6.06 mg/100 mL) content was recorded in kinnow: red grapes: papaya: carrot blend. Maximum titratable acidity (0.82%) and antioxidant activity (62.79%) was recorded in kinnow: red grapes: papaya: tomato blend. The maximum overall acceptability score (8.20) was achieved by kinnow: red grapes: papaya: carrot blend.

6.6.9 Among winter season blends maximum antioxidant activity (high antioxidant potential) was recorded in kinnow: red grapes: beetroot as 66.81 per cent.

6.7 Effect of storage on quality characteristics of juice blends

6.7.1 An insignificant increase in TSS, titratable acidity, reducing and total sugars was recorded in different blends during storage of 6 month at ambient and refrigerated temperature.

6.7.2 Non-enzymatic browning of all the blends increased during the storage except the blends containing jamun, red grapes and beetroot pulp/juice where NEB decreased during storage.

6.7.3 Ascorbic acid, total phenolics, total anthocyanins, antioxidant activity and sensory score of the blends was recorded to decrease with the advancement of storage period.

6.8 Cost of production

The cost of production of different juice blends of summer fruits and vegetables ranged in between Rs. 5.25 (apple: pear) and Rs. 15.98 (apple: mango: jamun: bottlegourd) for 200 mL glass bottle whereas, for winter season fruits and vegetables it was in between Rs. 8.87 (kinnow: red grapes: papaya: cabbage) and Rs 18.26 (kinnow: red grapes) for 200 mL glass bottle.

Conclusion

Summer and winter season fruits (apple, sand pear, mango, jamun, Kinnow, papaya, red grapes and aonla) and vegetables (bottlegourd, bittergourd, pumpkin, tomato, carrot, beetroot and cabbage) utilization for the preparation of blended two fruit juices, three fruit juices, two fruit and one vegetable juices and three fruit and one vegetable juice blends indicated that the fruit and/or vegetable juices/pulps which are unacceptable due to their insipid taste/aroma or other undesirable physical and chemical characteristics can best be developed into refreshing and natural juices with high sensory quality. At the same time, blending enriched the juices with one or more functional ingredients like ascorbic acids, polyphenolics, carotenoids, anthocyanins which otherwise were either present in negligible proportion in the original juice/pulp of the fruit/vegetable or were completely absent in some juices/pulps. For instance, the apple and Kinnow juice as such were lacking in carotenoids and anthocyanins, respectively. Blending of different juices/pulps showed high antioxidant potential of the blended product e.g. the antioxidant activity of pure Kinnow juice was about 23% which increased on blending to 60-65% depending upon the type of fruit/vegetable contained in the developed blend. Therefore, blending of pulpy fruits and/or vegetables with the juicy one could be an effective approach to exploit the functional properties of selected fruits and vegetables. Further, the production and availability of these functional juices with high antioxidant potential will add variety in the category of healthy juices in the market besides, ensuring good returns to the growers for their produce which otherwise is not that remunerative particularly bottlegourd, pumpkin, carrot, cabbage and sand pear.

REFERENCES

Chapter-7

REFERENCES

Abdel-Kader ZM. 1991. Determination of carotenoids in foods by high-performance liquid chromatography. *Nahrung*. **35**: 689-693

Acquaviva R, Russo A and Galvano F. 2003. Cyanidin and cyanidin 3-*O*-beta-D-glucoside as DNA cleavage protectors and antioxidants. *Cell Biol. Toxicol*. **19**(4): 243–252

Adams JB. 1973. Thermal degradation of anthocyanins with particular reference to the 3-glycosides of cyanindin I in acidified aqueous solution at 100^{o}C deg. *J. Sci. Food Agric*. **24**: 747-762

Aggarwal P, Singh B and Sidhu JS. 1995. Studies on the physico-chemical and processing characteristics of some newly evolved tomato cultivars for making juice and concentrates. *Ind. Food Pckr.* **49**: 45-53

Ahire DB, Kulkarnj SS and Satbhat RD. 2010. Studies on extraction, packaging and storage of pomegranate juice. *Bev. Food World.* **37**(1): 66-68

Ahmed AA, Watrous GH, Hargrove GL and Dimick PS. 1976. Effect of fluorescent light on flavour and ascorbic acid retention in refrigerated orange juice and drinks. *J. Milk Food Technol*. **39**: 322-336

Ahmed J, Shivahare US and Raghavan GSV. 2004. Thermal degradation kinetics of anthocyanins and visual colour of plum puree. *Eur. Food Res. Technol*. **218**: 525-528

Ahmed M, Ahmad A, Chatha ZA and Dilshad SMR. 2008. Studies on preparation of ready-to-serve mandarin (*Citrus reticulata*) diet drink. *Pak. J. Agric. Sci.* **45**(4): 234-237

Akinwale TO. 2000. Cashew apple juice: its use in fortifying the nutritional quality of some tropical fruits. *Eur. Food Res. Technol.* **211**: 205-207

Alam MI and Gomes A, 2003. Snake venom neutralization by Indian medicinal plants (*Vitex negundo* and *Emblica officinalis*) root extract. *J. Ethnopharmacol.* **86**: 75–80

Albrecht JA, Schafer HW and Zottola EA. 1991. Relationship of total sulfur to initial and retained ascorbic acid in selected cruciferous and noncruciferous vegetables. *J. Food Sci*. **55**: 181-183

Alkesh. 2001. Evaluation of some low chilling apple cultivars for dehydration and development of dehydrated fruit based products. M.Sc. Thesis, Dr Y S Parmar University of Horticulture and Forestry, Nauni, Solan, Himachal Pradesh, India

Almeida A, Callou KRD, Sadigov S, Lajolo FM and Genovese MI. 2010. Isoflavones and antioxidant capacity of commercial soy-based beverages: effect of storage. *J. Agric. Food Chem*. **58**: 4284–4291

Almeida LB and Penteado MVC. 1987. Carotenóides com atividade pró-vitamínica A de cenouras (*Daucus carota* L.) comercializadas em Sao Paulo, Brasil. *Rev. Farm. Bioquím. Univ. S. Paulo.* **23**:133-141

Al-Rehaily AJ, Al-Howiriny TA, Al-Sohaibani MO and Rafatullah S. 2002. Gastroprotective effects of “amla” *Emblica officinalis* on *in vivo* test models in rats. *Phytomed.* **9**: 515–522

Amerine MA, Pangborn RM. and Rossler EB. 1965. Principles of sensory evaluation of food. Academic Press, New York

Ames B, Shigenanga M and Hagen T. 1993. Oxidants, antioxidants and the degenerative diseases of aging. *Biomed. Pharmacoth.* **90**: 7915-7922

Ames BM. 1998. Dietary carcinogens and anticarinogens: Oxygen radicals and degenerative diseases. *Sci.* **221**:1256-1263

Anese M, Lpittia P and Nicoli MC. 1993. Oxygen consuming properties of heated glucose-glycine aqueous solution. *Ital. J. Food. Sci*. **1**: 75-79

Anonymous. 2000. White book on the antioxidants in tomatoes and tomato products and their health benefits. Final report of the Concerted Action Fair C T. 97-3233

Anonymous. 2001. USDA Agricultural Research Service (ARS) National nutrition database for standard reference.

Anonymous. 2009. Food and Agricultural Organization. Principles and practices of small- and medium-scale fruit juice processing. Chapter 9, Juice and beverage blends, Agriculture and consumer protection, FAO Corporate Document Repository

Anonymous. 2010. Indian Horticulture Database. National Horticulture Board. Ministry of Agriculture. Govt of India. Gurgaon Haryana. pp 33-126

AOAC. 2004. Official Methods of Analysis of the Association of Official Analytical Chemists. 20th edn. Association of Official Analytical Chemists, Washington DC

Arena E, Fallico B and Maccarone E. 2001. Evaluation of antioxidant capacity of blood orange juices as influenced by constituents, concentration process and storage. *Food Chem.* **74**: 423–427

Asenjo CF. 1953. Story of the West Indian cherry. (*Malpighia punicifolia*, L.) colegio del quimicoa de Puerto Rico. *Boletin (San Juan, Puerto Rico).* **10**: 1-11

Attri BL, Lal BB and Joshi VK. 1998. Physico-chemical characterstics, sensory quality and storage behaviour of sand pear juice blended with temperate fruit juices/pulp. *Ind. Food Pckr*. **52**(6): 36-42

Awad M, de Jager A and Westing L. 2000. Flavonoid and chlorogenic acid levels in apple fruit: characterisation of variation. *Scientia Hort.* **83**: 249-263

Azizah AH, Wee KC, Azizah O and Azizah M. 2009. Effect of boiling and stir frying on total phenolics, carotenoids and radical scavenging activity of pumpkin (*Cucurbita moschato*) *Int. Food Res. J.* **16***:* 45-51

Babsky JE, Toribio JL and Lozano JE. 1986. Influence of storage on the composition of clarified apple juice concentrate. *J. Food Sci*. **51**(3): 564-567

Bagchi D, Bagchi M, Stohs SJ, Das DK, Ray CA, Kuszynski SS and Joshi HG. 2000. Free radicals and grape seed proanthocyanidin extract: importance in human health and disease prevention. *Toxicol.***148**: 187–197

Bala S, Ram S and Prasad J. 2009. Studies on variabitity and genetic diversity in selected Aonla genotypes. *Ind. J. Hort*. **66** (4): 433-437

Balaswamy K, Rao PP, Nagender A, Satyanarayana A. 2011. Preparation of sour grape (*Vitis vinifera*) beverages and evaluation of their storage stability. *J. Food Process. Technol.* **2**:116

Bender AE. 1958. Stability of vitamin C in commercial fruit squashes. *J. Sci. Food Agric*. **9**: 754-760

Benherlal PS and Arumughan C. 2007. Chemical composition and in vitro antioxidant studies on *Syzygium cumini* fruit. *J. Sci. Food Agric.* **87**: 2560–2569

Bhardwaj R L and Mukherjee S. 2011. Effects of fruit juice blending ratios on Kinnow juice preservation at ambient storage condition. *Afri. J. Food Sci*. **5**(5):281-286.

Bingham S and Riboli E. 2003. Diet and cancer: the European prospective investigation into cancer and nutrition. *Nat. Rev. Cancer*. **4**(3): 206-215

Bisset OW and Berry RE. 1975. Ascorbic acid retention in orange juice as related to container type. *J. Food Sci*. **40**: 178-180

Block G, Patterson B and Subar A. 1992. Fruit, vegetables and cancer prevention: a review of the epidemiological evidence. *Nutr. Cancer* **18**: 1-29

Bose TK and Mitra SK. 1996. Fruits: tropical and subtropical. Naya Prokash, Calcutta

Boyer J and Liu RH. 2004. Apple phytochemicals and their health benefits. *Nutri. J.* **3**:1-15

Brand-Williams W, Cuvelier ME and Berset C. 1995. Use of a free radical method to evaluate antioxidant activity. *Leben. Wiss. U.Tech*. **28**: 25-30

Bray HG and Thorpe WV. 1954. Standard methods of biochemical analysis. Kalyani Publishers, New Delhi

Bray TM. 2000. Dietary antioxidants and assessment of oxidative stress. *Nutr.* **16**: 578–581

Britton G. 1995. Structure and properties of carotenoids in relation to function. *FASEB J*. **9**: 1551–1558

Brouillard R. 1982. Chemical structure of anthocyanins. In: Markakis, P (ed.). Anthocyanins as food colours. Academic Press, New York

Buglione M and Lozano J. 2002. Nonenzymatic browning and chemical changes during grape juice storage. *J. Food Sci.* **67**(4): 1538-1543

Buijsse B, Feskens EJ and Schlettwein-Gsell D. 2005. Plasma carotene and alpha-tocopherol in relation to 10-y all-cause and cause-specific mortality in European elderly: the Survey in Europe on Nutrition and the Elderly: a Concerted Action (SENECA). *Am. J. Clin. Nutr*. **82**: 879-886

Burdulu HS, Koca N and Karadeniz F. 2006. Degradation of vitamin C in citrus juice concentrates during storage. *J. Food Eng.* **74**: 211-216

Candenas E and Packer L. 1996. Handbook of antioxidants. Plenum, New York

Cantos E, Espin JC and Tomas-Barberan FA. 2002. Varietal differences among the polyphenol profiles of seven table grape cultivars studied by LC-DAD-MS-MS. *J. Agric. Food Chem.* **50**: 5691–5696

Carvalho JM, Maia GA, Figueiredo RW, Brito ES and Rodrigues S. 2007. Storage stability of a stimulant coconut water-cashew apple juice beverage. *J. Food Process. Preserv.* **31**: 178-189

Chacona MR, Ceperuelo-Mallafrea V, Maymo-Masipa E, Mateo-Sanzb JM, Arolac L, Guitierreza C, Fernandez-Reald JM, Ardevolc A, Simona I and Vendrella J. 2009. Grape-seed procyanidins modulate inflammation on human differentiated adipocytes *in vitro*. *Cytokine*.**47**: 137–142

Chandel V. 2011. Studies on functionally enriched fruit rolls. M. Sc. Thesis. Dr. Y S Parmar University of Horticulture and Forestry, Nauni, Solan, Himachal Pradesh, India

Chandler LA and Schwartz SJ. 1988. Isomerization and losses of *trans*-α-carotene in sweet potatoes as affected by processing treatments. *J. Agric. Food Chem.* **36**:129-133

Chang MM, Chan TK and Chang YH. 2000. A study on pink discoloration of canned sand pear (*Pyrus pyrifolia* Nakai). *Food Preserv. Sci*. **26**: 161–165

Chaudhary MI. 1994. Fruit crops in horticulture. National Book Foundation, Islamabad

Chen X, Liu J, Gu X and Ding F. 2008. Salidroside attenuates glutamateinduced apoptotic cell death in primary cultured hippocampal neurons of rats. *Brain Res.***1238**:189-198

Cho J, Kang J, Long P, Jing J, Back Y and Chung K. 2003. Antioxidant and memory enhancing effects of purple sweet potato anthocyanin and *Cordyceps* mushroom extract. *Arch. Pharm. Res*. **26**(10): 821-825

Chu YF, Sun J, Wu X and Liu R H. 2002. Antioxidant and antiproliferative activities of common vegetables. *J. Agric. Food Chem*. **50**: 6910 – 6916

Clemens R and Dubost J. 2008. Juicy approach to health. *Food Technol*. **6**: 27-28

Clifford M N. 2000. Anthocyanins-natural occurrence and dietary burden. *J. Sci. Food Agric.* **80**: 1063-1072

Conn EE and Stumpt PK. 1976. Outlines of biochemistry. Willey Eastern Ltd, New York

Connor AM, Luby JJ, Hancock JF, Berkheimer S and Hanson EJ. 2002. Changes in fruit antioxidant activity among blueberry cultivars during cold-temperature storage, *J. Agric. Food Chem.* **50**: 893–898

Considine M. 1982. Food and food production encyclopedia. *Van-Nostrand.* **24**(3): 123-127

Cortis C, Esteno MJ, Frigola A and Terregrosa F. 2005. Changes in carotenoids including geometrical isomers and ascorbic acid content in orange – carrot juice during frozen storage. *Eur. Food Res. Technol.* **221**: 125-131

Costa MCO, Maira GA and De Figueiredo RW. 2003. Storage stability of cashew apple juice preserved by hot fill and aseptic processes. *Cience. Technol. Aliment. Companies*. **23**: 106-109

Das JN. 2009. Studies on storage stability of Jamun beverages. *Ind. J. Hort.* **66** (4): 508-510

