DEVELOPMENT AND EVALUATION OF BEVERAGES FROM ASH GOURD FRUIT

Thesis

by

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CERTIFICATE- I

This is to certify that the thesis titled **"Development and Evaluation of beverages from Ash gourd fruit"** submitted in partial fulfilment of the requirements for the award of the degree of Master of Science (Food Technology)in the discipline of **Food Science and Technology** of Dr. Yashwant Singh Parmar University of Horticulture& Forestry, (Nauni) Solan (HP) – 173 230 is a bonafide research work carried out by **Ms. Pooja Thakur (NH-2019-14-M)** daughter of Shri Charanji Lal under my supervision and that no part of this thesis has been submitted for any other degree or diploma.

The assistance and help received during the course of this investigation has been fully acknowledged.

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CERTIFICATE - II

This is to certify that the thesis entitled, **"Development and evaluation of beverages from ash gourd fruit "** submitted by **Ms. Pooja Thakur (NH-2019-14-M)**daughter of Shri Charanji Lal to Dr.Yashwant Singh Parmar University of Horticulture & Forestry, (Nauni) Solan (HP) in partial fulfilment of the requirements for the award of degree of **Master of Science (Food Technology)** in the discipline of **Food Science and Technology** has been approved by the Student's Advisory Committee after an oral examination of the student in collaboration with an External Examiner.

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CONTENTS

ABBREVIATIONS USED

%	:	Per cent
/	:	Per
@	:	At the rate of
µg	:	Microgram
ANOVA	:	Analysis of Variance
CD	:	Critical difference
cfu	:	Colony forming units
cm	:	Centimeter
et al.	:	Co-workers
etc.	:	et cetera
FSSAI	:	Food Safety and Standards Authority of India
g	:	Gram
GAE	:	Gallic acid equivalent
hrs/hr	:	Hours
i.e.	:	that is
kg	:	Kilogram
KMS	:	Potassium meta-bisulphite
mg	:	Milligram
min	:	Minute
ml	:	Millilitre
nm	:	Nanometer
NS	:	Non-Significant
O.D	:	Optical Density
^{o}B	:	Degree brix
^{o}C	:	Degree Celsius
pH		Power of hydrogen
ppm	:	Parts Per Million
rpm	:	Revolution per minute
Rs.	:	Rupees
RTS	:	Ready to Serve beverages
TPC	:	Total plate count
TSS	:	Total soluble solids
viz.	:	Namely
w/v	:	Weight by volume
w/w	:	Weight by weight

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Chapter-1

INTRODUCTION

In India, Ash gourd (*Benincasa hispida* Thunb.) is grown extensively in Uttar Pradesh, Madhya Pradesh, Maharashtra, Kerala, Karnataka, Andhra Pradesh and Tamil Nadu for both mature and immature fruits (Pradhan *et al.,* 2020). India has a rich diversity of Cucurbitaceae which is considered as the primary and secondary center of origin of several gourds and melons (Choudhury, 2017). Ash gourd (*Benincasa hispida* Thunb.), also known as winter melon, white gourd, white pumpkin, wax gourd, etc. (Seshadri, 1993), belongs to family Cucurbitaceae, is an annual trailing or climbing herb (Walters, 1989). The Ash gourd is thought to have been introduced in India from Japan and java by foreign navigators and missionaries (Peter, 1998) and is believed to be a native plant of Southern Asia. Petha (Hindi), Kundur (Malay), Bhuru Kolu or Safed Kolu (Gujarati), Kushmanda (Sanskrit), Donggua (Chinese), and Beligo (Indonesia) or Winter melon/Wax gourd (English) are a few important alternate names of ash gourd used by the people in different countries of the world (Bimakar *et al.,* 2012).

Fruits are covered by a white chalky wax which deters microorganism and impart longevity to the gourd (Haque *et al.,* 2008). Fruits are mostly used for edible purpose and seed production (George, 2008). The ash gourd fruit peel is light green to dark green in colour with a bland taste, aroma and flavor of fruit juice (Kadam and Lele, 2016). Apart from edible uses, the remaining portion of the cucurbit fruits, often discarded as agro-waste, can be utilized for other food applications such as preservative, animal feed and oil extraction, contributing to less waste disposal and value-addition (Sew *et al.,* 2010). In Himachal Pradesh no exact figures on cultivation of ash gourd are available but fruits can be seen in some places where these are utilized for making petha. The immatured fruit is used for curry preparation whereas the matured one is for seed oil extraction and value addition (Majumdar *et al.,* 2009). In India, the ash gourd is usually used to worship Gods in religious ceremonies but can also be utilized for making processed products like jam, ketchup, beverages, cakes, sweets, and ice cream (Palamthodi *et al.,* 2019).

The fruit is harvested after complete drying of the stalk. In North India, ash gourd is used for the preparation of petha as a sweet item, also famous as ‘Agra ka Petha’ and in South India, it is used as a fruit drink (Rashinkar, 2012). In ayurvedic ‘kushmanda

rasayanam' is prepared by using the fruit of ash gourd, which is used as a nerve tonic and health rejuvenator (George, 2008).

Ash gourd is useful in treating different disorders like diabetes mellitus, diuresis diseases, chronic inflammatory (Lee *et al.,* 2005), epilepsy, cough, fever, heart conditions, liver disorders (Dhiman *et al.,* 2012), as well as an antibiotic and purgative vermifuge. Ash gourd juice is a popular home remedy for peptic ulcers. In Ayurveda, it is recommended for treating urinary tract infections, diabetes mellitus, epilepsy and other nervous system disorders (Palamthodi and Lele, 2014) and traditionally used to treat nervousness and delibity (Nadhiya and Vijaylakshmi, 2014). However, ash gourd is proved to have excellent prebiotic activity (Sreenivas and Lele, 2013), anti-mercurial, an antidote for alcohol poisoning, laxative, diuretic, and also helps in curing internal hemorrhages and constipation (CSIR, 1962). As a rich source of bio-actives and therapeutics such as triterpenes, phenolics, sterols, glycosides, and soluble dietary fibre, ash gourd is appreciated for therapeutic treatment (Prachi and Premavalli, 2010). The seed of ash gourd has medicinal properties as anti-angiogenic, anti-tumor, antioxidant, anti-nociceptive, and antipyretic activities (Bimakar *et al.,* 2012). However, ash gourd juice is used as supplement which reduces gastritis, infection and over breathing (Bhalodia *et al.,* 2009). Overall, we can conclude that ash gourd fruit can be explored as a potential source of high-value components for the functional food and nutraceutical industry (Zaini *et al.,* 2011).

Now a day, beverages are playing an important role in healthy diet. They are considered superior medium for the supplementation of nutrients such as vitamins, minerals, and antioxidants than the synthetic products, which are available in the market throughout the country (Dhiman *et al.,* 2017). A beverage is a drink processed for human consumption and confers greatly to quench thirst. Ziadi and Khan (2008) classify any drink other than water as a beverage. The beverages are retailed under a diverse name such as ready-to-serve, sweetened juice, squash, nectar, etc. (Kumar *et al.,* 2013).

A large number of cucurbitaceous species, which have not been exploited or are under-exploited, have a great potential for contributing to nutritive food requirement. Among them, ash gourd (*Benincasa hispida*) is an important (Pandey *et al.,* 2015). Due to the high pH level of vegetable juices, they are eminently prone to microbial contamination. Thus, it seems ideal to develop some value-added products which will boost the shelf life as well as properties of the beverage (Curi *et al.,* 2017). Therefore, there is an opportune moment to

promote the use of fruits and vegetables beverages which shall go a long way is not only meeting the nutritional requirements of the population but will have positive impact on the national economy and substantial rural development. (Dhiman *et al.,* 2017). Fruit, vegetable or herbal juices could play an important role in enhancing human health (Pushpa *et al.,* 2016).

Thus, keeping in view, the excellent nutritive as well as pharmaceutical significance of ash gourd fruit, there is a tremendous scope to utilize the ash gourd fruit for the preparation of some value- added products such as sweetened beverage and squash. In North India the fruit is commercially used for preparation of petha as a sweet item. The available information on the preparation of beverages from ash gourd and its storage is scanty in the literature. It is thereby envisaged that the successful development of beverages may possibly shift the trend of the consumer towards juice based beverages, which will not only result in primary nutritional drink to the consumers and diversify the industry but also aid in efficient utilization of ash gourd fruit in our state and country as a whole. So, the present investigation entitled "Development and Evaluation of beverages from Ash gourd fruit" have been undertaken with the following main objectives:

i) To evaluate the physico-chemical attributes of ash gourd fruit juice.
ii) To utilize ash gourd juice in the preparation of beverages.
iii) To study the storage stability of juice and developed beverages.

Chapter-2

REVIEW OF LITERATURE

To popularize ash gourd cultivation, efforts are being made to develop some value added processed products from fruits so that local people adopt them as an economic plant for their area. Exceptional therapeutic and nutritive property of ash gourd fruit offers a huge potential for processing into various value-added products. Except for a few solitary reports on functional and therapeutic properties of different parts of ash gourd fruit and utilization of fruit for making jam, ketchup, ice-cream especially petha, no systematic work has been conducted on development and evaluation of beverages from ash gourd fruit. The detail of research work carried out elsewhere in literature on relevant different aspects of preparation of beverages and storage stability has been presented here under:

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2.5.1 CHEMICAL CHARACTERISTICS

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2.1 PHYSICAL CHARACTERISTICS

The physical characteristics of fruits play a very important role in the development of processing technology and the quality of the final product. Aleem (2007) noticed white colour of ash gourd pulp with greenish tinge, having white colored seeds which are characterized elliptical in shape. The mean fruit weight is reported to be as 5.5 kg which constitutes 2.5 g. seed weight, 1.37 kg peel weight and 4.12 kg edible portion. According to Jyothi and Narayanankutty (2010) the average ash gourd fruit weight ranged between 1.0 to 10.0 kg. On an average basis the weight of ash gourd fruit was found more than 3 kg with size parameters ranging between 28-30 cm length, 27-30 cm breadth and 34-37 cm circumference. However, physical parameters of fruit varied with increase in the size of fruit Kapaleshwar (2010). Further, ash gourd fruits are characterized by oval or round in shape, with light green colour having average fruit weight of 4 kg, 24 cm length, and 17 cm width (Rashinkar, 2012). Wax gourd (*Benincasa hispida* Thunb.) is known as a crop with a strong sink strength having and produces fresh weight per single fruit about 50 kg (Dhillon *et al.,* 2016) or normally upto 20 kg (Xie *et al.,* 2019).