Das NP and Pereira TA. 1990. Effects of flavonoids on thermal autooxidation of palm oil: structure-activity relationship. *J. Am. Oil Chem. Soc.* **67**: 255-258

Deka B C, Sethi V and Saikia A. 2005. Changes in quality of mango-pineapple spiced beverage during storage. *Ind.J. Hort.* **62**(1): 71-75

Deka BC and Sethi V. 2001. Preparation of mixed fruit juice spiced RTS beverages. *Ind. Food Pckr*. **42**(3): 58-61

Deka BC, Sethi V, Suneja P and Sriastava VK. 2004. Physico-chemical changes of lime-aonla spiced beverage during storage. *J. Food Sci. Technol.* **41**: 329-332

Deka BC. 2000. Preparation and storage of mixed fruit juice spiced beverage. Ph.D. Thesis, Indian Agricultural Research Institute, New Delhi, India

DeMan JM. 1980. Vitamins. *In*: Principles of food chemistry. AVI Publishing Co., Westport

Deore SL. 2009. *In vitro* antioxidant activity and quantitative estimation of phenolic content of *Lagenaria siceraria. RASAYAN J.* **2**(1):129-132

Deshpande HR, Choudhari AA, Mishra MR, Mehgre VS, Wadhokar SG and Dorke AK. 2008. Benefical effects of *Lagehria siceraria* (Mol.) Standley fruit epicarp in animal models. *Ind. J. Exp. Biol.* **46**: 234-242

Dewanto V, Wu X, Adom KK and Liu RK. 2002. Thermal processing enhances the nutritional value of tomatoes by increasing total antioxidant activity. *J. Agric. Food Chem.* **50**: 3010-3014

Dhaigude G. 2010. Value added products from wild pomegranate. M. Sc. Thesis. Dr Y S Parmar University of Horticulture and Forestry, Nauni, Solan, Himachal Pradesh, India

Dhaliwal M and Hira CK. 2001. Effect of storage on physico-chemical and nutritional characteristics of carrot-beetroot and carrot-black carrot juices. *J. Food Sci.Technol.* **38**(4): 343-347

Dhiman AK, Sharma KD and Attri S. 2009. Functional constituents and processing of pumpkin: a review. *J. Food Sci. Technol.* **46**(5): 411-417

Dixon RA and Paiva NL. 1995. Stress-induced phenylpropanoid metabolism. *Plant Cell*.**7**: 1085-1097

Djutin KE. 1991. Pumpkin: nutritional properties. *Pot. Veg.* **3**: 25-26

Dopico-Garcia MS, Fique A, Guerra L, Afonso JM, Pereira O, Valentao P, Andrade PB and Seabra RM. 2008. Principal components of phenolics to characterize red Vinho Verde grapes: anthocyanins or non-coloured compounds. *Talanta.* **75**: 1190–1202

Doss A and Dhanbalan R. 2009. Antioxidant activity of commonly used vegetables. *Ind. J. Nutr. Diet.* **46**: 257-259

Drdak M and Vallova M. 1990. Kinetics of the thermal degradation of betanine. *Die Nahrung*. **34**: 307–310

Duda-Chodak AD, Tarko T, Srora P and Satora P. 2008. Antioxidant activity of different kinds of commercially available teas and changes during storage. *Electron J. Pol. Agric. Univ.* **11**(4): 7

Eder P. 1996. Group Polyphenols. *Polyphenol Commun*. **2**: 277-278

Edwards CG and Lee CY. 1986. Measurement of provitamin A carotenoids in fresh and canned carrots and peas. *J. Food Sci.* **51**: 534-535

Eiro MJ and Heinonen M. 2002. Anthocyanin colour behavior and stability during storage: effect of intermolecular copigmentation. *J. Agric. Food Chem.* **50**: 7461–7466

Ejechi BO, Souzey JA, Akpomedaya DE. 1998. Microbial stability of mango juice presented by combined application of mild heat and extracts of two tropical spices. *Food Prod*. **61**(6): 725-727

El Sheikha AF. 2004. Technological, chemical and microbiological studies on some packed foods. M.Sc. Thesis. Faculty of Agriculture, Minufiya University, Egypt

El-Bastawesy AM, Lobna AMH, El-Malky WA. 2008. Production and evaluation of nutraceutical vegetable juice blends. *Arab Univ. J. Agric. Sci.* **16** (2): 389-396

Elsayed NM. 2001. Antioxidant mobilization in response to oxidative stress: a dynamic environmental nutrition intervention. *Nutr.* **17**: 828–834

El-Sharouny NF. 2006. Preparing new blends of fruit juices to meet the needs of the potent antioxidant effects. *Arab Univ. J. Sci.* **14**(1): 289-297

Erasto P. 2009. Antioxidant activity and HPLC profile of *Lagenaria siceraria* fruits *Tanzania J. Health Res*. **11**(2): 79-83

Escarpa A and Gonzalez M. 2001. High performance liquid chromatography with diode-array detection for the performance of phenolics compounds in peel and pulp from different apple varieties. *J. Chromat.* **823**: 331-337

Escribano J, Pedreno MA, Garcia-Carmona F and Munoz R. 1998. Characterization of the antiradical activity of betalains from *Beta vulgaris* L. roots. *Phytochem. Analy*. **9**(3): 124−127

Ewaidah EH. 1992. Studies on commercially canned juices locally in Saudia Arabia. Physiochemical, organoleptic and microbiological assessment. *Food Chem*. **44**: 103-111

Falade OS, Sowunmi OR, Oladipo A, Tobosun A and Adewusi SRA. 2003. The level of organic acids in some Nigerian fruit and their effect on mineral availability in composite diet. *Pak. J. Nutr*. **2**(2): 82-83

Fang S. 2008. Physico-chemical and organoleptic evaluations of wheat bread substituted with different percentage of pumpkin flour *(Cucurbita moschata)*. M. Sc. Thesis. Universiti Sains, Malaysia

Fasuyi AO. 2006. Nutritional potentials of some tropical vegetable leaf meals: chemical characterization and functional properties. *Afr. J. Biotechnol.* **5** (1): 49-53

Figueredo E, Cuesta HG, Mintuez A, Vidarte L, Pastor C, De Las HM, Vivanco S and Lohoz C. 2000. Allergy to pumpkin and cross reactivity to other cucurbitaceae fruits. *J. Allergy Clinic. Immunol.* **106** (2): 402-403

Fletcher AE, Breeze E and Shetty PS. 2003. Antioxidant vitamins and mortality in older persons: findings from the nutrition add-on study to the Medical Research Council trial of assessment and management of older people in the community. *Am. J. Clin. Nutr*. **78**: 999 –1010

Flora LF. 1979. Optimum quality parameters of muscadine grape juices, beverages, and blends. *J. Food Qual*. **2**: 219-229

Franke AA, Custer LJ, Arakaki C and Murphy SP. 2004. Vitamin C and flavonoid levels of fruits and vegetables consumed in Hawaii. *J. Food Comp. Anal.* **17**: 1-35

Gaertner V and Goldman IL. 2005. Pigment distribution and total dissolved solids of selected cycles of table beet from a recurrent selection program for increased pigment. *J. Amer. Soc. Hort. Sci.* **130**: 424–433

Gahler S, Otto K and Bohm V. 2003. Alterations of vitamin C, total phenolics, and antioxidant capacity as affected by processing tomatoes to different products. *J. Agric. Food Chem.* **51**: 7962-7968

Garande VK and Joshi GD. 1995. Storage of Jamun products. *Asian Food J.* **10**: 54-56

Gardener PT, White TAC, Mc Phaid DB and Duthie GG. 2002. Relative contribution of vitamin C, carotenoids and phenolics to the antioxidant potential of fruit juices. *Food Chem.* **68**: 471-474

Garg A. 2010. Studies on processing and development of carbonated spiced RTS drink from bittergourd and amla fruit. *Proc. Food Ind.* **11**: 23-26

Garzon GA and Wrolstad RE. 2002. Comparison of the stability of pelargonidin-based anthocyanins in strawberry juice and concentrate. *J. Food Sc*i. **67**: 1288–1299

Gasztonyi MN, Daood H, Hajos MT and Biacs P. 2001. Comparison of red beet (*Beta vulgaris* var. Conditiva) varieties on the basis of their pigment components. *J. Sci. Food Agric*. **81**: 932–933

Gentile C, Tesoriere L, Allegra M, Livrea MA and D'Alessio P. 2004. Antioxidant betalains from cactus pear (*Opuntia ficus-indica*) inhibit endothelial ICAM-1 expression. *Signal Transd. Comm. Cancer Cells*. **10**(28): 481–486

Ghodke SK and Chintapalli S. 2009. Neutraceuticals: role of carotenoids. *Bev. Food World*. **36**(10): 27-35

Gil MI, Aguayo E and Kader AA. 2006. Quality changes and nutrient retention in fresh cut vs. whole fruits during storage. *J. Agric. Food Chem.* **54**(12): 4284-4296

Gil MI, Ferreres F and Thomas-Barberan FA. 1999. Effect of postharvest storage and processing on the antioxidant constituents (flavonoids and vitamin C) of fresh-cut spinach. *J. Agric. Food Chem*. **47**: 2213–2217

Godoy HT and Rodriguez-Amaya DB. 1996. Occurrence of *cis*-isomers of provitamin A in Brazilian vegetables. *J. Agric. Food. Chem.* **42**: 1306-1313

Gokmen V, Artik N, Acar J, Kaliraman K and Poyrazoglu E. 2001. Effect of various clarification methods on patulin, phenolic compounds and organic acids composition of apple juice. *Eur. Food Technol.* **57**: 26-36

Gorinstein S, Martin-Belloso O, Park YS, Haruenkit R, Lojek A, Ciz M, Caspi A, Libman I and Trakhtenberg S. 2001. Comparison of some biochemical characteristics of different citrus fruits. *Food Chem.* **74**: 309–315

Gorinstein S, Zachwieja Z, Katrich E, Pawelzik E, Haruenkit R, Trakhtenberg S and Martin-Belloso O. 2004. Comparison of the contents of the main antioxidant compounds and the antioxidant activity of white grapefruit and his new hybrid, *Leb-Wiss Technol.* **37**: 337–343

Gowda IND. 1995. Studies on blending of mango and papaya pulp for Ready-to-serve beverage making. Proceedings of the National Seminar on Post Harvest Technology of fruits held from 7-9th Aug at Banglore

Goyal PK, Verma P and Sharma P. 2010. Evaluation of anticancer and antioxidative potential of *Syzygium cumini* against benzo(a) pyrene (BaP) induced gastric carcinogenesis in mice. *Asian Pac. J. Cancer Prev.* **11**: 753-758

Goyal R and Kshetarpaul N. 1994. Preparation and fermentation of rice-defatted soya flour blends: effect on protein, fat and ash content. *Plant Foods Hum. Nutr.* **45**: 81-89

Grover JK and Yadav SP. 2004. Phamacological actions and potential uses of *Momordica charantia* a review. *J. Ethnopharmacol.* **93**: 123-132

Gutteridge JMC and Halliwell B. 2000. Free radicals and antioxidants in the year 2000-a historical look to the future. *Ann. Newyork Acad. Sci.* **899**: 136-147

Halliwell B. 1994. Free radicals, antioxidants and human disease: curiosity cause or consequence. *Lancet.* **344**: 721-724

Halliwell B. 1995. Antioxidant: characterization methodology and mechanism. *Biochem. Pharmacol*. **49**: 1341-1348

Hamauzu Y, Yashui H, Inno T, Kumhe C and Omanyuda M. 2005. Phenolic profile, antioxidant property and anti influenza viral activity of Chinese quince (*Pseudocydonia sinensis* Schneid.), quince (*Cydonia oblonga* Mill.) and apple (*Malus domestica* Mill.) fruits. *Medline J. Agric. Food Chem.* **53**(4): 928-934

Haque R, Bin-Hafeez B, Ahmad I, Parvez S, Pandey S and Raisuddin S. 2001. Protective effects of *Emblica officinalis* Gaertn. In cyclophosphamide-treated mice. *Hum. Exp. Toxicol.* **20**: 643–650

Heinonen IM, Meyer AS and Frankel EN. 1989. Antioxidant activity of berry phenolics on human low density lipoprotein and liposome oxidation. *J. Agric. Food Chem*. **46**: 4107-4112

Henshall JD. 1982. Ascorbic acid in fruit juices and beverages. *In*: Counsell JN and Horning DH (eds). Appied Science Publishers, London

Hertog MGL, Hollman PCH and Kartan MB. 1993. Content of potentially anticarcinogenic flavonoids of 28 vegetables and 9 fruits commonly consumed in the Netherland. *J Agric. Food Chem.* **40**: 2379-2383

Holland B, Unwin JD and Buss DH. 1991. Vegetables, herbs and spices: fifth supplement to McCance and Widdowson’s, London

Howard LA,Wong AD, Perry AK and Klein BP. 1999. β-Carotene and ascorbic acid retention in fresh and processed vegetables. *J. Food Sci.* **64**: 929-936

Huang AS and Von Elbe JH. 1985. Kinetics of the degradation and regeneration of betanine. *J. Food Sci.* **50**: 1115–1129

Hussain I, Zeb A and Ayub M. 2011. Evaluation of apple and apricot blend juice preserved with sodium benzoate at refrigeration temperature. *World J. Dairy Food Sci*. **6**(1): 79-85

Hussain T. 2001. Food composition table for Pakistan. Govt. of Pakistan, Ministry of P and D Islamabad, Pakistan

Idouraine A, Kohelhepp EA, Weber CW, Warid WA and Martinez-tellez JJ. 1996. Nutrient constituent from eight lines of naked seed squash (*Cucurbita pepo* L.). *J. Agric. Food Chem.* **44**: 721-724

Imeh U and Khokhar S. 2002. Distribution of conjugates and free phenols in fruits: antioxidant activity and cultivar variations, *J. Agric. Food Chem.* **50**: 6301–6306

Jain S, Sankhla APK, Dashora A and Sankhla AK. 2003. Physiochemical and sensory properties of orange drink. *J. Food Sci. Technol.* **40**(6): 656-659

Jain SK and Khurdiya DS. 2004. Vitamin C enrichment of fruit juice based ready-to-serve beverages through blending of Indian gooseberry (*Emblica officinalis* Gaertn.) juice. *Plant Foods Hum. Nutr*. **59**(2): 63-66

Jawanda JS, Singh R and Kumar K. 1978. Studies on extending postharvest life of kinnow mandarin. *Punjab Hort. J.* **18**: 149-153

Jie M. 2002. Antioxidant and antiproliferative activities of common fruits. *J. Agric. Food. Chem*. **50**: 7449-7454

Jilani MS, Bibi F, Waseem K and Khan MA. 2010. Evaluation of physico-chemical characteristics of mango (*Mangifera indica* L.) cultivars grown in D I Khan. *J. Agric. Res.* **48**(2): 201-207

Johns T and Eyzyguire PB. 2006. Linking biodiversity, diet and health in policy and practice. *In*: Syposium on wild-gathered plants: basic nutrition, health and survival. *Proc. Nutr. Soc.* **65**: 182-89

Joseph JA, Shukitt HB and Wills LM. 2009. Grape juice, berries and walnuts affect brain aging and behaviors. *J. Nutr*. **6**(11): 18135-18175

Joshipura K, Manson HF, Stampfer M, Rimm E, Speizer F, Colditz G, Ascherio A, Rosner B, Spiegelman D and Willett W. 2001. The effect of fruit and vegetable intake on risk of coronary heart disease. *Ann. Int. Med.* **134**: 1106-1114

Kader F, Irmouli M, Nicolas JP, Metche M. 2002. Involvement of blueberry peroxidase in the mechanisms of anthocyanin degradation in blueberry juice. *J. Food Sci*. **67**: 910–5

Kalra SK, Tondon DK and Singh BP. 1991. Evaluation of mango-papaya blended beverage. *Ind. Food Pckr*. **45**(1): 33-36

Kalt W. 2005. Effects of production and processing factors on major fruit and vegetables antioxidants. *J. Food Sci.* **70**(1): R11-R18

Kannan S and Thirumaran AS. 2001. Studies on storage life of jamun products. *Ind. Food Pckr*. **55**(6): 125-127

Kanner J, Harel S and Granit R. 2001. Betalains- a new class of dietary cationized antioxidants. *J. Agric. Food Chem*. **49**: 5178–5185

Kapasakalidis PG, Rastali RA and Gordon MH. 2006. Extraction of polyphenols from processed blackcurrant (*Ribes nigrum* L.) *J. Agric. Food Chem*. **54**: 4016-4021

Kapoor LD. 1990. Handbook of ayurvedic medicinal plants. CRC Press, Boca Raton

Karl JH and John MF. 2002. The antioxidant activity and composition of fresh, frozen, jarred and canned vegetables. *Innov. Food Sci. Emerg. Technol.* **3**: 399–406

Kaunjoso BWT and Luh BS. 1967. Texture, Pectin and syrup viscosity of canned cling peaches. *Food Technol*. **21**(3): 139-142

Kaur C and Kapoor HC. 2005. Antioxidant activity of some fruits in indian diet. *Acta Hort.* **696**: 563-565

Kaur C, George B, Deepa N, Singh B and Kapoor HC. 2004. Antioxidant status of fresh and processed tomato: a review. *J. Food Sci. Tech*. **41**(5):479-486

Kawashima A, Madarame T, Koike H, Komatsu Y and Wise JA. 2007. Four week supplementation with mixed fruit and vegetable juice concentrates increased protective serum antioxidants and folate and decreased plasma homocysteine in Japanese subjects. *Asian Pac. J. Clin. Nutr.* **16**(3): 411-421

Khachik F, Beecher GR and Whitaker NF. 1987. Separation, identification, and quantification of the major carotenoid and chlorophyll constituents in extracts of several green vegetables by liquid chromatography. *J. Agric. Food Chem.* **34**: 603-616

Khan I, Shah ZA, Saeed M and Shah HU. 2010. Physico-chemical analysis of *Citrus sinensis, Citrus reticulata* and *Citrus paradisi. J. Chem. Soc. Pak.* **32**(6): 774-780

Khanizadeh S, Ding L, Tsao R, Rekika D, Yang R, Marie-Thérèse C, Vigneault C and Vasantha R. 2007. Phytochemical distribution among selected advanced apple genotypes developed for fresh market and processing. *J. Agric. Food Chem.* **55**(2): 321-329

Khaw KT, Bingham S and Welch A. 2001. Relation between plasma ascorbic acid and mortality in men and women in EPIC-Norfolk prospective study: a prospective population study. European Prospective Investigation into Cancer and Nutrition. *Lancet*. **357**: 657-663

Khurdiya DS and Anand JC. 1981. Effect of storage temperature on quality of phalsa beverage. *J. Food Sci*. *Technol*. **4**: 18-16

Kiefer I, Prock P, Lawrence C, Wise J, Bieger W and Bayer P. 2004. Supplementation with mixed fruit and vegetable juice concentrates increased serum antioxidants and folate in healthy adults. *J. Am. College Nutr.* **23**(3): 205−211

Kinh SAEH, Dunne CP and Hoover DG. 2001. Preparation and preservation of apple pulp with chemical preservatives and mild heat. *J. Food Prot.* **28**(6): 111-114

Kirca A and Cemeroglu B. 2003. Thermal stability of black carrot anthocyanins in blood orange juice. *J. Food Qual.* **26**(5): 361-366

Kirca A, Ozkan M and Comeroglu B. 2003. Stability of black carrot anthocyanins in various fruit juices and nectars. *Food Chem.* **97**(4): 598-605

Knoops KT, de Groot LC and Kromhout D. 2004. Mediterranean diet, lifestyle factors, and 10-year mortality in elderly European men and women: the HALE project. *JAMA.* **292**:1433-1439

Kohen R and Shalhoub R. 1994. Prevention and reduction of oxidative damage in *E. coli* cells by cationized proteins. *Free Rad. Biol. Med.* **16**: 571-590

Kopas-Lane LM and Warthesen JJ. 1995. Carotenoid photostability in raw spinach and carrots during cold storage. *J. Food Sci.* **60**: 773-776

Kris EPM, Hecker KD, Bonanome A, Coval SM, Binkoski AE, Hilpert KF, Griel E and Etherton TD. 2002. Bioactive compounds in foods: their role in the prevention of cardiovascular disease and cancer. *Am. J. Med*. **113**: 71S-88S

Krishna KL, Paridhan M and Patel JA. 2008. Review on nutritional, medicinal and pharmacological properties of papaya (*Carica papaya* Linn.*). Nat. Prod. Rad.* **7**(4): 364-374

Krishnaveni A, Manimegalai G and Saravana KR. 2001. Storage stability of jackfruit RTS beverage. *J. Food Sci. Technol.* **38**: 601-602

Kubde MS, Khadabadi SS and Farooqui IA and Deore SL. 2010. *Lagenaria siceraria*: phytochemistry, pharmacognosy and pharmacological studies. *Report and Opinion*. **2**(3): 91-98

Kujala TS, Loponen JM, Klika KD and Pihlaja K. 2000. Phenolics and betacyanins in red beetroot (*Beta vulgaris*) root: distribution and effect of cold storage on the content of total phenolics and three individual compounds. *J. Agric. Food Chem.* **48**(11): 5338-5342

Kumar M and Ghuman BS. 2007. Quality changes in processed sand pear slices during storage. *J. Food Sci. Technol*. **44**: 272–275

Kumar R, Kaushik RA and Chharia AS. 1992. Effect of postharvest treatment on the quality of mango during storage. *Haryana J. Hort. Sci.* **21**(1-2): 49

Kumar N, Charanjit KK, Jyothi R, Sagar R and Sadananda GK. 2010. Variations in antioxidant activity in carrot (*Daucus carota* L.) genotypes. *Prog. Agric.* **10**(1): 59-63

Lachance PA, Nakat Z and Jeong W. 2001. Antioxidants: an integrative approach. *Nutr.* **17**: 835–838

Lakhanpal P. 2010. Development and evaluation of honey enriched fruit nectars. M. Sc. Thesis. Dr Y S Parmar University of Horticulture and Forestry, Nauni, Solan, Himachal Pradesh, India

Lal BB and Sharma TR. 1989. Apricot: a potential fruit for processing. *Ind. Hort.* **33**: 11-14

Lambertini E, Piva R, Khan MT, Lampronti I, Bianchi N, Borgatti M and Gambari R. 2003. Effects of extracts from Bangladeshi medicinal plants on in vitro proliferation of human breast cancer cell lines and expression of estrogen receptor alpha gene. *Int. J. Oncolog.* **24**: 419–423

Lane JH and Eynon L.1923. Determination of reducing sugar by Fehling's solutions with methylene blue as indicator. *J. Soc. Chem. Ind.* **42**: 32

Langthasa S. 1999. Processing and preservation of apple pulp. Ph. D. thesis, Indian Agricultural Reasearch Institute, New Delhi, India

Lanjhiyana R, Sharma PK and Shukla N. 2010. Studies on effect of chemical preservatives on physico-chemical changes of beverages in lime and ginger juice with their combinations. *J. Hort. Sci.* **5**(2): 151-154

Lavelli V, Pompei C and Casadei M A. 2009. Quality of nectarine and peach nectars as affected by lye peeling and storage. *Food Chem.* **115**(4): 1291-1298

Lazze MC, Pizzala R, Savio M, Stivala LA, Prosperi E and Bianchi L. 2003. Anthocyanins protect against DNA damage induced by tert-butylhydroperoxide in rat smooth muscle and hepatoma cells. *Mutat. Res.* **535**: 103-115

Lee CY. 1999. Browning reactions: enzymatic. *In*: Francis FJ, *ed*. Encyclopedia of food science and technology. 2nd edition. New York, Willey

Lefevre M, Howard L, Most M, Ju Z and Delany J. 2004. Microarray analysis of the effects of grape anthocyanins on hepatic gene expression in mice. *FASEB J*. **18**: A851

Lim P, Wuenschell GE, Holland V, Lee D, Pfeifer GP, Rodriguez H and Termini J. 2002. Peroxyl radical mediated oxidative DNA base damage: implications for lipid peroxidation induced mutagenesis. *Biochem.* **43**: 15339–15348

Lin CH and Chang CY. 2005. Textural changes and antioxidant properties of broccoli under different cooking treatments. *Food Chem.* **90**: 9-15

Liu RH and Hotchkins JH. 1995. Potential genotoxicity of chronically elevated nitric oxide: a review. *Mutat. Res.* **339**:73-89

Liu RH. 2010. Potential synergy of phytochemicals in cancer prevention: mechanism of action. *J. Nutr.* **4:** 3479S-3485S

Lu G, Edwards CG, Fellman JK, Mattinson DS and Navazio J. 2003. Biosynthetic origin of geosmin in red beets (*Beta vulgaris* L.). *J. Agric. Food Chem.* **51**: 1026–1029

Ma L. 2004. Analysis of major activity constituents in Easter pear by high performance liquid chromatography. M. Sc. Thesis. Hebei Agricultural University, PR China

Madan S and Dhawan SS. 2005. Studies on development of bottled carrot juice and osmo-dehydrated carrot slices. *Bev. Food World.* **32**(5): 15-19

Mahony MO. 1985. Sensory evaluation of food. *In*: Statistical methods and procedures. Marcel Dekker Inc., New York

Majumdar TK and Sharma SK. 1990. Mango. *In*: Bose TK and Mitra SK (eds). Fruits: tropical and subtropical. Naya Prokash, Calcutta

Majumdar TK, Vasudish CR, Premvalli KS and Bawa AS. 2009a. Development and storage ability of cucumber-litchi-lemon juice. *J. Food Sci. Technol*. **46**: 269-270

Majumdar TK, Vasudish CR, Premvalli KS and Bawa AS. 2009b. Preservation of functional vegetable juices: ashgourd juice and ashgourd-pudina blended juices. *Bev. Food World.* **36**(4): 48-50

Majumdar TK, Wadikar DD, Vasudish CR, Premwalli KS and Bawa AS. 2011. Effect of storage on physico-chemical, microbiological and sensory quality of bottlegourd-basil leaves juice. *Am. J. Food Technol*. **6**: 226-234

Martin CM. 1961. Citrus beverages and marmalades. *Food Technol.* **13**: 363-373

Massamba KG and Nguyen M. 2008. Determination and consumption of vitamin C, calcium and potassium in four selected conventionally and organically grown fruits and vegetables. *Afr. J. Biotechnol.* **7**(16): 2915-2919

Mathur A, Verma SK, Purohit R, Gupta V, Dua VK, Prasad GBKS, Mathur D, Singh SK and Singh S. 2011. Evaluation of *in vitro* antimicrobial and antioxidant activities of peel and pulp of some citrus fruits. *IJPI'S J. Biotechnol. Biotherap*. **1**(2): 1-15

Mensah JK, Okoli RI, Ohaju-Obodo JO and Eifediyi K. 2008. Phytochemical, nutritional and medical properties of some leafy vegetables consumed by Edo people of Nigeria. *Afr. J. Biotechnol.* **7**: 2304-2309

Mikstacka R, Rimando AM and Ignatowicz E. 2010. Antioxidant effect of trans-resveratrol, pterostilbene, quercetin and their combinations in human erythrocytes *in vitro*. *Plant Foods Hum. Nutr.* **65**: 57-63

Miller NJ, Diplock AT and Rice-Evan CA. 1995. Evaluation of the total antioxidant activity as a marker of the deterioration of apple juice on storage. *J. Agric. Food Chem.* **43**: 1794–1801

Mitchell MD, Donald JD, Samuel SE and Sarah LS. 1990. Interleukin-6 stimulates prostaglandin production by human amnions and decidual cells. *Eur. J. Pharmacol.* **192**: 189-191

Morais G, Faupel M, Morris J and Mcnew R. 2001. Quality and stability of blueberry juice blended with apple, grape and cranberry juice. *J. Food Qual.* **24**(2): 111-125

Morais H, Ramos C, Forgacs E, Cserhati T, Matos N, Almeida V and Oliveira J. 2002. Stability of anthocyanins extracted from grape skin. *Chromatographia Supplement*. **56**: S173-S175

Murakami M, Shigeeda A, Danjo K, Yamaguchi T, Takamura H and Matoba T. 2002. Radical scavenging activity and brightly coloured pigments in early stage of Maillard reaction. *Food Chem. Toxicol*. **67**: 93-96

Murari K and Verma RA. 1989. Studies on the effect of varities and pulp extraction method on the quality of guava nectar. *Ind. Food Pckr*. **43**(5): 11-15

Murcia MA, Lopez-Ayerra B, Martinez-Tome M, Vera AM and Garcia-Carmona F. 2000. Evolution of ascorbic acid and peroxidase during industrial processing of broccoli. *J. Sci. Food Agric.* **80**: 1882-1886

Murkovic M, Mulleder U and Neunteufl H. 2002. Carotenoid content in different varieties of pumpkins. *J. Food Comp. Analys.* **15**: 633-638

Nadkani KM. 1954. Indian plants and drugs with their medical properties and uses. Shrishti Book, New Delhi

Nagashima H, Nakamura K, Sharma KD and Goro T. 2004. Investigation of the effects of anthocyanins on rubratoxin B treated HL 60 cells. *Mycotoxin.* **54**(1): 27-32

Nagra SA and Khan S. 1988. Vitamin A (α-carotene) losses in Pakistani cooking. *J. Sci. Food Agric.* **46**: 249-251

Namasivayam R, Ramchandran B and Munuswamy D. 2008. Effect of aqueous extract of *Syzygium cumini* pulp on antioxidant defense system in streptozotocin induced diabetic rats. *Iran. J. Pharamcol. Therap.* **7**: 137-145

Nani R, DiCesarf LF, Rizzolo A and Picariello M. 1993. New drinks based on clear juices-part 2: blends of apple juice and berry juice. *Fruit Process*. **6**: 219-222

Nath A and Yadav DS. 2005. Standardization of ginger–kinnow, a blended beverage from Kinnow mandarin juice. *Ind. J. Citri.* **29**: 189-192

Nchez-moreno C, Plaza L, Adeancos B and Pilarcano M. 2003. Vitamin C, provitamin A, carotenoids and other carotenoids in high-pressurized orange Juice during refrigerated storage. *J. Agric. Food Chem.* **51**: 647-653

Negi PS and Roy SK. 2001. Effect of blanching and drying method on carotene, ascorbic acid and chlorophyll retention of leafy vegetables. *J. Lebensmittel Issenschaftund Technol*. **33**(4): 295-298

Nicoli MC, Calligaris and Manzoco L. 2000. Effect of enzymatic and chemical oxidation on the antioxidant capacity of catechin mode systems and apple derivatives. *J. Agric. Food. Chem.* **48**: 4576-4580

Nicoli M C, Anese M and Parpinel M. 1999. Influence of processing on the antioxidant properties of fruits and vegetables. *Tr. Food Sci. Technol.* **10**: 94-100

Nilsson T. 1970. Studies into the pigments in beetroot (*Beta vulgaris* L. sp. *vulgaris* var. *rubra* L.). *Lantbrukhogskolans Annaler*. **36**: 179– 219