2.2 CHEMICAL CHARACTERISTICS

Mathad *et al.* (2005) reported that ash gourd fruit is a rich source of tri-terpenoids, flavonoids, glycosides, carotene, vitamins. According to Kapaleshwar (2010) edible portion of the matured fruit contained 0.58 g protein, 0.28 g fat, 1.68 per cent carbohydrates, 0.73 mg iron, 0.036 mg, copper and 0.14 mg/100 g zinc.

2.2.1 Moisture content

The moisture content in immatured and matured fruit of ash gourd was recorded 95.80 and 96.20 per cent, respectively by Julia (1971). Similarly, Aleem (2007); Duke and Ayenshu (2010) and Gopalan *et al.* (2007) and Kapaleshwar (2010) reported water content in ash gourd fruits to range between 95.00 to 96.20 per cent. While, Nurul *et al.* (2011) recorded higher values of moisture content (96.1-98.6 per cent) in ash gourd fruits grown in different countries of the world. Rashinkar (2012) and Bimakar *et al.* (2012) reported it to be 95.00 to 96.20 per cent in ash gourd fruits.

2.2.2 Total solids

According to Sunita (2019) the average total solids content in ash gourd juice was found to be 3.9 per cent.

2.2.3 Ash content

Aleem (2007) recorded 0.9 g/100 g total ash content in ash gourd fruit. However, the ash content of ash gourd has been reported as 0.3 to 0.45 g/100 g by Nurul *et al.* (2011) grown in different countries.

2.2.4 Total soluble solids (TSS)

There is a gradual increase in total soluble solids as the fruit approaches maturity. Aleem (2007) reported 2 °B TSS content in ash gourd fruit. Later on, Kapaleshwar (2010) and Rashinkar (2012) recorded 2.5 and 3 °B TSS in fresh ash gourd fruits, respectively. The total soluble solids content in ash gourd fruit has been reported to range between 2.35 to 3.55°B (Palamthodi *et al*., 2019).

2.2.5 Titrable acidity

The titrable acidity (%) in ash gourd fruits was estimated as 0.14 per cent, 1.20 per cent, 0.04 per cent and 0.135 per cent by Aleem (2007); Kapaleshwar (2010); Rashinkar (2012) and Sunita (2019), respectively.

2.2.6 pH

The pH of fruit greatly influenced by storage stability and impacts on flavour and other juice characteristics. Kapaleshwar (2010) reported 4.90 pH in ash gourd fruit. However, Sunita (2019) recorded higher values of pH (6.50).

2.2.7 Sugars

Ash gourd fruits had 1.3 per cent total sugar content and 0.6 per cent reducing sugars (Aleem, 2007). However, Kapaleshwar (2010) recorded 0.98 mg total sugars and 0.69 mg reducing sugars. Rashinkar (2012) reported that different samples of ash gourd fruit contained 32.97 per cent total sugars, 8.12 per cent reducing sugars and 24.2 per cent non-reducing sugars.

2.2.8 Ascorbic acid

The level of ascorbic acid in ash gourd fruits has been reported as 9.5 mg/100g by Aleem (2007), 11.04 mg of ascorbic acid per 100g by Kapaleshwar (2010), 0.55 mg/100g by Rashinkar (2012) and 4.00 mg/100 g by Busuioc *et al.* (2020). However, in ash gourd fruits grown in different countries, the level of vitamin C was 1.35 to 68 mg/100g (Nurul *et al.*, 2011).

2.2.9 Total Phenols

Total phenolic content of ash gourd pulp and fruits has been reported as 184.9 per cent by Abdullah (2012) and 28.36 per cent by Devaki and Premavalli (2012). According to Ahmad (2013) phenolic content of *Benincasa hispida* ranged between 3 mg/lt to 12 mg/lt. However, Busuioc *et al.* (2020) recorded lower values of total phenolic content (10.32 mgGAE/ml) in *Benincasa hispida*.

2.2.10 Crude Fibre

Immatured ash gourd fruits had 0.56 per cent crude fibre while matured contained higher content of crude fibre as 0.68 per cent (Mortan, 1971). However, Aleem (2007) recorded crude fibre as 1.7 per cent. Later on, Nurul *et al.* (2011) recorded 0.5 to 1.5 per cent crude fibre in ash gourd fruits grown in different countries.

2.2.11 Antioxidant Activity

Abdullah (2012) reported antioxidant activity of ash gourd pulp as 195.17 µg/ml. Methanolic extract of dried peels of *Benincasa hispida* was found to have highest scavenging activity i.e. 87.87 per cent at concentration of 100 µg mL^{-1} (Rana and Suttee, 2012). Further, Badhani *et al.* (2013) recorded the free radical scavenging activity of *Benincasa hispida* and found the scavenging activity of DPPH as 59.7 per cent at concentration of 200 µg mL^{-1} for aqueous extract and for ethanolic extract it was 77.4 per cent at concentration of 250 µg mL^{-1}. Yenda *et al.* (2014) investigated in vitro antioxidant activity of hexane, ethyl acetate and methanolic extract of *Benincasa hispida* leaves by using superoxide radical, hydroxyl radical and DPPH radical scavenging methods and concluded that the methanolic extract of *Benincasa hispida* shows better antioxidant activity as compared to others.

2.3 METHOD FOR EXTRACTION OF JUICE

The pulp/juice yield, vary with fruit structure, its composition and with the methods of extraction. Chobbe (1999) obtained maximum (55 per cent) pomegranate juice yield with screw type juice extractor followed by basket press (48 per cent) and lowest (40 per cent) in muslin cloth. While, Panesar *et al.* (2000) obtained maximum (49.6 per cent) juice yield in kinnow fruits by using screw extraction method and lowest (47.2 per cent) in hand Reaming method.

Barwal *et al.* (2005) standardized the juice extraction method from bitter gourd and recorded 50 per cent juice by basket pressing after grating followed by 30 per cent with spiral pressing and 10 per cent with carrot grater after blanching, seeds were removed manually and segments were fed to the centrifugal juice extractor. The extracted juice was strained through muslin cloth to obtain clear juice. Fruit juice have been extracted by using various methods such as screw type machine for kinnow mandarin and ginger rhizome (Nath *et al.* 2005) and home-scale food processor to extract the juice from bottle gourd fruits (Madhukar, 2008).

According to Majumdar *et al.* (2010), the method for extraction of ash gourd juice involves removal of the rind, cutting into pieces, then blanching of pieces for 2 minutes in boiling water, and finally passing through a juice extractor. Pareek (2010) found that extraction of Nagpur mandarin juice by using screw type extractor followed by processing at 65 °C for 15 minutes maintained better qualitative characteristics like total soluble solids, acidity, ascorbic acid, sugars, non-enzymatic browning during 6 months storage at 3-4 °C.

Rashinkar (2012) conducted a preliminary trial to assess the proper method for extraction of ash gourd juice with the help of home scale food processor by pressing through muslin cloth with the juice recovery of 40 per cent. Generally, juices from fresh fruits were extracted by crushing and pressing them. Sunita (2019) extracted ash gourd juice by using grinder and filtered by using muslin cloth followed by heating (80 °C/15 min). According to Wilczynski *et al.* (2019) application of the screw press ensured higher yields in comparison to the basket press.

2.4 PRESERVATION OF JUICE AND ITS UTILIZATION FOR PREPARATION OF SWEETENED BEVERAGE AND SQUASH

2.4.1 Processing of juice

Kinh *et al.* (2001) prepared and preserved the apple pulp with mild heat and different chemical preservatives. Mehmood *et al.* (2008) reported the effect of pasteurization and preservatives on quality and shelf stability of apple juice. The reports of Hossain *et al.* (2011) and Kaur and Aggarwal (2014a) worked on effect of chemical preservatives namely sodium benzoate, potassium metabisulphite (KMS) and their combination on the shelf life and physico-chemical properties of tomato juice and bitter gourd juice upto storage of 6 months. Ranganna (2014) preserved sweet orange juice with 350 ppm SO_2. Shweta (2020) stated that most commonly used preservatives for the aonla juice were KMS and Sodium benzoate either singly or in combinations with stored at ambient (20-25°C) and low temperature (5±1°C).

2.4.2 Preparation of Sweetened Beverage

Chauhan *et al.* (2001) successfully utilized the sea buckthorn pulp/juice for the preparation of ready to serve beverage by blending it with orange, apple and papaya pulp in the ratio of 50:50, 60:40 and 70:30, respectively. The beverage of 15 °B TSS was found most acceptable. Kaushal (2004) stated that preservation of sea buckthorn ready-to-serve beverage by either heat processing or by addition of KMS (70 ppm SO_2) or sodium benzoate (120 ppm) either singly or in combination (1:1) showed good storage stability up to six months under both the conditions of storage. Beverages from various fruits have been prepared by using various juice, TSS and acid composition such as; lime-aonla based beverage having 6 per cent juice, 10 °B TSS and 0.30 per cent acidity (Deka *et al.* 2004); RTS beverage from seabuckthorn fruits with 5 per cent pulp and 14 °B TSS (Bisht *et al.* 2008) RTS beverage from pomegranate with 20 per cent juice, 15 °B TSS and 0.24 per cent acidity (Akhtar *et al.* 2013); RTS beverage from ash gourd with 20 per cent juice, 15 °B TSS and 0.3 per cent acidity (Rashinkar *et al.* (2013); RTS beverage from box myrtle (*Myrica nagi*) fruit with 14

per cent juice, 12 °B TSS and 0.30 per cent acidity (Thakur, 2014) and Mulberry RTS beverage with 14 per cent juice , 12 °B TSS and 0.30 per cent acidity (Hamid *et al.* 2017). Shelar *et al.* (2017) evaluated the pomegranate juice powder for the preparation of ready-to-serve beverage with different levels of powder quantities (6, 8, 10, 12 and 14 g powder per 100 ml RTS), TSS (12, 13, 14, 15 and 16 °B) and acidity (control, 0.20, 0.25, 0.30 and 0.35 per cent). Chandra *et al.* (2018) prepared ready-to-serve beverage from amla, aloe-vera, ginger, and mint juice having formulation of (100:0:0:0), (50:50:0:0), (50:40:5:5) and (35:40:20:5) and studied its storage stability. The quality of beverages was found to acceptable even up to 3 months of storage.

2.4.3 Preparation of Squash

According to Food Safety and Standards Act, 2006, fruit squash should have minimum percentage of TSS as 40 ºB and fruit juice as 25 per cent in final product which is diluted before consumption. Lal *et al.* (1986) standardized the technique for the preparation of fruit squash containing a moderate quantity of fruit pulp and cane sugar.