Nosallova G, Mokry J and Hassan KM. 2003. Antitussive activity of the fruit extract of *Emblica officinalis* Gaertn. (Euphorbiaceae). *Phytomed*. **10**: 583–589

Novaka I, Janeiroa P, Serugab M and Oliveira-Brett AM. 2008. Ultrasound extracted flavonoids from four varieties of Portuguese red grape skins determined by reverse-phase high-performance liquid chromatography with electrochemical detection. *Anal. Chem. Acta.* **630**: 107–115

Nunes MCN, Morais MB, Brecht JK and Sargent SA. 1995. Quality of strawberries after storage in controlled atmospheres at above optimum storage temperatures. *Proc. Florida State Hort. Soc.* **108**: 273-278

Ohr LM. 2008. Pondering polyphenols. *Food Technol.* **11**(8): 59-61

Oleszek W, Lee CY, Jaworski AW and Price KR. 1988. Identification of some phenolics compounds in apples. *J. Agric. Food Chem.* **36**: 430–432

Oszmianski J and Wojdylo A. 2009. Effects of blackcurrant and apple mesh blending on the phenolics content, antioxidant capacity and colour of juices. *Czech J. Food Sci*. **5**: 338-351

Ou B, Huang D, Maureen HW, Flanagan JA and Deemeri EK. 2006. Analysis of antioxidant activities of common vegetable employing oxygen radical absorbance capacity (ORAC) and ferric reducing antioxidant power (FRAP) assays: a comparative study, *J. Agric. Food Chem.* **50**: 3122–3128

Ozkan A, Gubbuk H, Gunes E and Erdogan A. 2011. Antioxidant capacity of juice from different papaya (*Carica papaya* L.) cultivars grown under greenhouse conditions in Turkey. *Turk J. Biol*. **35**: 619-625

Pakhale SS, Karibasappags and Ramchandani AG. 2007. Scavenging effect of Indian grape poplyphenols on 2,2 – diphenyl -1- picryl hydrazyl, (DPPH) radical by electron spin resonance spectrometry. *Ind. J. Exp. Biol.* **45**: 968-973

Palaniswamy KP and Muthukrishnan CR. 1974. Studies on the physiochemical characters of lemon juices and squashes during storage. *Ind.Food Pckr.* **28**: 37-41

Panda S and Kar A. 2003. Fruit extract of *Emblica officinalis* ameliorates hyperthyroidism and hepatic lipid peroxidation in mice. *Pharmazie*. **58**: 753–755

Pathak S. 1988. Post harvest technology of Aonla (*Emblica officinalis*) fruits. Ph. D. thesis. Narendradev University of Agriculture and Technology, Faizabad, Uttar Pradesh, India

Patil S and Sharma HK. 2009. Functional beverages. *Bev. Food World*. **6**(4): 27-32

Patras A, Brunton NP, Da Pieve S and Butler F. 2009. Impact of high pressure processing on total antioxidant activity, phenolic, ascorbic acid, anthocyanin content and colour of strawberry and blackberry purées. *Innov. Food Sci. Emerg. Technol.* **10**(3): 308-313

Patras A, Tiwari BK and Brunton NP. 2011. Influence of blanching and low temperature preservation strategies on antioxidant activity and phytochemical content of carrots, green beans and broccoli. *LWT - Food Sci.Technol*. **44**: 299-306

Patthamakanokporn O, Puwastien P, Nitithamyong A and Sirichakwal PP. 2008. Changes of antioxidant activity and total phenolic compounds during storage of selected fruits. *J. Food Comp. Analys.* **21**(3): 241-248

Paul AA and Southgate DAT. 1978. The composition of foods. HMSO, London

Pavlov A, Kovatchera P, Georgier V, Koleval I and Ilieva M. 2002. Biosynthesis and radical scavenging activity during cultivation of red beet (*Beta vulgaris)* hairy root cultures. *Z. Natur. Forsch.* **75c**: 640-644

Pilando LS, Wrolstad RE and Heatherbell DA.1985. Influence of fruit composition, maturity and mold contamination on the colour and appearance of strawberry wine. *J. Food Sci.* **50**: 1121-1125

Podsedek A, Wilska-Jeska J, Ander B and Markowski J. 2000. Compositional characteristics of some apple varieties. *Eur. Food Res. Technol.* **210**(4): 268-272

Powell FK, Holt SHA and Brand-Miller JC. 2002. International table of glycemic index and glycemic load values. *Am. J. Clinic. Nutr.* **76**: 5-56

Prakash J and Gupta S. 2009. Studies on Indian green leafy vegetables for their antioxidant activity. *Plants Foods Hum. Nutr.* **64**: 39-45

Premi BR, Lal BB and Joshi VK. 1994. Distribution pattern of bittering principle in Kinnow fruits. *J. Food Sci. Technol.* **31**: 140-141

Prior RL, Cao G, Martin A, Sofic E and McEwen J O'Brien. 1998. Antioxidant capacity as influenced by total phenolic and anthocyanin content, maturity and variety of *Vaccinium* species. *J. Agric. Food Chem.* **46**: 2686–2693

Priyadevi S, Thangan N and Desai AR. 2002. Studies on variability in physico-chemical characters of different jamun cultivars. *Ind. J. Hort.* **59**: 153-156

Prochaska LJ, Nguyen XT, Donat N and Piekutowski WV. 2000. Effects of food processing on the thermodynamic and nutritive value of foods: literature and database survey. *Med. Hypoth.* **54**(2): 254-262

Pruthi JS, Manan JK, Teotia MS, Podhakri-Shnasetty G, Epison WE, Saroja S and Chikkappaji KC. 1984. Studies on the utilization of Kinnow and Malta. *J. Food Sci. Technol.* **21**(3): 123-127

Pszczola DE. 1998. Natural colours: pigments of imagination. *Food Technol*. **52**: 70–76

Puupponen-Pimia R, Hakkinen ST, Aarni M, Suortti T, Lampi MA and Eurola M. 2003. Blanching and long term freezing affect on various bioactive compounds of vegetables in different ways. *J. Sci. Food Agric*. **83**: 1389-1402

Qusti SY, Abo-khatwa AN and Bin Lahwa MA. 2010. Screening of antioxidant activity and phenolic content of selected food items cited in the holly Quran. *EJBS*. **2**(1): 23-27

Rai DR, Chadha S, Kaur MP, Jaiswal P and Patil RT. 2011. Biochemical, microbiological and physiological changes in jamun (*Syzygium cumini* L.) kept for long term storage under modified atmosphere packaging. *J Food Sci Technol.* **48**(3): 357-365

Rai RD and Saxena S. 1989. Biochemical changes during post-harvest storage of mushroom (*Agaricus bisporus*). *Curr. Sci.* **58**: 508-510

Raj D, Sharma PC and Vaidya D. 2011. Effect of blending and storage on quality characteristics of blended sand pear-apple juice beverage. *J. Food Sci. Technol*. **48**: 102-105

Rajeshkumar NV, Pillai MR and Kuttan R. 2003. Induction of apoptosis in mouse and human carcinoma cell lines by *Emblica officinalis* polyphenols and its effect on chemical carcinogenesis. *J. Exp. Clinic. Cancer Res.* **22**: 201–212

Ram M, Neetu D, Deepti P, Vandana M, Ilavazhagan G, Kumar D and Selvamurthy W. 2003. Cytoprotective activity of amla (*Emblica officinalis*) against chromium (VI) induced oxidative injury in murine macrophages. *Phytotherapy Res*. **17**: 430–433

Ram M, Neetu D, Yogesh B, Anju B, Dipti P, Pauline T, Sharma SK, Sarada, SKS, Ilavazhagan G, Kumar D and Selvamurthy W. 2002. Cyto-protective and immunomodulating properties of amla (*Emblica officinalis*) on lymphocytes: an *in-vitro* study. *J. Ethnopharmacol.* **81**: 5–10

Ramirez-Tortosa C, Andersen O and Gardner P. 2001. Anthocyanin-rich extract decreases indices of lipid peroxidation and DNA damage in vitamin Edepleted rats. *Free Rad. Biol. Med*. **31**(9): 1033-1037

Ranganna, S. 2007. Handbook of analysis and quality control for fruit and vegetable products. 2nd ed. Tata Mc Graw Hill Publication Co, New Delhi

Ranote PS and Bains GS. 1982. Juice of kinnow fruit. *Ind. Food Pckr*. **36**(5): 23-33

Raven PH. 2005. *Biology of Plants*. 7th Edition. WH Freeman Publishing, New York

Re R, Bramley PM and Rice-Evans C. 2002. Effects of food processing on flavonoids and lycopene status in a Mediterranean tomato variety. *Free Rad. Res*. **36**: 803-810

Record IR, Dreosti I and McInery JK. 2000. Changes in plasma antioxidant status following consumption of diets high or low in fruit and vegetables or following dietary supplementation with antioxidant mixture. *British J. Nutr.* **85**: 459-464

Riaz RA, Ali A and Saleem M. 1988. Studies on the preparation and storage stability of comminuted kinow fruit beverage bees. *Pak. J. Sci. Ind. Res.* **32**: 574-578

Rice-Evans CA, Miller NJ and Paganga G. 1997. Antioxidant properties of phenolic compounds. *Tr. Plant Sci.* **2**: 152-159

Robinson T. 1963. The organic constituents of higher plants. Burgess Publishing, Minneapolis

Rodriguez-Amaya DB. 1999. Changes in carotenoids during processing and storage of food. *Arch. Latinoam Nutr.* **49**: 38-47

Rodriguez-Amaya DB. 1997. Critical review of provitamin A determination in plant foods. *J. Micronutr. Anal.* **5**: 191-225

Rossi A, Serraino I and Dugo P. 2003. Protective effects of anthocyanins from blackberry in a rat model of acute lung inflammation. *Free Rad. Res*. **37**(8): 891–900

Ruiz-Nieto A, Lopez AJM, Lopez MR, Lopez MJ, Medina JJ, Scheer HAT, Lieten F and Dijkstra J. 1997. Analysis of sucrose's from strawberry cultivars of commercial interest-contents evolution. *Acta Hort.* **439**: 663-667

Russell LF, Wolfe LI and Ryan DAJ. 2002. Method development and generation of profiles for selected phenolics from apple cultivars used for processed products. *J. Food Sci*. **67**: 2819–2826

Russo A, Acquaviva R and Campisi A. 2000. Bioflavonoids as antiradicals, antioxidants and DNA cleavage protectors. *Cell Biol. Toxicol*. **16**(2): 91–98

Sabu MC and Kuttan, R. 2002. Anti-diabetic activity of medicinal plants and its relationship with their antioxidant property. *J. Ethnopharmacol.* **81**: 155–160

Sadasivam S and Manickam A. 1991. Biochemical methods. New Age International Ltd. New Delhi

Sagar VR and Kumar PS. 2009. Involvement of some process variables in mass transfer kinetics of osmotic dehydration of mango slices and storage stability. *J. Sci. Ind. Res*. **68**: 1043–1048

Saguy I, Kopelman IJ and Mizrahi S. 1978. Thermal kinetic degradation of betanin and betalamic acid. *J. Agric. Food Chem.* **26**: 360–362

Sahni CK and Kumar S. 1998. Browning reaction in foods: recent approaches to control browning- an overview. *Ind. Food Pckr.* **52**(4): 40-47

Sahota P, Pandove G, Jairath S and Phutela RP. 2009. Preparation of alcoholic, self carbonated beverages from carrot- amla juice. *Bev. Food World.* **36**(4): 15-23

Salama MF, Amin AA and Moharram HA. 2008. Relationship between antioxidant activities of red table beet root pigments with a potential application as a neutral juice blend. *Alex J. Food Sci. Technol.* **25**(2): 261-266

Sandhu KS and Sindhu JS. 1992. Studies on the development of multi fruits ready-to-serve beverage. *J. Plant Sci. Res.* **8**: 87-88

Saoji AN. 2009. Antihyperlipidemic effect of the methanolic extract from *Lagenaria siceraria* Stand. fruit in hyperlipidemic rats. *J. Ethnopharmacol.* **124**: 333–337

Saravanan K, Godara R K, Goyal RK and Sharma RK. 2004. Standardization of recipe for papaya nectar and its storage. *Haryana J. Hort. Sci.* **33**: 204-206

Sarolia DK and Mukherjee S. 2002. Comparative efficiency of different preservation methods in keeping quality of lime (*Citrus aurantifolia*) swingle juice during storage. *Haryana J. Hort. Sci*. **31**(3-4): 185-188

Sato E, Kohno M, Hamano H and Niwano Y. 2006. Increased antioxidative potency of garlic by spontaneous short term fermentation. *Plant Foods Hum. Nutr.* **61**: 157-160

Saxena AK, Teotia MS and Berry SK. 1996. Studies on the development of grape - mango and grape pineapple beverage blends. *Ind. Food Pckr.* **50**(4): 26–32

Scalbert A, Manach C, Morand C, Remesy C and Jimenez L. 2005. Dietary polyphenols and the prevention of diseases. *Crit. Rev. Food Sci. Nutr.* **45**: 287-306

Scartezzini P and Speroni, E. 2000. Review on some plants of Indian traditional medicine with antioxidant activity. *J. Ethnopharmacol.* **71**: 23-43

Schliemann W, Kobayashi N and Strack D. 1999. The decisive step in betaxanthin biosynthesis is a spontaneous reaction. *Plant Physiol*. **119**: 1217–1232

Schwartz SJ and Von Elbe JH. 1983. Identification of betanin degradation products. *Zeitschrift fur Lebensmittel-Untersuchung und-Forschung.* **176**: 448–453

Semiz A and Sen A. 2007. Antioxidants and Chemopreventive properties of *Momordica charan*tia L. (Bitter melon) fruit extract. *Afr. J. Biotechnol.* **6**(3): 273-277

Seok-Moon J, So-Young K, Dong- Ryzeng K, Seong Chun J, Nam KC, Ahn DU and Seung Cheol L. 2004. Effect of heat treatments on the antioxidant activity of extracts from citrus peels. *J. Agric. Food. Chem.* **52**: 3389-3393

Sethi V. 1992. Preparation and storage study of lime-ginger cocktail cocktail at room and low temperature. *Bev. Food World.* **19**(12): 51-52

Shah WH, Sufi NA and Zafar SI. 1975. Studies on the storage stability of guava fruit juice. *Pak. J. Sci. Ind. Res.* **18**(3-4): 179-183

Sharma I, Kaul RK and Anju B. 2008. Effect of different treatment combinations guava and papaya on quality and storability of ready-to-serve beverages. *J. Res. SKUAST.* **7**: 18

Sharma JN, Josan JS, Thind SK, Arora PK. 1999. Evaluation of mango cultivars for arid-irrigated region of Punjab. *J. Appl. Hort.* **1**(2):103-104

Sharma KD and Hashinaga F. 2004. Alpinia leaf extract: a perspective natural preservative. *J. Sci. Ind. Res.* **64**: 689-693

Sharma KD and Nagashima H. 2005. Protective effects of flavonoids against rubratoxin B toxicity in hepatocellular carcinoma cells. *Mycotoxin.* **55** (2): 101-105

Sharma KD, Karki Swati, Thakur NS and Attri S. 2012. Composition, functional properties and processing of carrot-a review. *J. Food Sci. Technol.* **49**(1): 22-32

Sharma KD, Kathrin S, Bronwen S and Lauri M. 2011. Antioxidant capacity, polyphenolics and pigments of broccoli-cheese powder blends. *J. Food Sci. Technol.* **48**(4): 510-514

Sharma N, Trikha M and Raisuddin S. 2000. Inhibitory effect of *Emblica officinalis* on the in vivo clastogenicity of benzo(*a*)pyrene and cyclophosphamide in mice. *Hum. Exp. Toxicol*. **19**: 377-384

Shi A and Le Maguer M. 2000. Lycopene in tomatoes: chemical and physical properties affected by food processing. *Crit. Rev. Food Sci. Nutr.* **110**: 1-42

Shimoda M and Osajima Y. 1981. Studies on off-flavour formed during storage of Satsuma mandarinjuice. *J. Agric. Chem. Soc. Japan*. **55**: 319-324

Shrestha MK and Bhatia BS. 1982. Apple juice: physico-chemical characteristics and storage study. *Ind. Food Pckr*. **36**(3): 53-57

Shrikhande AJ, Race EJ, Wightman JD and Sambueso RD. 2003. Process for extraction, purification and enrichment of polyphenolic substances from whole grapes, grape seeds and grape pomace. U.S. patent. 6544581

Siddiqi M and Cash JN. 2000. Physico-chemical properties of polyphenoloxidase from 'd' Anjou and Bartlett pear. *J. Process. Pres.* **24**(3): 353-364

Sies H. and Stahl W. 1995. Vitamin E and C, β-carotene and other carotenoids as antioxidants. *Am. J. Chem. Nutr.* **62**:131-155

Sikora E, Cieslik E, Leszczynska T, Filipiak-Florkiewicz A and Pawe1 MP. 2008. The antioxidant activity of selected cruciferous vegetables subjected to aquathermal processing. *Food Chem*. **107**: 55-59

Siler A and Morris JR. 1993. Quality effects of carbonation and ethyl maltol on venus and concord grape juices and their grape apple blends. *Am. J. Enol. Viticul.* **44**: 320-324

Silva RC, Rigaud J, Cheynier V and Chemina A. 1991. Procyanidin dimers and trimers from grape seeds. *Phytochem.* **30**: 1259–1264

Singh J, Upadhyay AK, Singh S and Rai M. 2009. Total phenolic content and free radical scavenging activity of brassica vegetables. *J. Food Sci. Technol.* **46**(6): 595-597

Sistrunk WA and Morris JR. 1985. Quality acceptable of two cultivars of muscadine grapes mixed with other juices. *J. Am. Soc. Hort. Sci*. **110**: 325-332

Sivaraj N and Pandravada S R. 2005. Morphological diversity for fruit characters in bottle gourd germplasm from tribal pockets of Telangana Region of Andhra Pradesh. *Ind. Asian Agric. Hist.* **9**(4): 305–310

Skrede S, Wrolstad RE and Durst RW. 2000. Changes in anthocyanins and polyphenolics during juice processing of Highbush blueberries (*Vaccinium corymbosum* L.). *J. Food Sci.* **65**(2): 357-364

Slinkard K and Singletan VL. 1977. Total phenolic analysis: automation and comparison with manual methods. *Am. J. Enol. Viticul.* **28**: 49-55

Sloan EA. 2003. What consumers want and what don't want on food and beverage lables. *Food Technol.* **57**: 26-36

Sogi DS and Singh S. 2001. Studies on bitterness development in Kinnow juice ready-to-serve beverage, squash, jam and candy. *J. Food Sci. Technol.* **38**(5): 433-438

Sood S, Minhas S, Kalia M and Katoch S. 2009. Storage study of mango squash by using cheese whey and soy whey. *Bev. Food World.* **36**(4): 44-46

Spacil Z, Novakova L and Solich P. 2008. Analysis of phenolic compounds by high performance liquidchromatography and ultra performance liquid chromatography. *Talanta*. **76**: 189–199

Spayd SE, Nagel CW, Hayrynen LD and Drake SR. 1984. Colour stability of apple and pear juice blended with fruit juices containing anthocyanins. *J. Food Sci*. **49**: 411-414

Spormann T M, Albert FW, Rath T, Dietrich H, Will F, Jean-Pierre S, Eisenbrand G and Janzowski C. 2011. Anthocyanin/polyphenolic–rich fruit juice reduces oxidative cell damage in an intervention study with patients on hemodialysis. *Cancer Epidemiol. Biomarkers Prev.* **17**: 3372-3380

Srivastava JS. 1998. Comparative study of RTS drinks prepared from Dashehari and Bangannapalli mangoes. *Ind. Food Pckr*. **52**(2): 38-42

Steinberg D. 1991. Antioxidants and atherosclerosis: a current assessment. *Circulation*: *J. Am. Heart Assoc.* **84**: 1420-1425

Stintzing FC and Carle R. 2004. Functional properties of anthocyanins and betalains in plants, food and in human nutrition. *Tr. Food Sci. Technol*. **15**: 19–38

Strack, D and Wray V. 1989. Anthocyanins. *In*: Methods in plant biochemistry, Vol. I: Plant Phenolics (PM Dey and J.B. Harborne,eds.)

Suganyadevi P, Saravanakumar M, Aravinthan KM, Arunkumar A, Krishna RK and Karthikeyani S. 2011. Extraction of Betacyanin from Red Beet root (*Beta vulgaris* L.) and to evaluate its antioxidant potential. *J. Pharmacol. Res*. **3**(11): 2693-2696

Sun J, Chu YF, Wu X and Liu RH. 2002. Antioxidant and antiproliferative activities of common fruits. *J. Agric. Food Chem.* **50**: 7449–7454

Tandon DK, Kumar S, Dikshit A and Shukla DK. 2007. Storage study on bael-papaya blended RTS beverage. *Ind. Food Pckr.* **73**: 91-93

Tanrioven D and Eksi A. 2005. Phonolic compounds in pear juice from different cultivars. *Food Chem.* **93**: 89-93

Temple NJ. 2000. Antioxidants and disease: more questions than answers. *Nutr. Res*. **20**:449-459

Tesoriere L, Allegra M, Butera D and Livrea MA. 2004. Absorption, excretion, and distribution of dietary antioxidant betalains in LDLs: Potential health effects of betalains in humans. *Am. J. Clinic. Nutr*. **80**: 941–945

Thamburaj S and Singh N. 2004. Textbook of vegetables, tuber crops and spices. Indian Council of Agricultural Research, New Delhi, India

Thielen C, Will F, Zacharias J, Dietrich H and Jacob H. 2005. Distribution of dihydrochalcones and flavonols in apple tissue and comparison between fruit and juice. Proc. "European Symp. on Apple Processing", 16-18 March 2005, Rennes, France

Tiwari RB. 2000. Studies on blending of guava and papaya pulp for RTS beverages. *Ind. Food Pckr*. **54**: 68-70

Touyz RM. 2004. Reactive oxygen species, vascular oxidative stress, and redox signaling in hypertension: what is the clinical significance. *Hypertension.* **44**: 248-254

Tripathi VK, Singh MB and Singh S. 1988. Studies on comparative compositional changes in different preserved products of aonla (*Emblical officinalis* Gaertn.) var, Banarasi. *Ind. Food Pckr.* **42**: 61-65

Turkmen N, Poyrazoglu E S, Sari F and Velioglu Y S. 2006. Effect of cooking methods on chlorophylls, pheophytins and colour of green leafy vegetables. *Int. J. Food Sci. Technol.* **41**: 281-288

Van der Sluis AA, Dekker M, Skrede G and Jongen WMF. 2005. Activity and concentration of polyphenolic antioxidants in apple juice: effect of novel production methods. *J. Agric. Food Chem.* **52**: 2840-2848

Viberg, U, Alklint C, Akesson B, Onning G, Sjoholm I, Kumpulainen JT and Salonen JT. 1999. The effect of processing on total antioxidatant capacity in strawberries. Proceedings of the Second International Conference on Natural Antioxidants and Anticarcionogens in Nutrition, Health and Disease held on 24-27 June, Helsinki, Finland

Vinson JA, Hao Y, Su X and Zubik L. 1998. Phenol antioxidant quantity and quality in foods: vegetables. *J. Agric. Food Chem.* **46**: 3630-3634

Von Elbe JH, Maing I and Amundson CH. 1974. Colour stability of betanin. *J. Food Sci.* **39**: 334-337.

Von Elbe JH. 1975. Stability of betalaines as food colours. *Food Technol*. **5**: 42–44

Vrhovsek U, Rigo A, Tonon D and Mattiri F. 2004. Quantification of polyphenol of different apple varities. *J. Agric. Food. Chem.* **52**: 6532-6538

Wall MM. 2006. Ascorbic acid, vitamin A and mineral composition of banana (*Musa* sp.) papaya (*Carica papaya*) cultivars grown in Hawai. *J. Food Comp. Anal*. **1**9: 434-445.

Wang H, Cao G and Prior RL. 1996. Total antioxidant capacity of fruits. *J. Agric. Food Chem*. **44**: 701-705

Wang H, Cao G and Prior RL. 1997. Oxygen Radical absorbing capacity of anthocyanins. J. *Agric. Food Chem*. **45**:304-309

Wangcharoen W and Morasuk W. 2007. Antioxidant capacity and phenolic content of some Thai culinary plants. *Mejo Int. J. Sci. Technol.* **1**(2): 100-106

Weisburger J H. 1991. Nutritional approach to cancer prevention with emphasis on vitamins, antioxidants, and carotenoids. *Am. J. Clinic. Nutr*. **53**(1): 226S−237S

Will F and Dietrich H. 2006. Optimized processing technique for colour and cloud-stable plum juices and stability of bioactive substances. *Eur. Food Res. Technol.* **223**: 419-425

Willett WC. 1994. Diet and health: what should we eat. *Sci*. **254**: 532-537

Willett WC. 1995. Diet, nutrition, and avoidable cancer. *Environ. Health Perspect*. **103**:165-170

Won SY and Park EH. 2005. Anti inflammatory and related pharmacological activities of cultural mycelia and fruiting bodies of cordyceps militaries. *J. Ethnopharmacol*. **96**: 555 – 561

Yamaguchi T, Mizobuchi T, Kajikawa R, Kawashima H, Miyabe F, Terao J, Takamura H and Matoba T. 2001. Radical-scavenging activity of vegetables and the effect of cooking on their activity. *Food Sci. Technol. Res*. **7**: 250–257

Yogeeshappa H. 2007. Yield and quality of grapes (cv. Thompson Seedless) in relation to soil fertility status of vineyards in Bijapur taluk of Karnataka. M. Sc. Thesis. University of Agricultural Sciences, Dharwad, India

Yoshida H, Shougaky Y, Hirakawa Y and Tomiyama Y. 2002. Lipid classes, fatty acid composition and triglycerol molecular species in the kernel of pumpkin (*Cucurbita* sp.) seeds. *J. Sci. Food Agric.* **84**(2): 158-163

Youdim K, Martin A and Joseph J. 2000. Incorporation of the elderberry anthocyanins by endothelial cells increases protection against oxidative stress. *Free Rad. Biol. Med*. **29**(1): 51-60

Youdim K, McDonald J, Kalt W and Joseph J. 2002. Potential role of dietary flavonoids in reducing microvascular endothelium vulnerability to oxidative and inflammatory insults. *J. Nutr. Biochem*. **13**(5): 282–288

Zhang D and Hamauzu Y. 2004a. Phenolic compounds and their antioxidant properties in different tissues of carrots (*Daucus carota* L.). *Food Agric. Environ*. **2**(1): 95-100

Zhang D and Hamauzu Y. 2004b. Phenolics, ascorbic acid, carotenoids and antioxidant activity of broccoli and their changes during conventional and microwave cooking. *Food Chem*. **88**: 503-509

Zhang G, Ji B, Li B, Tian F, Chen G, Ji F, Zhang H, Yang Z and Zhao L. 2008a. Effect of processing on phenolic concentration and antioxidant activities of apple and apple juices. *J. Food Sci. Technol*. **45**: 339-343

Zhang H, Wang L, Deroles S, Bennett R, and Davies K. 2006. New insight into the structures and formation of anthocyanic vacuolar inclusions in flower petals. *Bio. Med. Central Plant Biol.* **6**: 29–43

Zhang WZ, Venardos K, Chin-Dusting J and Kaye DM. 2008b. Adverse effects of cigarette smoke on bioavailability: role of arginine metabolism and oxidative stress. *Hypertens*. **48**: 278-285

ABSTRACT

Dr Y S Parmar University of Horticulture and Forestry
Nauni, Solan, Himachal Pradesh-173 230
Department of Food Science and Technology

Title of Thesis	:	**Seasonal fruit and vegetable juice blends with high antioxidant potential**
Name of the student	:	**Vigya Mishra**
Admission number	:	**H-2008-18-D**
Major Advisor	:	**Dr K D Sharma**
Major Field	:	**Post Harvest Technology**
Minor Field (s)	:	**i) Microbiology**
		ii) Biochemistry
Degree awarded	:	**Ph. D. (Horticulture)**
Year of award of degree	:	**2012**
No. of pages in thesis	:	**317+ i-xi**
No of words in abstract	:	**447**

Abstract

The present study entitled “Seasonal fruit and vegetable juice blends with high antioxidant potential was conducted during 2009-2010 and 2010-1011 in the Department of Food Science & Technology, Dr Y S Parmar University of Horticulture and Forestry, Nauni, Solan. Natural juices are more nutritional and therapeutic than synthetic juices. Blending of fruit and vegetable juices could be an economic requisite to utilize some fruits and vegetables which otherwise have unfavourable characters like aroma, colour and mouth feel. Besides, fruit and vegetables in combination have synergistic effects on the antioxidant activities leading to the greater reduction in the risk of chronic diseases. Therefore, seasonal blends were developed by blending juices/pulps of summer and winter season fruits (apple, mango, jamun, sand pear, kinnow, red grapes, aonla and papaya) and vegetables (bottlegourd, bittergourd, tomato, pumpkin, carrot, cabbage and beetroot) and were analyzed for different quality and functional parameters including antioxidant activity at 3 and 6 month under ambient and refrigerated storage conditions. Blending enriched the juices with one or more functional ingredients like ascorbic acids, polyphenolics, carotenoids and anthocyanins which otherwise were either present in negligible proportion in the original juice/pulp of the fruit/vegetable or were completely absent in some juices/pulps thus improving the antioxidant potential of the blends in comparison to single fruit. Maximum antioxidant activity was recorded in apple: jamun: pear blend (82.82%) among summer season blends and in kinnow: red grape: beetroot (66.81%) among winter season blends. A marginal increase in total soluble solids, titratable acidity and sugars of the blends was recorded during storage while ascorbic acid, total phenolics, total anthocyanins and antioxidant activity of the products decreased significantly during storage of 6 month. An insignificant decrease was recorded in total carotenoids and sensory score of the blends. Non-enzymatic browning was increased in case of all the blends except blends containing jamun, red grapes and beetroot juice/pulp. The storage of blends at low temperature was found optimum with minimum changes in their quality, functional and sensory characteristics. However, more reduction in antioxidant activity of blends was recorded at refrigerated storage as compared to ambient storage. Cost of production of the blends was in the range of Rs. 5.25 (apple: pear) to Rs. 15.98 (apple: mango: jamun: bottlegourd) for 200 mL glass bottle for summer season blends while Rs. 8.87 (kinnow: red grapes: papaya: cabbage) to Rs 18.26 (kinnow: red grapes) for 200 mL glass bottle. Therefore, blending of pulpy fruits and/or vegetables with the juicy one could be an effective approach to exploit the functional properties of selected fruits and vegetables. Further, the production and availability of these functional juices with high antioxidant potential will add variety in the category of healthy juices in the market.