Squash from various fruits have been prepared by using various juice ,TSS and acid composition such as seabuckthorn squash by keeping 25 per cent pulp, 50 ºB TSS and 1.2 per cent acidity (Bisht *et al.*, 2008); aonla squash with 45 per cent pulp, 50 ºB TSS and 1.00 per cent acidity (Jaiswal *et al.*, 2008); wild pomegranate squash by exploiting the natural acid by keeping higher percentage of juice (42 per cent) and 45 ºB TSS (Dhaygude, 2010); pomegranate squash with 25 per cent juice, 50 ºB TSS and 1.50 per cent acidity (Chavan *et al.*, 2011) and watermelon squash containing 25 per cent pulp, 40 ºB TSS, and 1.0 per cent acidity (as citric acid) and xanthan gum @ 0.2 per cent (Swamy *et al.*, 2012). Syed *et al.* (2012) also prepared squash with strained orange juice (250 ml) containing 750 ml water, 9 g citric acid, and 350 ppm KMS. According to Thakur *et al.* (2018) the wild pomegranate juice can be successfully utilized for the preparation of squash by using 42 per cent juice and 45 ºB TSS with the best various quality and sensory characteristics.

2.5 STORAGE STUDIES: CHANGES IN PHYSICO- CHEMICAL AND SENSORY ATTRIBUTES

2.5.1 CHEMICAL CHARACTERISTICS

2.5.1.1 Total Soluble Solids (TSS)

Barwal *et al.* (2005) noticed an insignificant increase in total soluble solids in of bitter gourd RTS drink during storage. Sharma and Singh (2005) observed increase in TSS of juice

with an increase in storage period of up to 90 days. Increase in TSS during storage from 45.00 to 47.14 ºB in lime blended amla squash has been observed by Reddy and Chikkasubbanna (2008); while in jamun squash TSS increased from 48.00 to 50.28 ºB for the storage period of 6 months observed by Das (2009). However, Krishnaveni *et al.* (2009) did not observe any change in jackfruit RTS beverage. A slight change in TSS of bottle gourd-basil leaves juice was noticed by Majumdar *et al.* (2011). An increasing trend in TSS has been reported by Ali *et al.* (2011) in seabuckthorn squash (40.00 to 40.50 ºB), Boghani *et al.* (2012) in papaya-aloevera (12.00 to 13.30 ºB), Akhtar *et al.* (2013) in pomegranate juice (13.00 to 13.50 ºB), Selvamuthukumaran and Khanum (2013) in spiced seabuckthorn squash (40.16 to 40.60 ºB) and Thakur (2014) in box myrtle (12.05 to 12.56 ºB) during storage irrespective of packaging materials and storage conditions.

An increase of TSS from 3.40 to 3.60 ºB of pasteurized cucumber juice has been observed by Kaur *et al.* (2014) during 6 months of storage at room temperature. Almost similar findings have been revealed by Kaur and Aggarwal (2014a) in bitter gourd juice. Bottle gourd juice when pasteurized and preserved by the addition of KMS @ 3000 ppm + citric acid @ 0.15 per cent and packed in glass bottles showed an increase from 3.30 to 3.70 ºB in TSS during storage period of 6 months (Kaur and Aggarwal, 2014b). Thakur *et al.* (2018) found increase TSS in wild pomegranate squash during storage from 45 to 45.67 ºB. Palamthodi *et al.* (2019) also observed a gradual increase during storage in the TSS of ash gourd/bottle gourd beverage blended with jamun.

2.5.1.2 Titrable acidity

Barwal (2005) found that in bitter gourd the titrable acidity remained non-significant. A slight decrease in titrable acidity has been noticed by Hussain *et al.* (2005) in mango squash (1.40 to 0.96 per cent) and by Reddy and Chikkasubbanna (2008) in lime blended amla squash (1.17 to 1.02 per cent) during 3 months of storage. However, Jain and Asati (2009) observed an increase in titrable acidity (0.45 to 0.46 per cent) of guava pulp preserved with KMS @ 750 ppm in glass bottles. Similarly, slight increase (1.0 to 1.30 per cent) in titrable acidity of seabuckthorn squash was observed during 4 months of storage (Ali *et al.*, 2011).

Majumdar *et al.* (2011) and Boghani *et al.* (2012) showed an increasing trend in titrable acidity from 0.25 to 0.36 per cent in bottle gourd-basil leaves juice during 6 months

of storage period and 0.30 to 0.37 per cent in papaya-aloevera RTS beverage during storage of 5 months at room temperature. A decreasing trend has been noticed by Syed *et al*. (2012) in sweet orange squash (0.40 to 0.37 %) during storage. While, an increase from 2.74 to 2.86 per cent in sapota squash during 6 months of storage at room temperature was reported by Relekar *et al.* (2013). However, Vijayanand *et al.* (2013) observed no change in acidity of canned mango pulp during two-month period of storage at room temperature.

The presence of acids in fruits is reported to affect the promotion of flavour and every fruit has a specific range of acidity over which consumers prefer it (Nisar *et al.,* 2015). Hamid *et al.* (2017) observed a decreasing trend in titratable acidity of mulberry RTS beverage from 0.30 to 0.25 per cent during storage irrespective of packaging materials and storage conditions.

2.5.1.3 pH

Panesar *et al.* (2000) recorded 4.41 pH in kinnow fruit juice. According to Majumdar *et al.* (2009) the pH of blended beverages ranged between 3.9 to 4.0. Decrease in pH have been reported during storage of various beverages such as from 3.6 to 3.2 in ready-to-serve ash gourd beverage (Rashinkar, 2012) and from 3.68 to 2.52 (31.52 per cent decrease) in aonla squash during storage upto 8 months at ambient storage temperature (Choudhary *et al.*, 2013). Earlier, Relekar *et al.* (2013) have also reported an increase in pH in sapota squash from 2.47 to 2.86 (4.37 per cent increase) during storage of 6 months at ambient temperature. Increase in pH of mixed fruit squash from 5.03 to 5.16 (2.58 per cent increase) has been observed during 2 months of storage at room temperature by Kayshar *et al.* (2014). Kadam and Lele (2016) reported that the pH greatly influences storage stability and has impact on flavour and other juice characteristics. pH decreased with length of storage, but not significantly at storage temperature of 4°C and 28°C. Hamid *et al.* (2017) have observed as light increase in pH of mulberry RTS beverage from 4.10 to 4.19 stored at ambient temperature as compared to refrigerated conditions.

2.5.1.4 Reducing sugars

Reducing sugars are very important component of a processed product with respect to quality, shelf life, taste and discoloration during storage. Prasad and Mali (2000) reported an increase from 34.96 to 35.93 per cent in reducing sugars of pomegranate squash during 12 months of storage at ambient condition. Barwal *et al.* (2005) reported 0.26 per cent to 4.47

per cent reducing sugar in bitter gourd RTS drink and Hussain *et al.* (2005) reported 23.00 to 24.12 per cent reducing sugar in mango squash.

A significant increase (4.80 to 9.74 per cent) in reducing sugars of seabuckthorn RTS beverage was recorded by Bisht *et al.* (2008) during 3 months storage at ambient conditions. Hussain *et al.* (2010) studied the effect of storage on sugars of apple-apricot blends and concluded that there was an increase in reducing sugars while non-reducing sugars decreased. Harsimrat *et al.* (2013) reported that guava pulp preserved by KMS (700 ppm) showed an increase in reducing sugar from 4.70 to 6.49 per cent during storage of 3 months at ambient temperature. Similar increasing trend of reducing sugars was observed by Kaur and Aggarwal (2014b) in bottle gourd; and Kaur *et al.* (2014) in cucumber juice. According to Satkar *et al.* (2013) reducing sugars in bitter gourd RTS beverage increased from 4.50 to 4.74 per cent during storage upto 6 months at ambient temperature. Further, Kumar (2019) reported that the reducing sugars in different methods of juice extraction varied from 2.98 to 3.02 mg/ml.

2.5.1.5 Total sugars

Sugars, are important constituent of fruit products considered as essential factor for the flavour of food products. They also act as natural food preservative beyond 60 per cent concentration. Several researchers have reported a significant increase in sugars during storage.

A significant increase (37.00 to 38.94 %) in total sugars has been observed by Prasad and Mali (2000) in pomegranate squash. According to Dhaliwal and Hira (2004) the pasteurization and storage of carrot-spinach and carrot-pineapple blended juice for 6 months showed minor variations of total sugars. Khamrui and Pal (2004) recorded that fresh whey based kinnow juice concentrate possessed 44.83 per cent total sugars, whereas, Hussain *et al.* (2005) has noticed a slight increase (48.67 to 48.71 per cent) with the advancement of storage at room temperature.

The increase in total sugars reported by various researchers in different beverages was 11.83 to 12.77 per cent during 6 months of storage period in seabuckthorn RTS beverage (Bisht *et al.*, 2008); 37.68 to 38.00 per cent in lime-amla squash during 3 months of storage under ambient temperature (Reddy and Chikkasubbanna, 2008)**;** 42.30 to 43.60 per cent in seabuckthorn squash (Ali *et al.*, 2011) and 3.04 to 4.97 mg/ml in different methods of juice extraction (Kumar, 2019).

Majumdar *et al.* (2012) observed that the reducing sugars in ash gourd-mint leaves juice increased (from 1.73 to 2.42 per cent) while total sugars values did not show significant difference during storage. An increase from 44.14 to 46.23 per cent has been noticed by Relekar *et al.* (2013) in sapota squash stored up to 6 months at room temperature. Similar increasing trend has been reported by Satkar *et al*. (2013) in bitter gourd RTS and Sindumathi and Premalatha (2015) in flavoured papaya-pineapple RTS beverage during 4 months of storage at ambient temperature.

2.5.1.6 Ascorbic acid

Ascorbic acid is the least stable of all 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). Murtaza *et al*. (2004) have reported a decrease ascorbic acid content from 65.00 to 38.00 mg/100 g in of strawberry drink during 3 months of storage under ambient conditions. Pandey (2004) observed also decrease in ascorbic acid content from 78.86 to 45.04 mg/100g during storage of 6 months in guava squash. The value ranged from 24 to 5.19 mg/100 g reported by Bisht *et al.* (2008) in seabuckthorn RTS. A 74 per cent reduction in ascorbic acid content observed by Majumdar *et al.* (2009) in blended beverages which stored upto six months at room temperature (28±2C°). Jain and Asati (2009) recorded a significant loss in ascorbic content in guava pulp preserved with KMS @ 750 from 198.25 to 186.00 mg/100 g when packed in glass bottles. Further, Durrani *et al.* (2010) also reported a gradual decrease (26.11 to 21.02 mg/100 g) in ascorbic acid of apple pulp packed in plastic containers during storage upto 6 months at ambient temperature.

A remarkable decrease in ascorbic acid was observed in processed products during storage (Hossain *et al.*, 2011). Selvamuthukumaran and Khanum (2013) reported a decrease from 6.72 to 3.15 mg/100 g in spiced seabuckthorn mixed fruit squash packed in PET bottles during storage upto 6 months at ambient temperature. Similar decrease in ascorbic acid content from 34.03 to 18.21 mg/100 g in bitter gourd juice, 3.92 to 2.44 mg/100 g in bottle gourd juice and 7.26 to 4.12 mg/100 g cucumber juice preserved with 3000 ppm KMS has been recorded by Kaur and Aggarwal (2014a); Kaur and Aggarwal (2014b) and Kaur *et al.* (2014) respectively, for the storage period of 6 month at ambient temperature.

2.5.1.7 Total phenols

Kavitha *et al.* (2014) recorded a significant loss in total phenolic content of blanched ber fruits RTS beverage. However, phenolic content was better in raw fruits Thakur (2014) has reported a decrease in total phenolic content of box myrtle drink upto storage of 6 months. In the same year, Yadav *et al.* (2014) have also reported a decrease in total phenolic content of guava and mango squash from 0.71 to 0.20 mg/100 ml (71.83 % decrease) and 17.50 to 9.60 mg/100 ml (45.14 % decrease) upto storage of 3 months at ambient temperature packed in glass bottles. Hamid *et al.* (2017) has also noticed a decreasing trend in total phenols content in mulberry RTS (21.61 to 15.24 mg/100ml and 18.53 mg/100ml) and squash (44.20 to 40.73 and 42.55 mg/100ml) beverage during storage of 6 months at ambient and refrigerated conditions respectively. Kumar (2019) observed that total phenols content ranged between 2.24 to 2.47 mg GAE/ml of papaya leaf extract.

2.5.1.8 Antioxidant activity

According to Barman and Barooah (2016) the antioxidant activity in terms of DPPH free radical scavenging activity was found to be higher in all the blended RTS beverages as compared to RTS beverages prepared from 100 per cent jamun juice during storage. Cautela *et al.* (2019) found that extraction of bergamot juice by screw press method shas resulted highest antioxidant activity with EC_{50} value of 9.35 µg/mL.

2.5.2 SENSORY CHARACTERISTICS

2.5.2.1 Juice

The storage life of a product depends on the sensory quality which is considered a prime factor for its marketability. A decrease in colour (9.0 to 6.9), flavour (8.8 to 6.2) and overall acceptability (8.8 to 6.5) of mango pulp preserved by KMS @ 0.2 per cent in plastic containers has been observed by Hashmi *et al.* (2007). Hossain *et al.* (2011) has also observed decrease in sensory attributes i.e., colour, flavour, texture and overall acceptability of tomato juice from 7.40 to 7.10, 7.70 to 6.90, 7.60 to 6.70 and 7.20 to 6.50, respectively during 30 days storage period. Further, it was found that color, flavor, taste and overall acceptability of tomato juice prepared with Na-benzoate was more acceptable than KMS.

2.5.2.2 Sweetened beverage

According to Kapaleshwar (2010) the mean score for overall acceptability of the RTS decreased from 7.2 to 6.7 therefore it can be concluded that the stability of Ready-to-serve

beverage made from ash gourd was up to 30 days. Boghani *et al.* (2012) reported a slight decrease (7.80 to 7.60) in overall sensory qualities of papaya + aloe-vera blended RTS beverage after 3 months of ambient storage. Also found that prepared blended RTS could be successfully stored at refrigerated temperature for the period of 3 months without changes in senatorial quality profile. A significant decrease in colour scores from 8 to 7 (12.5 per cent decrease), flavour scores from 7.50 to 6.50 (13.33 per cent decrease) and overall acceptability from 8 to 7 (12.5 % decrease) has been reported in herbal RTS beverage during storage upto 2 months at room temperature by Chauhan *et al.* (2012). Akhtar *et al.* (2013) also observed decline in colour scores from 9 to 6.5 (27.77 per cent), taste scores from 8 to 7 (12.50 per cent), flavour scores from 8 to 7 (12.50 per cent), texture scores from 7 to 6.5 (7.14 per cent decrease) and overall acceptability from 9 to 7 (22.22 per cent) of pomegranate drink during storage of 3 months at ambient temperature. Thakur (2014) reported a significant decrease in colour (8.60 to 7.41), body (8.40 to 7.73), taste 26 (8.23 to 7.69), aroma (8.13 to 7.18) and overall acceptability (8.24 to 7.13) of box myrtle drink.

2.7.2.3 Squash

A gradual decrease in overall acceptability score was observed in nectarine squash (8.1 to 7.4) during storage up to 6 months (Shivani, 2011). Patil *et al.* (2011) have also reported decrease in organoleptic scores of best recipes including colour from 7.0 to 5.0 (28.57 per cent decrease) flavour from 8.5 to 6.0 (29.41 per cent decrease) and texture from 7.5 to 7.0 (6.66 per cent decrease) in custard apple squash storage up to 32 days at ambient temperature.

According to Anitha (2012), the scores for colour of fig squash decreased from 8.50 to 7.80 during a storage period of one year. Further, the author has revealed that the overall acceptability of kaiphal squash decreased from “liked very much” to “liked moderately” and on the whole, the score for colour, flavour and overall acceptability decreased significantly from 8.80 to 8.10, 8.70 to 7.60 and 8.70 to 7.87, respectively during storage upto 9 months Relekar *et al.* (2013) have observed 15.20 per cent decrease in colour scores (7.63 to 6.47), 8.58 per cent decrease in flavour scores (7.69 to 7.02) and 8.71 per cent decrease in overall acceptability scores (7.57 to 6.91) in sapota squash during storage of 6 months at ambient temperature.

2.6 MICROBIOLOGICAL QUALITY

Assessment of microbial contamination indicates the sanitary quality of the food products. Micro-organisms associated with the food products not only cause the spoilage, but also responsible for the food borne illness. Addition of 350 ppm of potassium meta bisulphite in whey based kinnow juice concentrate was found to be effective in retarding the growth of yeast and mould counts during storage at refrigerated temperature (4±1°C, 80% RH) for nine months and at ambient temperature (15-35°C, 66-85 per cent RH) for four months by Khamrui and Pal (2004). Full plate growth of micro flora was observed after 60 days of storage at room temperature in RTS beverage developed from bitter gourd fruit (Barwal *et al.,* 2005). Nirmal *et al.* (2006) found that in the wood apple RTS beverage, addition of sodium benzoate was found to be effective in controlling the growth of micro-organisms and no microbial growth was observed during storage of 90 days. Standard plate count of bottle gourd juice treated with sodium benzoate (100 ppm) registered 4x10-3 and 3x10-3 counts during the storage of three months at room temperature (30±2°C) and cold temperature (5±1°C), respectively (Madhukar, 2008). Majumdar *et al.* (2012) evaluated ashgourd-mint leaves juice for microbiological quality and found that Total Plate Count (TPC) was nil upto 6 months of storage.

Chapter-3

MATERIALS AND METHODS

The present investigations entitled **"Development and Evaluation of beverages from Ash gourd fruit"** were conducted in the Department of Food Science and Technology at College of Horticulture and Forestry (Dr. Y.S. Parmar University of Horticulture and Forestry), Neri-Hamirpur (H.P) during the years 2020-21. The experimental details and methodology employed in this study are described as below under suitable captions:

3.1 RAW MATERIAL

Well matured of ash gourd fruits (Plate 3.1) were procured from local market, Hamirpur and brought to the Department of Food Science and Technology, College of Horticulture and Forestry, Neri for conducting the studies. Fruits were analyzed for various physico-chemical characteristics to evaluate their suitability for preparation of different products.

EXPERIMENT-1: EVALUATION OF ASH GOURD FRUITS AND JUICE FOR PHYSICO-CHEMICAL ATTRIBUTES AND STORAGE STUDIES

3.2. JUICE EXTRACTION

The fruit juice was obtained by using a screw type juice extractor (M/S Bajaj machinery Pvt. Ltd. Delhi). Ash gourd fruits were manually cut into four pieces, peeled with the help of stainless steel knife and finally seeds were removed, prior to juice extraction. The extracted juice was packed in two different packages (glass and PET bottles) and stored at ambient temperature for a period of 90 days.

The storage stability of the packed juice was evaluated at ambient temperature (20-25°C) up to 90 days at periodic intervals of 0, 45 and 90 days for its preservation by using following treatments:

Treatments:

T_1: Pasteurization of juice at 90°C for 10 seconds followed by filling in glass bottles.

T_2: Preservation by addition of potassium metabisulphite (KMS) @ 350 ppm SO_2 (FSSAI, 2006) in glass bottles.