Signature of Major Advisor **Signature of student**

Countersigned

Professor and Head
Department of Food Science and Technology
Dr Y S Parmar University of Horticulture and Forestry,
Nauni, Solan, Himachal Pradesh-173 230

APPENDICES

APPENDIX-I

Development of summer season juice blends

Source	df	Apple: Pear				Apple: Jamun			
		Colour	Flavour	Body	OAA	Colour	Flavour	Body	OAA
Treatment	9	4.87×10^{-1}	2.60×10^{-1}	2.92×10^{-1}	3.80×10^{-1}	2.23×10^{-1}	7.00×10^{-1}	5.75×10^{-1}	5.79×10^{-1}
Replication	2	5.52×10^{-3}	9.00×10^{-5}	9.28×10^{-2}	1.96×10^{-3}	1.12×10^{-2}	3.84×10^{-2}	9.00×10^{-5}	9.02×10^{-5}
Error	18	3.56×10^{-3}	2.23×10^{-4}	3.12×10^{-3}	5.38×10^{-4}	1.78×10^{-2}	2.69×10^{-2}	2.23×10^{-4}	2.26×10^{-4}

Source	df	Apple: Mango				Apple: Pear: Mango			
		Colour	Flavour	Body	OAA	Colour	Flavour	Body	OAA
Treatment	9	5.71×10^{-1}	5.65×10^{-1}	8.19×10^{-1}	5.71×10^{-1}	2.28	2.29	3.58×10^{-1}	2.60×10^{-1}
Replication	2	8.92×10^{-5}	8.72×10^{-5}	3.36×10^{-3}	8.92×10^{-5}	2.12×10^{-2}	2.12×10^{-2}	6.25×10^{-3}	9.00×10^{-5}
Error	18	2.13×10^{-4}	1.23×10^{-4}	2.20×10^{-3}	2.13×10^{-4}	2.07×10^{-3}	2.07×10^{-3}	6.50×10^{-3}	2.46×10^{-4}

Source	df	Apple: Pear: Bottlegourd				Apple: Pear: Bittergourd			
		Colour	Flavour	Body	OAA	Colour	Flavour	Body	OAA
Treatment	9	6.61×10^{-2}	6.68×10^{-2}	3.80×10^{-1}	3.81×10^{-1}	6.63×10^{-2}	5.75×10^{-1}	6.56×10^{-2}	4.70×10^{-1}
Replication	2	1.85×10^{-3}	1.95×10^{-3}	1.96×10^{-3}	1.93×10^{-3}	1.86×10^{-3}	9.00×10^{-5}	1.82×10^{-3}	5.32×10^{-3}
Error	18	9.65×10^{-4}	9.69×10^{-4}	5.38×10^{-4}	5.36×10^{-4}	9.64×10^{-4}	2.23×10^{-4}	9.67×10^{-4}	3.36×10^{-3}

Source	df	Apple: Jamun: Pear				Apple: Mango: Jamun			
		Colour	Flavour	Body	OAA	Colour	Flavour	Body	OAA
Treatment	9	2.35	2.37	3.59×10^{-1}	6.56×10^{-2}	6.61×10^{-2}	3.65×10^{-1}	3.36×10^{-1}	2.42×10^{-1}
Replication	2	2.19×10^{-2}	2.192×10^{-2}	6.27×10^{-3}	1.82×10^{-3}	1.85×10^{-3}	6.38×10^{-3}	6.17×10^{-3}	1.00×10^{-6}
Error	18	2.13×10^{-3}	2.16×10^{-3}	6.49×10^{-3}	9.67×10^{-4}	9.65×10^{-4}	6.55×10^{-3}	6.29×10^{-3}	9.78×10^{-4}

Source	df	Apple: Pear: Pumpkin				Apple: Pear: Tomato			
		Colour	Flavour	Body	OAA	Colour	Flavour	Body	OAA
Treatment	9	2.28	3.80×10^{-1}	2.60×10^{-1}	3.80×10^{-1}	1.82	1.75	9.75×10^{-2}	7.40×10^{-2}
Replication	2	2.12×10^{-2}	1.96×10^{-3}	9.00×10^{-5}	1.96×10^{-3}	3.36×10^{-2}	3.32×10^{-2}	1.30×10^{-2}	6.30×10^{-5}
Error	18	2.07×10^{-3}	5.38×10^{-4}	2.23×10^{-4}	5.38×10^{-4}	2.20×10^{-3}	2.17×10^{-3}	1.09×10^{-2}	9.07×10^{-5}

Source	df	Apple: Jamun: Bottlegourd				Apple: Jamun: Bittergourd			
		Colour	Flavour	Body	OAA	Colour	Flavour	Body	OAA
Treatment	9	4.23	4.20	7.87×10^{-1}	1.82×10^{-1}	2.23×10^{-1}	2.42×10^{-1}	4.61×10^{-1}	9.05×10^{-1}
Replication	2	1.06×10^{-2}	1.01×10^{-2}	1.48×10^{-3}	3.36×10^{-2}	1.12×10^{-1}	1.00×10^{-6}	4.00×10^{-6}	1.60×10^{-3}
Error	18	6.06×10^{-2}	6.00×10^{-2}	5.30×10^{-2}	2.20×10^{-3}	1.40×10^{-1}	9.78×10^{-4}	9.83×10^{-4}	4.98×10^{-2}

Source	df	Apple: Jamun: Pumpkin				Apple: Jamun: Tomato			
		Colour	Flavour	Body	OAA	Colour	Flavour	Body	OAA
Treatment	9	5.71×10^{-1}	2.37	3.59×10^{-1}	3.63×10^{-1}	4.20	5.75×10^{-1}	5.79×10^{-1}	4.23
Replication	2	8.92×10^{-5}	2.192×10^{-2}	6.27×10^{-3}	6.32×10^{-3}	1.01×10^{-2}	9.00×10^{-5}	9.03×10^{-5}	1.09×10^{-2}
Error	18	2.13×10^{-4}	2.16×10^{-3}	6.49×10^{-3}	6.45×10^{-3}	6.00×10^{-2}	2.23×10^{-4}	2.26×10^{-4}	6.12×10^{-2}

Source	df	Apple: Mango: Bottlegourd				Apple: Mango: Bittergourd			
		Colour	Flavour	Body	OAA	Colour	Flavour	Body	OAA
Treatment	9	4.66×10^{-1}	4.20	2.28	6.21×10^{-1}	9.79×10^{-2}	3.65×10^{-1}	4.57×10^{-1}	3.80×10^{-1}
Replication	2	1.29×10^{-2}	1.01×10^{-2}	2.12×10^{-2}	6.25×10^{-3}	1.41×10^{-2}	6.38×10^{-3}	2.25×10^{-3}	1.96×10^{-3}
Error	18	21.30×10^{-1}	6.00×10^{-2}	2.07×10^{-3}	3.76×10^{-3}	1.11×10^{-2}	6.55×10^{-3}	1.45×10^{-3}	5.38×10^{-4}

Source	df	Apple: Mango: Pumpkin				Apple: Mango: Tomato			
		Colour	Flavour	Body	OAA	Colour	Flavour	Body	OAA
Treatment	9	4.24	4.57×10^{-1}	5.75×10^{-1}	6.56×10^{-2}	3.65×10^{-1}	7.40×10^{-2}	3.80×10^{-1}	3.82×10^{-1}
Replication	2	1.06×10^{-2}	2.25×10^{-3}	9.00×10^{-5}	1.82×10^{-3}	6.38×10^{-3}	6.30×10^{-5}	1.96×10^{-3}	1.97×10^{-3}
Error	18	6.05×10^{-2}	1.45×10^{-3}	2.23×10^{-4}	9.67×10^{-4}	6.55×10^{-3}	9.07×10^{-3}	5.38×10^{-4}	5.39×10^{-4}

Source	df	Apple: Pear: Mango: Bottlegourd				Apple: Pear: Mango: Bittergourd			
		Colour	Flavour	Body	OAA	Colour	Flavour	Body	OAA
Treatment	9	7.87 x 10-1	2.80 x 10-1	6.21×10^{-1}	9.05×10^{-1}	3.62×10^{-1}	7.87 x 10-1	6.21×10^{-1}	2.28
Replication	2	1.48×10^{-2}	8.41×10^{-3}	6.25×10^{-2}	1.60×10^{-4}	6.25×10^{-3}	1.48×10^{-2}	6.25×10^{-2}	2.12×10^{-2}
Error	18	5.32×10^{-3}	1.77×10^{-3}	3.76×10^{-3}	4.98×10^{-3}	6.45×10^{-3}	5.32×10^{-3}	3.76×10^{-3}	2.07×10^{-3}

Source	df	Apple: Pear: Mango: Pumpkin				Apple: Pear: Mango: Tomato			
		Colour	Flavour	Body	OAA	Colour	Flavour	Body	OAA
Treatment	9	7.87 x 10-1	7.78 x 10-1	6.21×10^{-1}	7.82 x 10-1	6.61×10^{-2}	3.58×10^{-1}	7.78 x 10-1	1.82×10^{-1}
Replication	2	1.48×10^{-2}	1.40×10^{-2}	6.25×10^{-2}	1.45×10^{-2}	1.85×10^{-3}	6.25×10^{-3}	1.40×10^{-2}	1.00×10^{-5}
Error	18	5.32×10^{-3}	5.27×10^{-3}	3.76×10^{-3}	5.30×10^{-3}	9.65×10^{-4}	6.50×10^{-3}	5.27×10^{-3}	1.30×10^{-3}

Source	df	Apple: Pear: Mango: Pumpkin				Apple: Pear: Mango: Tomato			
		Colour	Flavour	Body	OAA	Colour	Flavour	Body	OAA
Treatment	9	7.87 x 10-1	7.78 x 10-1	6.21×10^{-1}	7.82 x 10-1	6.61×10^{-2}	3.58×10^{-1}	7.78 x 10-1	1.82×10^{-1}
Replication	2	1.48×10^{-2}	1.40×10^{-2}	6.25×10^{-2}	1.45×10^{-2}	1.85×10^{-3}	6.25×10^{-3}	1.40×10^{-2}	1.00×10^{-5}
Error	18	5.32×10^{-3}	5.27×10^{-3}	3.76×10^{-3}	5.30×10^{-3}	9.65×10^{-4}	6.50×10^{-3}	5.27×10^{-3}	1.30×10^{-3}

Source	df	Apple: Jamun: Pear: Bottlegourd				Apple: Jamun: Pear: Bittergourd			
		Colour	Flavour	Body	OAA	Colour	Flavour	Body	OAA
Treatment	9	9.79 x 10-2	6.56×10^{-2}	6.56×10^{-2}	1.25	6.61×10^{-2}	1.25	3.36×10^{-1}	4.37×10^{-1}
Replication	2	1.41×10^{-2}	1.82×10^{-3}	1.82×10^{-3}	1.60×10^{-5}	1.85×10^{-3}	1.60×10^{-4}	6.17×10^{-3}	7.29×10^{-2}
Error	18	1.11×10^{-3}	9.67×10^{-3}	9.67×10^{-3}	5.60×10^{-4}	9.65×10^{-4}	5.60×10^{-3}	6.29×10^{-3}	2.05×10^{-3}

Source	df	Apple: Jamun: Pear: Pumpkin				Apple: Jamun: Pear: Tomato			
		Colour	Flavour	Body	OAA	Colour	Flavour	Body	OAA
Treatment	9	3.80 x 10-1	3.59×10^{-1}	2.80 x 10-^{2}	8.19×10^{-1}	6.61×10^{-2}	3.65×10^{-1}	3.36×10^{-1}	2.42×10^{-1}
Replication	2	1.96×10^{-3}	6.27×10^{-3}	8.40×10^{-3}	3.36×10^{-3}	1.85×10^{-3}	6.38×10^{-3}	6.17×10^{-3}	1.00×10^{-6}
Error	18	2.13×10^{-3}	6.49×10^{-3}	1.76×10^{-3}	2.20×10^{-3}	9.65×10^{-4}	6.55×10^{-3}	6.29×10^{-3}	9.78×10^{-4}

Source	df	Apple: Mango: Jamun: Bottlegourd				Apple: Mango: Jamun: Bittergourd			
		Colour	Flavour	Body	OAA	Colour	Flavour	Body	OAA
Treatment	9	5.15×10^{-5}	5.94×10^{-1}	3.59×10^{-1}	1.25	6.61×10^{-2}	9.05×10^{-1}	3.36×10^{-1}	4.37×10^{-1}
Replication	2	1.63×10^{-1}	3.80×10^{-3}	6.27×10^{-3}	1.60×10^{-4}	1.85×10^{-3}	1.60×10^{-3}	6.17×10^{-3}	7.29×10^{-6}
Error	18	5.12×10^{-3}	1.50×10^{-3}	6.49×10^{-3}	5.60×10^{-4}	9.65×10^{-4}	4.98×10^{-3}	6.29×10^{-3}	2.05×10^{-4}

Source	df	Apple: Mango: Jamun: Pumpkin				Apple: Mango: Jamun: Tomato			
		Colour	Flavour	Body	OAA	Colour	Flavour	Body	OAA
Treatment	9	2.35	2.37	2.69×10^{-1}	6.56×10^{-2}	6.61×10^{-2}	5.94×10^{-1}	6.21×10^{-1}	2.42×10^{-1}
Replication	2	2.19×10^{-2}	2.192×10^{-2}	2.50×10^{-1}	1.82×10^{-3}	1.85×10^{-3}	3.80×10^{-3}	6.25×10^{-3}	1.00×10^{-6}
Error	18	2.13×10^{-3}	2.16×10^{-3}	1.89×10^{-1}	9.67×10^{-4}	9.65×10^{-4}	1.50×10^{-3}	3.76×10^{-3}	9.78×10^{-4}

ANOVA: Effect of storage on the quality characteristics of apple based (two fruit juice blends)

Source of variation	df	Mean sum of squares				
		TSS	Acidity	Ascorbic acid	Total sugars	Reducing sugars
Treatments (T)	3	17.58	140.03	52.74	25.51	12.68
Interval (I)	2	6.57×10^{-1}	30.02	1.31	0.014	0.101
Error	48	2.49	3.84	119.38	3.62	5.10

Source of variation	df	Mean sum of squares		
		Total phenols	Antioxidant activity	Non enzymatic browning
Treatments (T)	3	4852.50	28.51	4.77
Interval (I)	2	11815.29	0.132	2.55 x 10-3
Error	48	116.53	11.29	9.55 x 10-3

Source of variation	df	Mean sum of squares			
		Colour	Flavour	Body	Overall acceptability
Treatments (T)	3	22.25	15.41	25.83	20.77
Interval (I)	2	3.86 x 10-1	0.346	0.524	0.518
Error	50	5.61	0.659	2.77	2.93

Source of variation	df	Mean sum of squares				
		TSS	Acidity	Ascorbic acid	Total sugars	Reducing sugars
Treatments (T)	3	19.91	7.18×10^{-2}	502.78	23.73	1.86
Interval (I)	2	8.60 x 10-1	2.41×10^{-2}	243.60	1.30×10^{-2}	3.29×10^{-1}
Error	48	2.59	3.12×10^{-2}	87.99	2.18	1.45×10^{-3}

Source of variation	df	Mean sum of squares		
		Total phenols	Antioxidant activity	Non enzymatic browning
Treatments (T)	3	27644.06	148.38	3.77
Interval (I)	2	11466.36	96.85	9.84 x 10-1
Error	48	105.13	6.80	6.28 x 10-3

Source of variation	df	Mean sum of squares			
		Colour	Flavour	Body	Overall acceptability
Treatments (T)	3	15.66	22.94	5.71	22.74
Interval (I)	2	5.66 x 10-1	0.485	5.95	3.29 x 10-1
Error	50	5.02	5.61	4.79	5.05