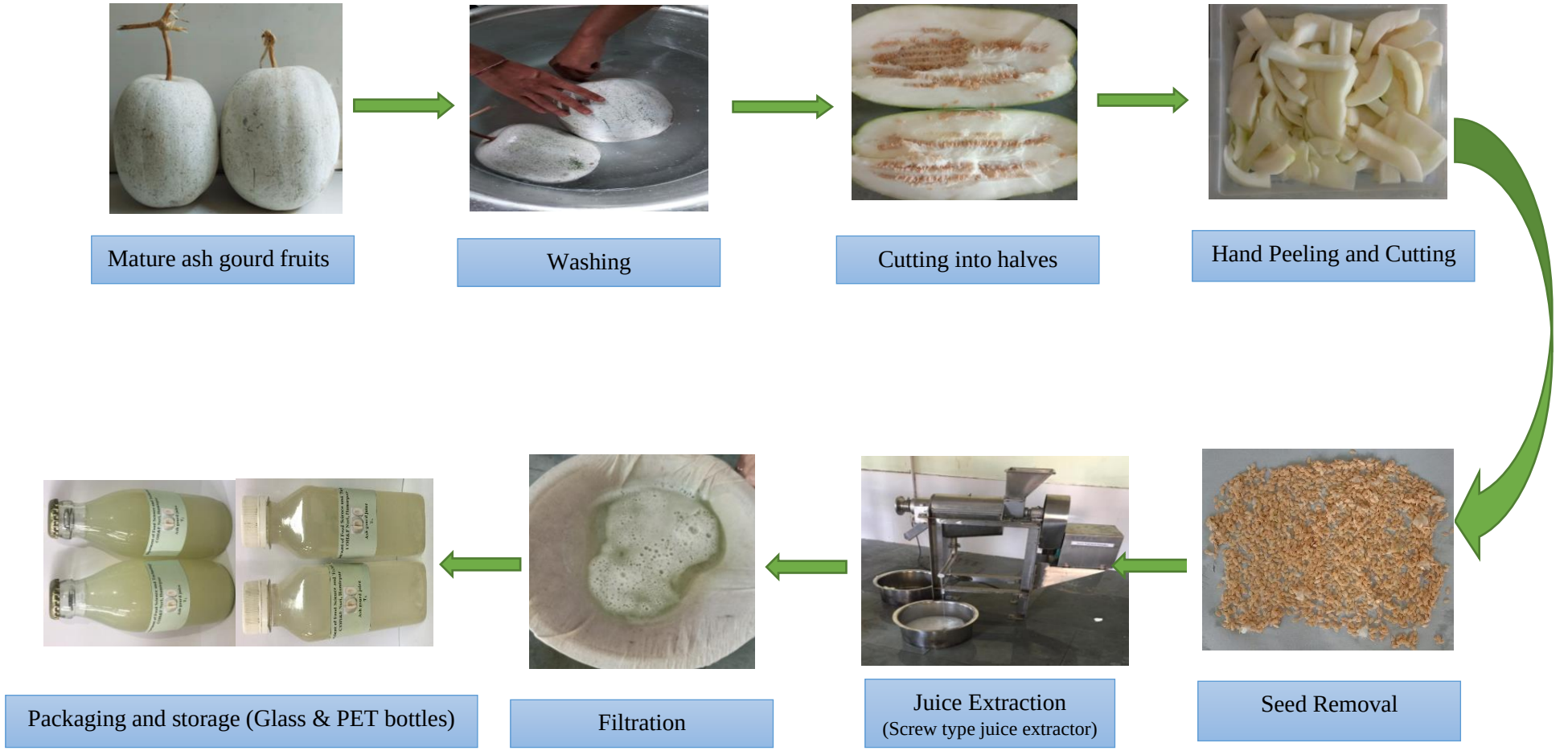

Figure 3.1 Flow sheet for extraction of juice from ash gourd fruit

Plate 3.1 Ash gourd fruits

T_3: Preservation by addition of sodium benzoate @ 600 ppm benzoic acid (FSSAI, 2006) in glass bottles.

T_4: Preservation by addition of KMS @ 250 ppm and sodium benzoate @ 100 ppm in 1:1 proportion (FSSAI, 2006) in glass bottles.

T_5: Pasteurization of juice at 90°C for 10 seconds followed by filling in PET bottles.

T_6: Preservation by addition of potassium metabisulphite (KMS) @ 350 ppm SO_2 (FSSAI, 2006) in PET bottles.

T_7: Preservation by addition of sodium benzoate @ 600 ppm benzoic acid (FSSAI, 2006) in PET bottles.

T_8: Preservation by addition of KMS @ 250 ppm and sodium benzoate @ 100 ppm in PET bottles (FSSAI, 2006).

EXPERIMENT-2: UTILIZATION OF ASH GOURD JUICE FOR THE PREPARATION OF BEVERAGES

3.3. SWEETENED BEVERAGE

The suitability of utilizing ash gourd juice for the preparation of sweetened beverage of acceptable sensory qualities was evaluated. Different combinations were tried for the preparation of sweetened beverage (Table 3.1).

The combination having an optimum scale for sensory analysis with respect to various parameters was selected and utilized for optimizing conditions for its storage at ambient temperature. For conducting storage studies, the product was packed in PET bottles by using following treatments for its preservation upto 90 days.

Treatments

1. Pasteurization of sweetened beverage at 90°C for 10 seconds followed by filling in PET bottles.
2. Preservation by addition of potassium meta-bisulphite (KMS) @ 350 ppm SO_2 (FSSAI, 2006) in PET bottles.
3. Preservation by addition of sodium benzoate @ 600 ppm benzoic acid (FSSAI, 2006) in PET bottles.
4. Preservation by addition of KMS and sodium benzoate in 1:1 proportion (KMS @ 350 + sodium benzoate @ 350 ppm in PET bottles**.**

Table 3.1 Standardization of recipe for the preparation of ash gourd sweetened beverage

Treatments	Fruit Juice (%)	TSS (°B)
T_1 (Natural)	Natural juice (100)	Natural (3°B)
T_2 (Natural:10)	Natural juice (100)	10
T_3 (Natural:15)	Natural juice (100)	15
T_4 (85:10)	85	10
T_5 (85:15)	85	15

3.4 Squash

The ash gourd squash was prepared by using varying proportions of ash gourd juice viz., 25.0, 30.0, 40.0 and 55.0 per cent at a fixed level of Total Soluble Solids (TSS) i.e 40 °B and acidity as 1.2 per cent. The combinations having an optimum score with respect to varying sensory attributes was selected and utilized for optimization condition for storage. For conducting storage studies, the product at ambient temperature was packed in PET bottles by using following treatments for its preservation upto 90 days.

Treatments:

1. Preservation by addition of potassium meta-bisulphite (KMS) @ 350 ppm SO_2 (FSSAI, 2006) in PET bottles.
2. Preservation by addition of sodium benzoate @ 600 ppm benzoic acid (FSSAI, 2006) in PET bottles.
3. Preservation by addition of KMS and sodium benzoate in 1:1 proportion (KMS @ 350 ppm + sodium benzoate @ 350 ppm in PET bottles.

3.5 PHYSICO-CHEMICAL ANALYSIS

3.5.1 Physical characteristics

Five fruits of ash gourd were randomly selected from the whole lot for determining the physical characteristics.

3.5.1.1 Fruit size

Length and diameter of ash gourd fruit was measured by using thread and scale, vernier calliper as applicable.

3.5.1.2 Fruit weight

The weight of fruits in kilograms was determined gravimetrically and expressed as mean weight (kg).

3.5.1.3 Visual colour

The fruits were evaluated for the colour by visual appearance.

3.5.1.4 Fruit Shape

The shape of randomly selected ash gourd fruits was evaluated visually.

3.4.1.5 Peel percentage

Selected 5 ash gourd fruits were weighted, peeled and assessed for peel percentage by using the following formula:

$$\text{Peel percentage (\%)} = \frac{\text{Wt. of peel}}{\text{Total fruit weight}} \times 100$$

3.4.1.6 Juice recovery

The juice obtained from ash gourd fruits was weighed to find out the per cent juice recovery as follows:

$$\text{Juice recovery (\%)} = \frac{\text{Wt. of juice extracted}}{\text{Wt. of fruits taken}} \times 100$$

3.4.1.7 Pomace

The pomace obtained from ash gourd fruits was weighed to find out the pomace percentage as follows:

$$\text{Pomace (\%)} = \frac{\text{Wt. of pomace}}{\text{Wt. of fruit taken}} \times 100$$

3.4.1.8 Seed percentage

The seeds obtained from ash gourd fruits were weighed to find out the seed percentage as follows:

$$\text{Seed percentage (\%)} = \frac{\text{Wt. of seeds}}{\text{Total fruit weight}} \times 100$$

3.4.1.9 Edible portion

The edible portion obtained from ash gourd fruits was weighed to find out the percentage as follows:

$$\text{Edible portion (\%)} = \frac{\text{Wt. of edible portion}}{\text{Total fruit weight}} \times 100$$

3.5.2 Physico-chemical characteristics

3.5.2.1 Moisture and Total solids

The oven drying method was used to determine the moisture content as given by Ranganna (2014). The moisture content was estimated by drying the weighed samples to a constant weight in hot air oven at 70 ± 2 °C. The dried samples were then cooled to room temperature in a desiccator prior to weighing. Total solids in terms of percentage were calculated as given below:

$$\text{Total solids (\%)} = \frac{\text{Weight of sample after drying}}{\text{Weight of sample before drying}} \times 100$$

Loss in weight of sample after drying representing the moisture content was expressed as per cent

$$\text{Moisture content (\%)} = \frac{\text{Weight of fresh sample - Weight of dried sample}}{\text{Weight of fresh sample}} \times 100$$

3.5.2.2 Ash content

Total ash content of prepared product was determined gravimetrically by taking known weight of sample in tared silica crucibles. The dried samples after moisture determination were slowly heated over a hot plate untill the bulk of organic matter was burnt. The crucibles were then kept in a muffle furnace at a temperature of 550 °C to obtain a carbon free white ash with a constant weight. Ash content of samples was then calculated and

expressed as per cent w/w (Ranganna, 2014). Per cent ash content was calculated by using the following formula:

$$\text{Ash (\%)} = \frac{\text{Weight of ash}}{\text{Weight of sample}} \times 100$$

3.5.2.3 Total soluble solids

The total soluble solids were recorded with the help of Hand Refractometer of range 0-32 °B and 30-60 °B. Total soluble solids of sample were measured by placing a drop of the juice on the prism of the refractometer and reading was expressed in the term of degree Brix (Ranganna, 2014).

3.5.2.4 Titrable acidity

The titrable acidity was determined by the standard method of Ranganna (2014). 10ml of sample was diluted with 100 ml distilled water. Further, 10 ml of this aliquot was titrated against 0.1N NaOH solution to a pink end point using 0.1% phenolphthalein as an indicator. The titrable acidity as % citric acid was calculated by the following expression:

$$\text{Titrable acidity (\%)} = \frac{\text{Titre value} \times \text{Normality of alkali} \times \text{Volume made up} \times \text{Eq. weight of dominating acid}}{\text{Weight of sample taken for estimation} \times \text{Volume of aliquot} \times 1000} \times 100$$

3.5.2.5 pH

The pH of ash gourd juice was determined by using pH meter. Buffer solution of pH 7 was used for periodical calibration of pH meter.

3.5.2.6 Sugars

For estimation of reducing sugars, a known weight of sample (25 g) was diluted to 100 ml with distilled water in 250 ml volumetric flask and neutralized with 1 N NaOH. To the neutralized solution 2 ml of 45% lead acetate was added. Whole solution was shaken for 10 min. Excess of lead acetate was removed from the sample by using 2 ml of 22 % potassium oxalate. The volume was made upto 250 ml in volumetric flask. The aliquot 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 under:

a) $$\% \text{ Reducing sugar} = \frac{^{*}\text{Factor} \times \text{Dilution}}{\text{Titre} \times \text{Wt./Volume of sample (g/ml)}} \times 100$$

*Factor = 0.05

Total sugars were estimated by adding 5 g citric acid to 50 ml filtrate from the reducing sugar estimation and heating it for 10 min., then neutralized the sample with 1N NaOH using phenolphthalein as indicator and volume was made to 250 ml in volumetric flask with distilled water. The total sugars were estimated as per cent and calculated as under:

b) % Total sugars as invert sugars = Calculated as in (a) making use of titre value obtained in the determination of total sugars after inversion

3.5.2.7 Ascorbic acid

The ascorbic acid content was calculated by the method described by Ranganna (2014). 10 ml of sample (juice/squash) was mixed with 3 per cent metaphosphoric acid to make 100 ml volume followed by filtration through filter paper. Then, 5 ml of the aliquot was taken and titrated against standard dye (2, 6- dichlorophenol- indophenol) to a faint pink colour persisting for atleast 15 seconds. Ascorbic acid (mg/100g) in the sample was calculated by using the following expression:

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

3.5.2.8 Total phenols

The total phenols in the different samples of ash gourd were 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 make up with 10 ml of 80 per cent ethanol and centrifuged for 20 min at 1000 rpm and filtered. Filtrate was evaporated in oven up to dryness and residue 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 3ml with water. Then 0.5ml Folin-Ciocalteu reagent was added. After 3 min 2ml 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 650nm 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 (8-32µg/mL) of catechol and results were expressed as mg per 100g on fresh weight basis.