ANOVA: Effect of storage on the quality characteristics of apple-pear based vegetable juice blends

Source of variation	df	Mean sum of squares				
		TSS	Acidity	Ascorbic acid	Total sugars	Reducing sugars
Treatments (T)	4	16.13	8.86 x 10-3	26.17	16.85	6.40
Interval (I)	2	3.28	2.10 x 10-3	43.80	1.03 x 10-2	4.28 x 10-2
Error	60	25.56	8.83 x 10-4	8.57 x 10-1	9.65 x 10-1	3.02 x 10-3

Source of variation	df	Mean sum of squares		
		Total phenols	Antioxidant activity	Non enzymatic browning
Treatments (T)	4	18572.26	243.15	2.14
Interval (I)	2	7251.82	105.07	1.79 x 10-1
Error	60	231.10	19.36	3.02 x 10-3

Source of variation	df	Mean sum of squares			
		Colour	Flavour	Body	Overall acceptability
Treatments (T)	4	3.04	12.66	12.47	5.44
Interval (I)	2	4.20 x 10-1	3.97 x 10-1	4.71 x 10-1	4.43 x 10-1
Error	60	6.78 x 10-2	5.00 x 10-1	4.64	4.21 x 10-1

ANOVA: Effect of storage on quality characteristics of apple-jamun based vegetable juice blends

Source of variation	df	Mean sum of squares				
		TSS	Acidity	Ascorbic acid	Total sugars	Reducing sugars
Treatments (T)	4	1.21	1.25 x 10-2	55.00	2.29	5.73
Interval (I)	2	2.60 x 10-1	2.50 x 10-4	74.79	1.51 x 10-2	2.13 x 10-2
Error	60	5.82 x 10-1	8.67 x 10-4	9.42 x 10-1	6.30 x 10-1	1.04

Source of variation	Df	Mean sum of squares			
		Total phenols	Antioxidant activity	Non enzymatic browning	Total anthocyanins
Treatments (T)	4	2471.84	84.27	5.86 x 10-1	9.75
Interval (I)	2	10291.81	169.11	2.80 x 10-1	328.87
Error	60	611.65	5.27	9.96 x 10-3	2.64

Source of variation	df	Mean sum of squares			
		Colour	Flavour	Body	Overall acceptability
Treatments (T)	4	3.01 x 10-1	9.28	4.88	2.84 x 10-1
Interval (I)	2	1.25	3.27 x 10-1	5.40 x 10-1	8.41 x 10-1
Error	60	1.39 x 10-1	5.99 x 10-1	4.91 x 10-2	1.59 x 10-1

ANOVA: Effect of storage on the quality characteristics of apple-mango based vegetable juice blends

Source of variation	df	Mean sum of squares				
		TSS	Acidity	Ascorbic acid	Total sugars	Reducing sugars
Treatments (T)	4	18.28	8.37 x 10-3	7.48	20.38	35.11
Interval (I)	2	6.90 x 10-2	4.80 x 10-4	67.33	2.44 x 10-2	4.43 x 10-2
Error	60	2.41 x 10-1	7.33 x 10-4	9.60 x 10-1	5.91 x 10-1	9.53 x 10-1

Source of variation	df	Mean sum of squares			
		Total phenols	Antioxidant activity	Total Carotenoids	Non enzymatic browning
Treatments (T)	4	2263.01	122.94	1.24	5.66 x 10-1
Interval (I)	2	9415.64	129.76	2.72 x 10-2	4.94 x 10-3
Error	60	44.92	3.16	1.23 x 10-2	1.93 x 10-3

Source of variation	df	Mean sum of squares			
		Colour	Flavour	Body	Overall acceptability
Treatments (T)	4	1.54	1.08	9.28	2.30
Interval (I)	2	4.48 x 10-1	4.77 x 10-1	3.28 x 10-1	8.59 x 10-1
Error	60	4.52	3.97 x 10-1	2.46 x 10-3	2.16 x 10-1

ANOVA: Effect of storage on the quality characteristics Apple: Pear: Mango and vegetable juice blends

Source of variation	df	Mean sum of squares				
		TSS	Acidity	Ascorbic acid	Total sugars	Reducing sugars
Treatments (T)	4	12.94	7.04 x 10-3	143.44	5.04	2.37
Interval (I)	2	8.53 x 10-1	2.71 x 10-3	71.98	1.14	3.78 x 10-2
Error	60	1.44 x 10-1	1.08 x 10-3	9.81 x 10-1	1.65	5.94 x 10-2

Source of variation	df	Mean sum of squares			
		Total phenols	Antioxidant activity	Total carotenoids	Non enzymatic browning
Treatments (T)	4	970.79	121.24	4.20 x 10-1	9.46 x 10-1
Interval (I)	2	8520.79	80.33	6.37 x 10-3	1.56 x 10-4
Error	60	244.02	4.67	7.59 x 10-3	2,54 x10-4

ANOVA: Effect of storage on the quality characteristics of Apple: Jamun: Pear based vegetable juice blends

Source of variation	df	Mean sum of squares			
		TSS	Acidity	Total sugars	Reducing sugars
Treatments (T)	4	47.81	7.52 x 10-2	29.93	10.82
Interval (I)	2	4.74 x 10-1	4.69 x 10-3	1.20 x 10-2	6.51 x 10-1
Error	60	3.64	8.63 x 10-4	2.24 x 10-1	6.34 x 10-1

Source of variation	df	Mean sum of squares			
		Total phenols	Antioxidant activity	Total anthocyanins	Non enzymatic browning
Treatments (T)	4	22518.79	446.61	26.30	6.17 x 10-2
Interval (I)	2	13400.89	219.60	82.21	3.03
Error	60	52.05	1.50	3.05 x 10-1	5.31 x 10-3

ANOVA: Effect of storage on the quality characteristics of Apple: Mango: Jamun based vegetable juice blends

Source of variation	df	Mean sum of squares				
		TSS	Acidity	Ascorbic acid	Total sugars	Reducing sugars
Treatments (T)	4	2.90	2.07 x 10-2	171.66	3.87	8.35 x 10-1
Interval (I)	2	1.13	2.80 x 10-4	149.60	1.66 x 10-2	5.97 x 10-2
Error	60	8.25 x 10-1	8.03 x 10-4	2.25	1.54 x 10-1	7.19 x 10-1

Source of variation	df	Mean sum of squares		
		Total phenols	Antioxidant activity	Non enzymatic browning
Treatments (T)	4	28972.13	534.43	5.02 x 10-1
Interval (I)	2	24379.74	148.95	2.17
Error	60	32.45	8.48	3.49 x 10-4

Source of variation	df	Mean sum of squares	
		Total Anthocyanins	Carotenoids
Treatments (T)	4	10.82	5.61 x 10-1
Interval (I)	2	183.71	7.68 x 10-3
Error	60	1.44	5.15 x 10-2

ANOVA: Effect of storage on the quality characteristics of Kinnow-based (two fruit) juice blends

Source of variation	df	Mean sum of squares				
		TSS	Acidity	Ascorbic acid	Total sugars	Reducing sugars
Treatments (T)	3	32.79	2.51 x 10-1	2134.92	19.70	7.06 x 10-1
Interval (I)	2	1.53	4.99 x 10-3	105.21	1.50 x 10-2	1.36 x 10-2
Error	48	1.06 x 10-1	1.03 x 10-2	1.85 x 10-1	9.79 x 10-3	1.50 x 10-2

Source of variation	df	Mean sum of squares			
		Total phenols	Antioxidant activity	Total carotenoids	Non enzymatic browning
Treatments (T)	3	1339.61	5600.34	10.58	1.21
Interval (I)	2	69.56	110.53	5.45 x 10-3	1.82 x 10-4
Error	48	7.27 x 10-2	2.53 x 10-1	7.03 x 10-2	1.58 x 10-4

Source of variation	df	Mean sum of squares			
		Colour	Flavour	Body	Overall acceptability
Treatments (T)	3	1.83×10^{-1}	1.83	19.53	4.40
Interval (I)	2	8.75×10^{-3}	2.25	3.88×10^{-2}	5.09×10^{-2}
Error	48	1.03×10^{-1}	8.99×10^{-2}	2.79×10^{-1}	1.08×10^{-1}

ANOVA: Effect of storage on the quality characteristics of kinnow-based (three fruit) juice blends

Source of variation	df	Mean sum of squares				
		TSS	Acidity	Ascorbic acid	Total sugars	Reducing sugars
Treatments (T)	3	32.56	2.64 x 10-1	4395.72	17.25	17.50
Interval (I)	2	8.06 x 10-1	4.21 x 10-3	409.16	1.61 x 10-2	1.43 x 10-2
Error	48	387.32	2.90 x 10-3	2.41 x 10-1	1.07 x 10-2	4.83 x 10-3

Source of variation	df	Mean sum of squares			
		Total phenols	Antioxidant activity	Total carotenoids	Non enzymatic browning
Treatments (T)	3	19635.68	6388.68	29.48	2.15
Interval (I)	2	472.16	94.63	7.55 x 10-3	1.87 x 10-3
Error	48	2.32 x 10-1	5.44	4.40 x 10-2	2.81 x 10-3

Source of variation	df	Mean sum of squares			
		Colour	Flavour	Body	Overall acceptability
Treatments (T)	3	1.88	11.85	3.93	4.40
Interval (I)	2	9.76×10^{-1}	5.29×10^{-1}	7.10×10^{-2}	5.09×10^{-2}
Error	48	8.33×10^{-2}	4.41×10^{-1}	1.26×10^{-1}	1.08×10^{-1}

ANOVA: Effect of storage on the quality characteristics of Kinnow-Aonla based vegetable juice blends

Source of variation	df	Mean sum of squares				
		TSS	Acidity	Ascorbic acid	Total sugars	Reducing sugars
Treatments (T)	4	9.44	9.69 x 10-1	1017.08	5.13 x 10-1	6.24
Interval (I)	2	9.69 x 10-1	5.07 x 10-3	112.45	9.21 x 10-3	1.08 x 10-2
Error	60	4.46 x 10-2	6.01 x 10-3	1.75	3.55 x 10-3	8.95 x 10-3

Source of variation	df	Mean sum of squares			
		Total phenols	Antioxidant activity	Total carotenoids	Non enzymatic browning
Treatments (T)	4	7637.22	283.16	39.63	39.45
Interval (I)	2	500.88	111.40	1.46 x 10-2	3.57 x 10-4
Error	60	6.80	4.26	4.00 x 10-3	1.30 x 10-3

ANOVA: Effect of storage on the quality characteristics of kinnow-papaya-based vegetable juice blends

Source of variation	df	Mean sum of squares				
		TSS	Acidity	Ascorbic acid	Total sugars	Reducing sugars
Treatments (T)	4	9.46	2.33 x 10-1	68.70	2.70	3.03
Interval (I)	2	2.70 x 10-2	3.33 x 10-3	89.32	9.90 x 10-2	1.29 x 10-3
Error	60	6.98 x 10-2	1.81 x 10-3	1.80	3.30 x 10-2	2.44 x 10-3

Source of variation	df	Mean sum of squares			
		Total phenols	Antioxidant activity	Total carotenoids	Non enzymatic browning
Treatments (T)	4	9775.87	186.39	20.81	16.48
Interval (I)	2	83.76	135.59	1.09 x 10-2	1.90 x 10-3
Error	60	4.74	2.39	5.09 x 10-1	7.18 x 10-4

ANOVA: Effect of storage on the quality characteristics of Kinnow: Red grapes based vegetable juice blends

Source of variation	df	Mean sum of squares				
		TSS	Acidity	Ascorbic acid	Total sugars	Reducing sugars
Treatments (T)	4	11.32	4.27 x 10-1	57.56	5.56	2.47
Interval (I)	2	3.62 x 10-1	2.80 x 10-4	68.44	1.39 x 10-2	1.39 x 10-2
Error	60	8.76 x 10-2	7.57 x 10-4	2.54	3.14 x 10-3	1.04 x 10-2

Source of variation	df	Mean sum of squares		
		Total phenols	Antioxidant activity	Non enzymatic browning
Treatments (T)	4	1824.92	423.41	30.46
Interval (I)	2	169.56	842.33	7.30 x 10-2
Error	60	3.54	3.15	32539.32

Source of variation	df	Mean sum of squares	
		Anthocyanins	Carotenoids
Treatments (T)	4	449.54	42.44
Interval (I)	2	132.66	1.32 x 10-2
Error	60	6.33	1.09 x 10-3

ANOVA: Effect of storage on the quality characteristics of Kinnow: Aonla: Red grapes-based vegetable juice blends

Source of variation	df	Mean sum of squares				
		TSS	Acidity	Ascorbic acid	Total sugars	Reducing sugars
Treatments (T)	4	10.47	5.95 x 10-1	341.35	5.56	7.18
Interval (I)	2	5.69 x 10-1	5.49 x 10-3	122.44	1.88 x 10-2	2.61 x 10-2
Error	60	3.09 x 10-2	3.99 x 10-2	5.01	1.74 x 10-1	1.16 x 10-1

Source of variation	df	Mean sum of squares			
		Total phenols	Total carotenoids	Antioxidant activity	Non enzymatic browning
Treatments (T)	4	4928.16	41.16	181.89	30.61
Interval (I)	2	471.31	1.73 x 10-2	174.26	3.35 x 10-1
Error	60	19.67	1.30 x 10-1	7.05	1.39 x 10-3

ANOVA: Effect of storage on the quality characteristics of Kinnow: Papaya: Aonla based vegetable juice blends

Source of variation	df	Mean sum of squares				
		TSS	Acidity	Ascorbic acid	Total sugars	Reducing sugars
Treatments (T)	4	12.30	2.47 x 10-1	48.43	17.96	2.89
Interval (I)	2	1.21	5.92 x 10-3	60.54	1.20 x 10-2	2.13 x 10-2
Error	60	4.34 x 10-2	1.79 x 10-3	1.65	2.02 x 10-2	5.61 x 10-3

Source of variation	df	Mean sum of squares		
		Total phenols	Antioxidant activity	Non enzymatic browning
Treatments (T)	4	875.05	1200.88	30.26
Interval (I)	2	240.50	296.78	3.46 x 10-1
Error	60	3.60	4.37	1.23 x 10-3

Source of variation	df	Mean sum of squares	
		Anthocyanins	Carotenoids
Treatments (T)	4	429.36	39.22
Interval (I)	2	118.72	3.68 x 10-2
Error	60	2.60	1.52 x 10-1

ANOVA: Effect of storage on quality characteristics of Kinnow: Red Grapes: Papaya-based vegetable juice blends

Source of variation	df	Mean sum of squares				
		TSS	Acidity	Ascorbic acid	Total sugars	Reducing sugars
Treatments (T)	4	5.99	4.81 x 10-1	913.39	6.35	4.52
Interval (I)	2	1.53	5.08 x 10-3	633.34	1.20 x 10-2	2.62 x 10-2
Error	60	5.00 x 10-2	2.18 x 10-3	5.75	5.84 x 10-3	5.29 x 10-1

Source of variation	df	Mean sum of squares		
		Total phenols	Antioxidant activity	Non enzymatic browning
Treatments (T)	4	6166.26	86.78	36.05
Interval (I)	2	372.46	211.76	2.59 x 10-4
Error	60	4.45	10.06	4.21 x 10-3

Source of variation	df	Mean sum of squares	
		Anthocyanins	Carotenoids
Treatments (T)	4	429.36	39.80
Interval (I)	2	118.72	2.19 x 10-2
Error	60	2.60	3.25 x 10-2