3.4.2.9 Crude fibre

Distilled water (200 ml) was added to ash gourd fruit sample weighing 100 g and the contents were brought nearly to a boil. After adding 25 ml of sodium hydroxide solution the contents were boiled for five minutes (Gould, 1978). The material was transferred to previously weighed screen and washed thoroughly with water until the whole of sodium hydroxide had been removed. The presence of sodium hydroxide was checked by using phenolphthalein indicator. The contents were dried for 2 hours at 100°C in a hot air oven and fibre content was expressed in percentage.

$$\text{Fibre content (per cent)} = \frac{\text{Weight of residue}}{\text{Weight of sample taken}} \times 100$$

3.4.2.10 Non-enzymatic browning (NEB)

Non-enzymatic browning (NEB) of ash gourd products involved measuring of optical density (OD) values of methanol extracts of centrifuged samples at 440 nm in a UV-VIS spectrophotometer (Ranganna, 2014).

3.4.2.11 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 6x10-5 mol/L DPPH in methanol was put into a cuvette with 0.1 ml of sample extract and the absorbance was measured at 515 nm after 30 min. Methanol was used as blank. Antioxidant activity was calculated using following equation: -

$$\text{Antioxidant activity (\%)} = \frac{\text{Ab(b)} - \text{Ab(s)}}{\text{2Ab (b)}} \times 100$$

Where,

Ab (b) = Absorbance of blank

Ab (s) = Absorbance of sample

3.6 MICROBIOLOGICAL EXAMINATION

Microbiological examination of the products from ash gourd fruit, stored at ambient temperature 20-25°C, were carried out at periodic intervals of 0, 45 and 90 days.

Total plate counts (TPC) were taken by aseptically inoculating 1 ml of serially diluted sample in distilled water (Ranganna, 2014). 0.1ml of the diluted sample was aseptically inoculated on Tryptone Soya Agar taken in petri plates followed by incubation of inoculated petri plates at 37°C for 24 - 48 hrs for allowing the micro-organism to grow. The total plate count (TPC) as colony forming unit in the ash gourd products were expressed as log cfu/ml of the sample.

3.7 SENSORY EVALUATION

Ash gourd products were evaluated for sensory qualities on the basis of colour /appearance, body/consistency, flavour and overall acceptability by a panel of semi-trained judges (teachers, students and staff members) on a 9- point hedonic scale (Appendix-I) for each attribute as shown in Table 3.2 according to the method of Amerine *et al.* (1965). Efforts were made to keep the same panel for sensory analysis throughout the entire period of study.

Table 3.2 9-point Hedonic scale used for sensory evaluation of different products

Score	Rating
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

3.8 STATISTICAL ANALYSIS

The data pertaining to the sensory evaluation of the ash gourd products were analyzed according to Randomized Complete Block Design as described by Mahony (1985), while the data on chemical characteristics of different products before and during storage were analyzed statistically by following Completely Randomized Design (CRD) at 95 per cent level of significance (Cochran and Cox, 1967).

3.9 COST OF PRODUCTION

Cost of production of ash gourd products was calculated by taking into consideration various input costs such as cost of raw material, labour, electricity, processing cost, packaging and other charges. While, for calculating the sale price of the product, twenty per cent profit margin was added to the cost of production of each product.

Chapter-4

RESULTS AND DISCUSSION

The present study entitled **"Development and Evaluation of Beverages from Ash Gourd Fruit"** was conducted in the Department of Food Science and Technology, at College of Horticulture and Forestry, Neri-Hamirpur (HP) 177 001 during the years 2020-21. The results obtained of these studies are presented in Tables 4.1- 4.26, Figures 4.1 to 4.5 and Plates 4.1 to 4.3 are discussed below:

4.1 EVALUATION OF JUICE FOR PHYSICO-CHEMICAL ATTRIBUTES AND STORAGE STUDIES

4.1.1 Physico-chemical characteristics of ash gourd fruit

4.1.1.1 Physical characteristics

The average weight, length and diameter of ash gourd fruit was 7.50 kg, 29.67 cm and 22.00 cm, respectively which were found to be slightly lower than the observations of Rashinkar (2012) who had recorded 4 kg fruit weight, 20 cm fruit length and 17.00 fruit width. Different components of ash gourd fruit comprised of 10.67 per cent peel, 4.00 per cent seed and 85.33 per cent edible portion. The fruit juice recovery and pomace (left residue after juice extraction) were recorded as 64.06 per cent and 21.87 per cent, respectively. Our results are in consonance with the reports of Rashinkar (2012) and Kapaleshwar (2010). The ash gourd fruit were light green in colour, oval to round in shape. According to Aleem (2007) the ash gourd fruits are reported to have white coloured pulp with greenish tinge and elliptical shape white coloured seeds containing 5.5 kg fruit weight, 2.5 g seed weight and 1.375 kg peel weight.

Table 4.1 Physical characteristics of Ash gourd fruit

Physical Characteristics		**Mean±S.E**
Size	Length (cm)	29.67±6.84
	Diameter (cm)	22.00±1.53
Weight (kg)		7.50±2.02
Peel percentage (%)		10.67±0.16
Seed percentage (%)		4.00±0.87
Edible portion (%)		85.33±0.45
Juice recovery (%)		64.06±0.00
Pomace (%)		21.87±0.05
Fruit shape		Oval to round
Fruit colour		Light green

*n=10

4.1.1.2 Chemical characteristics

Data pertaining to the chemical characteristics presented in Table 4.2 indicate that moisture content and total solids in the ash gourd fruits were recorded as 95.29 per cent and 4.58 per cent, respectively which are in accordance with the results of Duke and Ayenshu (2010), Kapaleshwar (2010), Rashinkar (2012), and Bimakar *et al.* (2012). The ash gourd fruits were found to contain 3.00 °B total soluble solids which consisted of sugars (2.43 per cent) reducing sugars (0.50 per cent), titrable acidity (0.13 per cent as citric acid) and ascorbic acid (10.63 mg/100g). The phenolic content was recorded as 29.74 mg/100g on fresh weight basis as total phenols. The crude fibre content was 3.22 per cent on fresh weight basis. Thus, the fruits besides containing sugars, acids and minerals also contained a sufficient quantity of fibre. The pH was recorded 4.49 while, the non-enzymatic browning and antioxidant activity in the fruits were estimated to be 0.41 and 27.49 per cent, respectively.

Table 4.2 Chemical characteristics of Ash gourd fruit

Chemical Characteristics	Mean±S.E
Moisture (%)	95.29±0.17
Total solids (%)	4.58±0.08
Ash (%)	1.13±0.07
Total soluble solids (TSS) (°B)	3.00±0.00
Titrable acidity (% citric acid)	0.13±0.00
pH	4.49±0.00
Reducing sugars (%)	0.50±0.06
Total sugars (%)	2.43±0.09
Ascorbic acid (mg/100g)	10.63±0.05
Total phenols (mg GAE/100g)	29.74±0.27
Crude fibre (%)	3.22±0.01
Non-enzymatic browning (O.D)	0.04±0.00
Antioxidant activity (% free radical scavenging activity)	27.49±0.68

Variation in moisture content, protein, carbohydrate, fibre and ash content, of edible portion (pulp) of immatured and matured ash gourd fruits grown in different countries have been reported by Wills *et al.* (1984); Tee *et al*. (1997; Mingyu *et al*. (1995) and Morton (1971) that might be due to soil composition and agricultural practices. They reported that Vitamin C varied from 1.35 to 68.00 mg/100gm; ash 0.30 to 0.45 per cent; fibre 0.50 to 1.50 per cent; and moisture content 94.50 to 96.80 per cent at mature stage of fruits. Our findings are in consonance with the reports of Aleem (2007) who reported 2 °B TSS; Nurul *et al*. (2011) recorded slightly lower ash content (0.3-0.45 per cent) and fibre content (0.5-1.5 per cent). Similarly, Devaki and Premavalli (2012) reported 28.36 per cent total phenols. Sunita (2019) recorded pH 6.5, total solids 3.9 per cent and 0.135 per cent titrable acidity.

4.2 CHANGES IN CHEMICAL AND SENSORY ATTRIBUTES OF ASH GOURD JUICE DURING STORAGE

The storage stability of the juice extracted through screw type juice extractor was evaluated at periodic intervals of 0, 45 and 90 days storage after preserving either by heat processing or by adding KMS @ 350 ppm SO_2 or sodium benzoate @ 600 ppm either singly or in combination of KMS @ 250 ppm and sodium benzoate 100 ppm after packing in glass and PET bottles (each 200 ml capacity) prior to storage at ambient temperature. The results of this study presented in Tables 4.3 to 4.7, Plate 4.1 and Figure 4.1 are discussed as under:

4.2.1 Total soluble solids (TSS)

A perusal of data in Table 4.3 indicate that total soluble solids (°B) of ash gourd juice subjected to different preservation treatments, packed in glass and PET bottles, varied from 3.00 °B to 3.30 °B during storage at ambient temperature, evaluated at periodic intervals of 0, 45 and 90 days. Among various preservation methods, the mean total soluble solids (°B) were found maximum (3.19 °B) in juice preserved by pasteurization while minimum (3.08 °B) with KMS @ 350 ppm SO_2. The juice packed in PET bottles showed slightly higher increase in mean total soluble solids (°B) than that of juice packed in glass bottles. With progressive storage, TSS significantly increased from initial value of 3.00 to 3.21 °B in ash gourd juice during 90 days storage period at ambient temperature. However, the interaction between method of preservation, storage intervals and packaging materials were found to be non- significant. An increase in TSS during storage may be due to breakdown of polysaccharides into monosaccharides. Similar increasing trend for TSS was noticed by li *et al.* (2009) in longan juice, by Majumdar *et al.* (2011) in bottle gourd-basil leaves juice, by Majumdar *et al.* (2012) in ash gourd-mint leaves juice, by Kaur and Aggarwal (2014a) in bitter gourd juice preserved with different chemical preservatives. Similarly, Gajera and Joshi (2015) and Babu (2015) has also reported a significant increase in bottle gourd based blend juice and pumpkin pulp during 6 months of storage.

4.2.2 pH

The pH of ash gourd juice packed in glass and PET bottles subjected to different preservation treatments varied from 5.03 to 5.09, evaluated at periodic intervals of 0, 45 and 90 days (Table 4.3). The pH in ash gourd juice registered a consistent decrease from 5.06 to 4.92 with the increase in storage intervals. The decrease in pH of ash gourd juice during storage intervals might be attributed due to rise in titrable acidity. In both glass and PET bottles the reduction in pH values were observed. However, the interaction between different methods of preservation, storage intervals and packaging were found to be significant. Similar decreasing trend in pH of ash gourd juice was observed by Gajera and Joshi (2015) in bottle gourd based blend juice, by Majumdar *et al.* (2011) in bottle gourd-basil leaves juice and by Majumdar *et al*. (2012) in ash gourd-mint leaves juice.

4.2.3 Titrable acidity

It is evident from Table 4.4 that titrable acidity of ash gourd juice packed in glass and PET bottles subjected to different preservation treatments varied from 0.13 to 0.23 per cent, evaluated at periodic intervals of 0, 45 and 90 days. Among different methods, the level of titrable acidity in heat processed juice was 0.17 per cent which was reduced to the mean values of 0.15, 0.16 and 0.15 per cent in juice preserved by KMS @ 350 ppm SO_2, Sodium benzoate @ 600 ppm and 250 ppm SO_2 + Sodium benzoate @ 100 ppm, respectively. In comparison to glass bottles, the storage of juice in PET bottles exhibited comparatively more increase in titrable acidity. Further, storage of juice resulted in significant increase (0.13 to 0.18 per cent) in titrable acidity of ash gourd juice. However, the interaction between different methods of preservation, packaging materials and storage intervals were also found to be significant. Increase in acidity might be attributed due to breakdown of pectin into pectinic acid or due to formation of acid by the breakdown of polysaccharides or oxidation of reducing sugars. Majumdar *et al.* (2012); Kaur and Aggarwal (2014a); Gajera and Joshi (2015); and Babu (2015) have also observed increase in titrable acidity during storage in ash gourd-mint leaves juice, bitter gourd juice, bottle gourd based blend juice and ripe pumpkin pulp, respectively.

4.2.4 Ascorbic acid

A perusal of data in Table 4.4 indicate that ascorbic acid content of ash gourd juice subjected to different preservation treatments, packed in glass and PET bottles, varied from

a.

Juice (pasteurized)

Juice
(KMS @ 350 ppm)

Juice (Sodium benzoate
@ 600 ppm)

Juice (KMS @ 250 ppm
+ Sodium benzoate @
100 ppm

b.

Juice (pasteurized)

Juice
(KMS @ 350 ppm)

Juice (Sodium benzoate
@ 600 ppm)

Juice (KMS @ 250 ppm
+ Sodium benzoate @
100 ppm

Plate 4.1 Ash gourd juice in glass(a) and PET (b) bottles

4.77 to 8.13 mg/100g during storage at ambient temperature, evaluated periodic intervals of 0, 45 and 90 days. Ascorbic acid content of ash gourd juice packed in glass and PET bottles showed a consistent decrease from 8.13 mg/100g to 5.50 mg/100g. During storage, there was a gradual decrease in ascorbic acid of ash gourd juice from 8.13 to 5.55 mg/100g. However, the interaction between the packaging materials, storage intervals and different methods of preservation were found to be significant. Slight decrease in ascorbic acid in juice 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 (Jaiswal *et al.,* 2008). Similar trend has also been observed by Upale (2005) during storage of jamun juice, by Majumdar *et al.* (2012) in ash gourd-mint leaves juice, by Babu (2015) in ripe pumpkin pulp and by Gajera and Joshi (2015) in bottle gourd based blend juice storage.

4.2.5 Reducing sugars

A perusal of data in Table 4.5 reveal that the reducing sugars of ash gourd juice subjected to different preservation treatments during storage of 90 days varied from 0.15 to 0.90 per cent among two types of packaging viz. glass and PET bottles**.** Among various preservation methods, the mean reducing sugars were found to be maximum (0.48 per cent) in juice preserved by heat processing in PET bottles while minimum (0.23 per cent) in treatment KMS @ 250 ppm SO_2 + sodium benzoate @ 100 ppm in glass bottles. During storage an increase in reducing sugars of ash gourd juice was observed from 0.15 to 0.59 per cent. However, the interaction between the packaging materials, storage intervals and different methods of preservation were found to be significant. The increase in reducing sugars during storage might be due to the rapid hydrolysis of polysaccharide and their subsequent conversion to reducing sugars. Similarly, Majumdar *et al.* (2012); Babu (2015) and Kadam and Lele (2016) also reported an increase in reducing sugars of ash gourd-mint leaves juice, ripe pumpkin pulp and ash gourd-carrot juice during storage, respectively.

4.2.6 Total sugars

A perusal of data in Table 4.5 reveal that the total sugars of ash gourd juice subjected to different preservation treatments during storage of 90 days varied from 2.19 to 2.54 per cent among two types of packaging *viz.* glass and PET bottles**.** The total sugar content of ash gourd juice during storage increased from 2.20 to 2.42 per cent. The mean maximum (2.35 per cent) value of total sugars was recorded in juice preserved by heat processing while mean minimum (2.27 per cent) was recorded in juice preserved with KMS @ 350 ppm SO_2. The increase in total sugars was slightly higher in PET bottles as compared to glass bottles.

However, the interaction between the packaging materials, storage intervals and different methods of preservation were found to be non-significant. Increase in total sugars might be due to inversion of sucrose to glucose and fructose during storage. Similar increasing trend has been observed by Majumdar *et al.* (2011) in bottle gourd-basil leaves juice and by Babu (2015) in ripe pumpkin pulp storage.

4.2.7 Total phenols

A perusal of data in Table 4.6 reveal that the total phenols of ash gourd juice subjected to different preservation treatments during storage of 90 days varied from 23.20 to 24.28 mg GAE/100g among two types of packaging *viz*. glass and PET bottles**.** The total phenolic content of ash gourd juice during storage decreased from 24.28 mg GAE/100g to 23.22 mg GAE/100g. The mean maximum value of total phenols (23.91 mg GAE/100g) was recorded in juice preserved with KMS @ 350 ppm SO_2 while mean minimum value (23.85 mg GAE/100g) with KMS @ 250 ppm SO_2 + sodium benzoate @ 100 ppm combination. The ash gourd juice showed a decreasing trend in total phenols with increase in storage intervals. The decrease in total phenols was found to be slightly higher in PET bottles as compared to glass bottles. However, the interaction between the packaging materials, storage intervals and different methods of preservation were found to be significant. Significant decrease in total phenol content during storage might be due to their involvement in the formation of polymeric compounds, complex formation of phenols with protein. Similar decreasing trend was noticed by Vallverdu-Queralt (2011) in tomato juice, by Kaur and Aggarwal (2014a) in bitter gourd juice preserved with different chemical preservatives and by Palamthodi *et al.* (2019) in ash gourd -bottle gourd juice blended with jamun during their storage.

4.2.8 Non-enzymatic Browning

Data given in Table 4.6 show that non-enzymatic browning of ash gourd juice subjected to different preservation treatments during storage of 90 days varied from 0.010 to 0.071 among two types of packaging *viz*. glass and PET bottles. The mean Non-enzymatic Browning in ash gourd juice among different preservation methods ranged between 0.028 to 0. 045. The extent of non-enzymatic browning was more pronounced in juice packed in PET bottles than those packed in glass bottles. The highest non-enzymatic browning was found in juice preserved with heat processing (0.045) while the juice preserved by using KMS @ 350 SO_2 recorded minimum non-enzymatic browning (0.028). With the increase in period of storage, the non-enzymatic browning in the juice registered a consistent increase from 0.010

to 0.051. The interactions between the packaging materials, storage intervals and different methods of preservation were found to be significant. Heat processed juice showed a higher degree of browning as compared to chemically preserved juice especially those preserved with Sulphur dioxide Bansal and Dhawan (1993). Thus, the use of potassium metabisulphite either singly or in combination with sodium benzoate brought about significant improvement in reducing the non-enzymatic browning in the juice during storage. Similar results were found by Bahattacherjee *et al.,* 2011 and Shweta (2020) in aonla juice at 440 nm.

4.2.9 Antioxidant activity

The antioxidant activity of ash gourd juice subjected to different preservation treatments during storage of 90 days varied between 24.44 to 26.82 per cent among two types of packaging *viz*. glass and PET bottles (Table 4.7). During storage, there was a significant decrease in antioxidant activity of ash gourd juice from 26.82 to 25.41 per cent. Among different preservation treatments, mean maximum antioxidant activity (26.36 per cent) was recorded in juice preserved with KMS @ 350 ppm SO_2. The methods of preservation used in this study cause a significant influence on the level of antioxidant activity. However, the interaction between method of preservation(M), storage intervals(S) and packaging material (P) were found to be significant. Klimczak (2007) reported that decrease in antioxidant activity during storage was attributed to a decrease in total phenolic content and vitamin C. Similar decreasing trend was noticed by Ibrahim *et al*. (2011) in apple juice during storage and by Kadam and Lele (2016) in ash gourd-carrot juice.

4.2.10 Sensory evaluation

Data pertaining to the sensory quality of juice during storage is presented in Tables 4.8 to 4.9 and Figure 4.1 and is discussed as under:

4.2.10.1 Colour

Data given in Table 4.8 show that colour score of ash gourd juice subjected to different preservation treatments during storage of 90 days varied from 6.10 to 7.01 among two types of packaging *viz*. glass and PET bottles. There was a general decrease in colour score of ash gourd juice from 6.93 to 6.28 during storage. Methods of preservation of ash gourd juice did not have significant influence on the colour of the juice. Further, the juice packed in glass bottles exhibited higher acceptability than that of packed in PET bottles.