Development of winter season juice blends

Source	df	Kinnow: Aonla				Kinnow: Papaya			
		Colour	Flavour	Body	OAA	Colour	Flavour	Body	OAA
Treatment	9	2.29	3.58 x 10-1	1.59 x 10^{-1}	3.66 x 10-1	9.29 x 10^{-1}	9.45 x 10^{-2}	9.89 x 10^{-12}	9.35 x 10^{-1}
Replication	2	2.12 x 10^{-2}	6.25 x 10^{-3}	0.00	1.00 x 10-3	3.44 x 10-1	1.24 x 10^{-2}	1.51 x 10^{-32}	2.56 x 10^{-3}
Error	18	2.07 x 10^{-3}	6.45 x 10^{-3}	1.49 x 10^{-4}	1.20 x 10-3	8.09 x 10^{-2}	1.02 x 10^{-2}	1.29 x 10^{-2}	6.05 x 10^{-3}

Source	df	Kinnow: Red grapes				Kinnow: Aonla: Red grapes			
		Colour	Flavour	Body	OAA	Colour	Flavour	Body	OAA
Treatment	9	7.87 x 10^{-1}	8.85 x 10^{-1}	4.61 x 10^{-1}	3.59 x 10^{-1}	2.29	3.66 x 10-1	3.59 x 10^{-1}	2.60 x 10^{-1}
Replication	2	1.48 x 10^{-2}	2.23 x 10^{-2}	5.30 x 10^{-3}	6.27 x 10^{-3}	2.12 x 10-2	1.00 x 10-3	6.27 x 10^{-3}	9.00 x 10^{-5}
Error	18	5.32 x 10^{-3}	6.20 x 10^{-3}	3.36 x 10^{-3}	6.49 x 10^{-3}	2.07 x 10-3	1.20 x 10-3	6.49 x 10^{-3}	2.46 x 10^{-4}

Source	df	Kinnow: Papaya: Aonla				Kinnow: Red grapes: Papaya			
		Colour	Flavour	Body	OAA	Colour	Flavour	Body	OAA
Treatment	9	2.29	3.80 x 10-1	3.66 x 10-1	1.82 x 10-1	7.40 x 10-2	9.79 x 10-2	7.05 x 10-1	3.08 x 10-1
Replication	2	2.12 x 10-2	1.96 x 10-3	1.00 x 10-3	1.00 x 10-5	6.30 x 10-5	1.37 x 10-2	3.86 x 10-2	1.61 x 10-1
Error	18	2.07 x 10-3	5.36 x 10-4	1.20 x 10-3	1.30 x 10-3	9.05 x 10-4	1.05 x 10-2	2.69 x 10-2	3.91 x 10-2

Source	df	Kinnow: Aonla: Beet root				Kinnow: Aonla: Cabbage			
		Colour	Flavour	Body	OAA	Colour	Flavour	Body	OAA
Treatment	9	1.74	2.37	1.80 x 10^{-1}	1.99	6.61 x 10^{-2}	2.80 x 10^{-1}	3.36 x 10^{-1}	2.42 x 10^{-1}
Replication	2	3.60 x 10^{-4}	2.192 x 10^{-2}	2.40 x 10^{-3}	0.00	1.85 x 10^{-3}	8.41 x 10^{-3}	6.17 x 10^{-3}	1.00 x 10^{-6}
Error	18	2.04 x 10^{-3}	2.16 x 10^{-3}	8.58 x 10^{-4}	4.22 x 10^{-4}	9.65 x 10^{-4}	1.77 x 10^{-3}	6.29 x 10^{-3}	9.78 x 10^{-4}

Source	df	Kinnow: Aonla: Tomato				Kinnow: Aonla: Carrot			
		Colour	Flavour	Body	OAA	Colour	Flavour	Body	OAA
Treatment	9	3.08 x 10^{-2}	7.60 x 10^{-2}	3.80 x 10-1	4.61	3.08 x 10^{-2}	3.65 x 10^{-1}	1.74 x 10^{-1}	2.42 x 10^{-1}
Replication	2	4.00 x 10^{-5}	6.50 x 10^{-5}	1.96 x 10^{-3}	5.45 x 10^{-3}	4.00 x 10^{-5}	6.38 x 10^{-3}	3.61 x 10^{-3}	1.00 x 10^{-6}
Error	18	1.13 x 10^{-4}	9.25 x 10^{-4}	5.36 x 10^{-4}	3.68 x 10^{-3}	1.13 x 10^{-4}	6.55 x 10^{-3}	1.02 x 10^{-3}	9.78 x 10^{-4}

Source	df	Kinnow: Papaya: Tomato				Kinnow: Papaya: Carrot			
		Colour	Flavour	Body	OAA	Colour	Flavour	Body	OAA
Treatment	9	2.35	2.37	3.59 x 10^{-1}	9.05 x 10^{-1}	6.61 x 10^{-2}	5.74 x 10^{-1}	3.36 x 10^{-1}	2.42 x 10^{-1}
Replication	2	2.19 x 10^{-2}	2.192 x 10^{-2}	6.27 x 10^{-3}	1.60 x 10^{-4}	1.85 x 10^{-3}	9.00 x 10^{-5}	6.17 x 10^{-3}	1.00 x 10^{-6}
Error	18	2.13 x 10^{-3}	2.16 x 10^{-3}	6.49 x 10^{-3}	4.98 x 10^{-3}	9.65 x 10^{-4}	2.23 x 10^{-4}	6.29 x 10^{-3}	9.78 x 10^{-4}

Source	df	Kinnow: Red grapes: Tomato				Kinnow: Red grapes: Carrot			
		Colour	Flavour	Body	OAA	Colour	Flavour	Body	OAA
Treatment	9	7.87 x 10-1	2.37	3.59 x 10^{-1}	7.01 x 10^{-1}	9.79 x 10^{-2}	3.65 x 10^{-1}	3.36 x 10^{-1}	4.57 x 10^{-1}
Replication	2	1.48 x 10^{-2}	2.192 x 10^{-2}	6.27 x 10^{-3}	3.82 x 10^{-3}	1.41 x 10^{-23}	6.38 x 10^{-3}	6.17 x 10^{-3}	2.25 x 10^{-3}
Error	18	5.32 x 10^{-3}	2.16 x 10^{-3}	6.49 x 10^{-3}	2.69 x 10^{-2}	1.11 x 10^{-2}	6.55 x 10^{-3}	6.29 x 10^{-3}	1.45 x 10^{-3}

Source	df	Kinnow: Papaya: Beet root				Kinnow: Papaya: Cabbage			
		Colour	Flavour	Body	OAA	Colour	Flavour	Body	OAA
Treatment	9	2.35	2.37	3.59 x 10^{-1}	6.56 x 10^{-2}	6.61 x 10^{-2}	3.65 x 10^{-1}	3.36 x 10^{-1}	2.42 x 10^{-1}
Replication	2	2.19 x 10^{-2}	2.192 x 10^{-2}	6.27 x 10^{-3}	1.82 x 10^{-3}	1.85 x 10^{-3}	6.38 x 10^{-3}	6.17 x 10^{-3}	1.00 x 10^{-6}
Error	18	2.13 x 10^{-3}	2.16 x 10^{-3}	6.49 x 10^{-3}	9.67 x 10^{-4}	9.65 x 10^{-4}	6.55 x 10^{-3}	6.29 x 10^{-3}	9.78 x 10^{-4}

Source	df	Kinnow: Red grapes: Beet root				Kinnow: Red grapes: Cabbage			
		Colour	Flavour	Body	OAA	Colour	Flavour	Body	OAA
Treatment	9	3.16 x 10^{-1}	2.37	3.59 x 10^{-1}	7.43 x 10^{-12}	6.61 x 10^{-2}	3.65 x 10^{-1}	9.05 x 10^{-1}	9.05 x 10^{-1}
Replication	2	3.61 x 10^{-2}	2.192 x 10^{-2}	6.27 x 10^{-3}	6.30 x 10^{-5}	1.85 x 10^{-3}	6.38 x 10^{-3}	1.60 x 10^{-6}	1.00 x 10^{-6}
Error	18	5.72 x 10^{-3}	2.16 x 10^{-3}	6.49 x 10^{-3}	9.17 x 10^{-2}	9.65 x 10^{-4}	6.55 x 10^{-3}	4.98 x 10^{-4}	9.78 x 10^{-4}

Source	df	Kinnow: Aonla: Red grapes: Tomato				Kinnow: Aonla: Red grapes: Carrot			
		Colour	Flavour	Body	OAA	Colour	Flavour	Body	OAA
Treatment	9	7.87 x 10-1	4.56 x 10^{-1}	3.59 x 10^{-1}	3.58 x 10^{-21}	7.87 x 10^{-1}	7.85 x 10^{-1}	3.36 x 10^{-1}	5.94 x 10^{-1}
Replication	2	1.48 x 10^{-2}	2.25 x 10^{-32}	6.27 x 10^{-3}	6.25 x 10^{-3}	1.48 x 10^{-2}	1.49 x 10^{-2}	6.17 x 10^{-3}	3.80 x 10^{-3}
Error	18	5.32 x 10^{-3}	1.46 x 10^{-3}	6.49 x 10^{-3}	6.45 x 10^{-4}	5.32 x 10^{-3}	5.31 x 10^{-3}	6.29 x 10^{-3}	1.50 x 10^{-3}

Source	df	Kinnow: Aonla: Red grapes: Beet root				Kinnow: Aonla: Red grapes: Cabbage			
		Colour	Flavour	Body	OAA	Colour	Flavour	Body	OAA
Treatment	9	2.65	4.57 x 10^{-1}	5.74 x 10^{-1}	2.45	3.80 x 10^{-2}	5.77 x 10^{-1}	6.71 x 10^{-1}	6.21 x 10-1
Replication	2	2.19 x 10^{-2}	2.25 x 10^{-3}	9.00 x 10^{-3}	2.25 x 10^{-2}	1.96 x 10^{-3}	4.98 x 10^{-3}	2.56 x 10^{-2}	6.25 x 10^{-3}
Error	18	2.13 x 10^{-3}	1.45 x 10^{-3}	2.23 x 10^{-3}	2.35 x 10^{-3}	5.38 x 10^{-4}	8.60 x 10^{-3}	4.34 x 10^{-3}	3.76 x 10^{-3}

Source	df	Kinnow: Papaya: Aonla: Tomato				Kinnow: Papaya: Aonla: Carrot			
		Colour	Flavour	Body	OAA	Colour	Flavour	Body	OAA
Treatment	9	4.61 x 10^{-1}	7.40 x 10^{-2}	7.40 x 10^{-2}	7.40 x 10^{-2}	2.48 x 10^{-1}	3.80 x 10^{-1}	2.48 x 10^{-1}	4.53 x 10^{-1}
Replication	2	5.30 x 10^{-3}	6.30 x 10^{-5}	6.30 x 10^{-5}	6.30 x 10^{-5}	1.00 x 10^{-6}	1.96 x 10^{-3}	1.00 x 10^{-6}	5.21 x 10^{-3}
Error	18	3.36 x 10^{-3}	9.07 x 10^{-4}	9.07 x 10^{-4}	9.07 x 10^{-4}	9.78 x 10^{-4}	5.38 x 10^{-3}	9.78 x 10^{-4}	3.16 x 10^{-3}

Source	df	Kinnow: Red grapes: Papaya: Tomato				Kinnow: Red grapes: Papaya : Carrot			
		Colour	Flavour	Body	OAA	Colour	Flavour	Body	OAA
Treatment	9	2.35	7.34 x 10^{-2}	7.34 x 10^{-2}	2.40	9.65 x 10^{-2}	7.40 x 10^{-2}	3.116 x 10^{-1}	2.60 x 10^{-1}
Replication	2	2.19 x 10^{-2}	6.30 x 10^{-5}	6.30 x 10^{-5}	2.17 x 10^{-2}	1.40 x 10^{-2}	6.30 x 10^{-5}	3.56 x 10^{-3}	9.00 x 10^{-5}
Error	18	2.13 x 10^{-3}	9.11 x 10^{-4}	9.11 x 10^{-4}	2.14 x 10^{-3}	1.03 x 10^{-2}	9.05 x 10^{-4}	5.67 x 10^{-3}	2.46 x 10^{-4}

Source	df	Kinnow: Red grapes: Papaya : Beet root				Kinnow: Red grapes: Papaya : Cabbage			
		Colour	Flavour	Body	OAA	Colour	Flavour	Body	OAA
Treatment	9	7.42×10^{-2}	2.60×10^{-1}	9.71×10^{-2}	3.03×10^{-1}	7.40×10^{-2}	4.57×10^{-1}	4.75×10^{-1}	2.23×10^{-1}
Replication	2	6.37×10^{-5}	9.00×10^{-5}	1.40×10^{-2}	3.56×10^{-3}	6.30×10^{-5}	2.25×10^{-3}	5.50×10^{-3}	1.12×10^{-1}
Error	18	9.07×10^{-4}	2.46×10^{-4}	1.11×10^{-2s}	5.78×10^{-3}	9.05×10^{-4}	1.45×10^{-3}	3.79×10^{-3}	1.18×10^{-1}

Source	df	Kinnow: Papaya: Aonla: Beet root				Kinnow: Papaya: Aonla : Cabbage			
		Colour	Flavour	Body	OAA	Colour	Flavour	Body	OAA
Treatment	9	9.35×10^{-1}	2.48×10^{-1}	4.41×10^{-1}	4.61×10^{-1}	2.96×10^{-1}	3.58×10^{-1}	3.65×10^{-1}	7.02×10^{-1}
Replication	2	2.56×10^{-3}	1.00×10^{-6}	5.23×10^{-3}	5.30×10^{-3}	2.85×10^{-3}	6.25×10^{-3}	6.27×10^{-3}	3.84×10^{-2}
Error	18	6.05×10^{-3}	9.78×10^{-4}	3.16×10^{-3}	3.36×10^{-3}	4.65×10^{-3}	6.45×10^{-3}	6.49×10^{-3}	2.69×10^{-2}

APPENDIX-II

Performa for Sensory Evaluation of Juice Blends

Sample: ____

Date of Evaluation: ____

Evaluator Name: ____

Sample No.	Colour	Body	Flavour	Overall Acceptability
T_1				
T_2				
T_3				
T_4				
T_5				

❖ Rating on 9 point Hedonic scale as:

9 : Like extremely
8 : Like very much
7 : Like moderately
6 : Like slightly
5 : Neither like nor dislike
4 : Dislike slightly
3 : Dislike moderately
2 : Dislike very much
1 : Dislike extremely

➢ Special observations, if any with particular treatment

____

____

Signature of evaluator

CURRICULUM VITAE

Name	**:**	Vigya Mishra
Father’s Name	**:**	Sh. Vinod Kant Mishra
Date of Birth	**:**	8th June, 1986
E-mail	**:**	vigya_horticulture@rediffmail.com
Sex	**:**	Female
Marital Status	**:**	Unmarried
Nationality	**:**	Indian

Educational Qualifications:

Certificate/ degree	Class/ grade	Board/ University	Year
Metric	First	UP State Board	2000
10+2	First	UP State Board	2002
B.Sc.	First	DDU Gorakhpur University	2005
M. Sc.	First	BBAU, Lucknow	2008
NET	-	ASRB, ICAR, New Delhi	2010

Whether sponsored by some state/ Central Govt./Univ./SAARC	:	NA
Scholarship/ Stipend/ Fellowship, any other financial assistance received during the study period	:	University merit scholarship for Ph. D. Research Fellowship of DST

(Vigya Mishra)