Table 4.3 Effect of different methods of preservation on total soluble solids (°B) and pH of ash gourd juice during storage at ambient temperature

TSS (°B)								pH					
Packaging material (P)	**Storage intervals (S) (Days)**	**Methods of Preservation (M)**				**Mean (P)**	**Mean (S)**	**Methods of Preservation (M)**				**Mean (P)**	**Mean (S)**
		Pasteurization	**KMS@ 350 ppm SO_2**	**Sodium benzoate @ 600 ppm**	**KMS@ 250 ppm SO_2 + Sodium benzoate @ 100 ppm**			**Pasteurization**	**KMS@ 350 ppm SO_2**	**Sodium benzoate @ 600 ppm**	**KMS@ 250 ppm SO_2 + Sodium benzoate @ 100 ppm**		
Glass bottle	**0**	3.00	3.00	3.00	3.00	**3.00**	**3.00**	5.06	5.06	5.05	5.05	**5.05**	**5.06**
	45	3.25	3.09	3.18	3.12	**3.16**	**3.17**	5.05	5.03	5.04	5.03	**5.04**	**5.04**
	90	3.28	3.14	3.21	3.16	**3.20**	**3.21**	5.04	5.02	5.03	5.03	**5.03**	**4.92**
	Mean	**3.18**	**3.08**	**3.13**	**3.09**			**5.05**	**5.04**	**5.04**	**5.04**		
PET bottle	**0**	3.00	3.00	3.00	3.00	**3.00**		5.09	5.09	5.05	5.05	**5.07**	
	45	3.28	3.13	3.20	3.14	**3.19**		5.07	5.04	5.04	5.04	**5.04**	
	90	3.30	3.20	3.23	3.18	**3.23**		5.04	4.10	5.04	5.03	**4.81**	
	Mean	**3.19**	**3.11**	**3.14**	**3.11**			**5.07**	**4.74**	**5.04**	**5.04**		
Mean (M)		**3.18**	**3.18**	**3.09**	**3.14**	**3.10**		**5.06**	**4.89**	**5.04**	**5.04**		

$CD_{0.05}$

Method of preservation (M)	=	0.01
Storage intervals (S)	=	0.01
Packaging (P)	=	0.01
MxS	=	0.02
MxP	=	NS
SxP	=	0.01
MxSxP	=	NS

$CD_{0.05}$

Method of preservation (M)	=	0.01
Storage intervals (S)	=	0.01
Packaging (P)	=	0.01
MxS	=	0.02
MxP	=	0.01
SxP	=	0.01
MxSxP	=	0.02

Table 4.4 Effect of different methods of preservation on titrable acidity (per cent) and ascorbic acid (mg/100g) of ash gourd juice during storage at ambient temperature

Titrable acidity (per cent)								Ascorbic acid (mg/100g)					
Packaging material (P)	**Storage intervals (S) (Days)**	**Methods of Preservation (M)**				**Mean (P)**	**Mean (S)**	**Methods of Preservation (M)**				**Mean (P)**	**Mean (S)**
		Pasteurization	**KMS@ 350 ppm SO_2**	**Sodium benzoate @ 600 ppm**	**KMS@ 250 ppm SO_2 + Sodium benzoate @ 100 ppm**			**Pasteurization**	**KMS@ 350 ppm SO_2**	**Sodium benzoate @ 600 ppm**	**KMS@ 250 ppm SO_2 + Sodium benzoate @ 100 ppm**		
Glass bottle	**0**	0.13	0.13	0.13	0.13	**0.13**	**0.13**	8.13	8.13	8.13	8.13	**8.13**	**8.13**
	45	0.16	0.13	0.15	0.14	**0.14**	**0.15**	6.89	6.75	6.93	7.87	**7.11**	**6.98**
	90	0.18	0.16	0.18	0.16	**0.17**	**0.18**	4.98	7.06	5.01	5.34	**5.60**	**5.55**
	Mean	**0.16**	**0.14**	**0.15**	**0.14**			**6.67**	**7.31**	**6.69**	**7.11**		
PET bottle	**0**	0.13	0.13	0.13	0.13	**0.13**		8.13	8.13	8.13	8.13	**8.13**	
	45	0.17	0.15	0.16	0.15	**0.16**		6.75	6.84	6.77	6.99	**6.84**	
	90	0.23	0.17	0.20	0.18	**0.20**		4.77	6.47	4.78	5.99	**5.50**	
	Mean	0.18	0.15	0.16	0.15			**6.55**	**7.15**	**6.56**	**7.04**		
Mean (M)		**0.17**	**0.15**	**0.16**	**0.15**			**6.61**	**7.23**	**6.63**	**7.08**		

$CD_{0.05}$

Method of preservation (M)	=	0.00
Storage intervals (S)	=	0.00
Packaging (P)	=	0.00
MxS	=	0.01
MxP	=	0.01
SxP	=	0.01
MxSxP	=	0.01

$CD_{0.05}$

Method of preservation (M)	=	0.02
Storage intervals (S)	=	0.02
Packaging (P)	=	0.01
MxS	=	0.03
MxP	=	0.03
SxP	=	0.02
MxSxP	=	0.05

Table 4.5 Effect of different methods of preservation on reducing sugars (per cent) and total sugars (per cent) of ash gourd juice during storage at ambient temperature

Reducing sugars (per cent)								Total sugars (per cent)					
Packaging material (P)	Storage intervals (S) (Days)	Methods of Preservation (M)				Mean (P)	Mean (S)	Methods of Preservation (M)				Mean (P)	Mean (S)
		Pasteurization	KMS@ 350 ppm SO_2	Sodium benzoate @ 600 ppm	KMS@ 250 ppm SO_2 + Sodium benzoate @ 100 ppm			Pasteurization	KMS@ 350 ppm SO_2	Sodium benzoate @ 600 ppm	KMS@ 250 ppm SO_2 + Sodium benzoate @ 100 ppm		
Glass bottle	**0**	0.15	0.15	0.15	0.15	**0.15**	**0.15**	2.19	2.20	2.20	2.20	**2.20**	**2.20**
	45	0.35	0.25	0.33	0.27	**0.30**	**0.37**	2.31	2.29	2.31	2.30	**2.30**	**2.32**
	90	0.85	0.30	0.43	0.33	**0.48**	**0.59**	2.53	2.34	2.38	2.34	**2.40**	**2.42**
	Mean	**0.45**	**0.23**	**0.30**	**0.25**			**2.34**	**2.27**	**2.29**	**2.28**		
PET bottle	**0**	0.15	0.15	0.15	0.15	**0.15**		2.19	2.20	2.20	2.20	**2.20**	
	45	0.39	0.44	0.46	0.43	**0.43**		2.33	2.32	2.36	2.34	**2.34**	
	90	0.90	0.64	0.68	0.55	**0.69**		2.54	2.36	2.44	2.40	**2.43**	
	Mean	**0.48**	**0.41**	**0.43**	**0.38**			**2.35**	**2.29**	**2.33**	**2.31**		
Mean (M)		**8.50**	**8.50**	**0.47**	**0.32**	**0.37**	**0.31**	**2.34**	**2.28**	**2.35**	**2.28**	**2.31**	**2.30**

$CD_{0.05}$

Method of preservation (M)	=	0.02
Storage intervals (S)	=	0.02
Packaging (P)	=	0.01
MxS	=	0.03
MxP	=	0.03
SxP	=	0.02
MxSxP	=	0.04

$CD_{0.05}$

Method of preservation (M)	=	0.01
Storage intervals (S)	=	0.01
Packaging (P)	=	0.01
MxS	=	0.01
MxP	=	0.01
SxP	=	0.01
MxSxP	=	NS

Table 4.6 Effect of different methods of preservation on total phenols (mg GAE/g) and non-enzymatic browning (O.D) of ash gourd juice during storage at ambient temperature

Total phenols (mg GAE/g)								Non-enzymatic browning (O.D)					
Packaging material (P)	Storage intervals (S) (Days)	Methods of Preservation (M)				Mean (P)	Mean (S)	Methods of Preservation (M)				Mean (P)	Mean (S)
		Pasteurization	KMS@ 350 ppm SO_2	Sodium benzoate @ 600 ppm	KMS@ 250 ppm SO_2 + Sodium benzoate @ 100 ppm			Pasteurization	KMS@ 350 ppm SO_2	Sodium benzoate @ 600 ppm	KMS@ 250 ppm SO_2 + Sodium benzoate @ 100 ppm		
Glass bottle	**0**	24.28	24.28	24.28	24.28	**24.28**	**24.28**	0.010	0.010	0.010	0.010	**0.010**	**0.010**
	45	24.18	24.22	24.21	24.22	**24.21**	**24.20**	0.052	0.030	0.041	0.032	**0.039**	**0.043**
	90	23.25	23.24	23.21	23.22	**23.23**	**23.22**	0.069	0.036	0.048	0.038	**0.048**	**0.051**
	Mean	**23.90**	**23.91**	**23.90**	**23.91**			**0.044**	**0.025**	**0.033**	**0.027**		
PET bottle	**0**	24.28	24.28	24.28	24.28	**24.28**		0.010	0.010	0.010	0.010	**0.010**	
	45	24.17	24.21	24.20	24.21	**24.20**		0.058	0.038	0.049	0.041	**0.047**	
	90	23.22	23.22	23.20	23.21	**23.21**		0.071	0.042	0.060	0.046	**0.055**	
	Mean	**23.89**	**23.90**	**23.89**	**23.90**			**0.046**	**0.030**	**0.040**	**0.032**		
Mean (M)		**23.90**	**23.91**	**23.90**	**23.85**			**0.045**	**0.028**	**0.036**	**0.030**		

$CD_{0.05}$

Method of preservation (M)	=	0.01
Storage intervals (S)	=	0.01
Packaging (P)	=	0.01
MxS	=	NS
MxP	=	NS
SxP	=	NS
MxSxP	=	0.03

$CD_{0.05}$

Method of preservation (M)	=	0.001
Storage intervals (S)	=	0.001
Packaging (P)	=	0.001
MxS	=	0.002
MxP	=	0.002
SxP	=	0.002
MxSxP	=	0.003

Table 4.7 Effect of different methods of preservation on antioxidant activity (per cent) of ash gourd juice during storage at ambient temperature

Antioxidant activity (per cent)							
Packaging material (P)	**Storage intervals (S) (Days)**	**Methods of Preservation (M)**				**Mean (P)**	**Mean (S)**
		Pasteurization	**KMS@ 350 ppm SO_2**	**Sodium benzoate @ 600 ppm**	**KMS@250 ppm SO_2 + Sodium benzoate @ 100 ppm**		
Glass Bottle	**0**	26.82	26.82	26.82	26.82	**26.82**	**26.82**
	45	25.62	26.57	26.31	26.56	**26.27**	**26.25**
	90	24.47	25.69	25.90	25.67	**25.43**	**25.41**
	Mean	**25.64**	**26.36**	**26.34**	**26.35**		
PET Bottle	**0**	26.82	26.82	26.82	26.82	**26.82**	
	45	25.60	26.53	26.51	26.28	**26.23**	
	90	24.44	25.65	25.62	25.87	**25.39**	
	Mean	**25.62**	**26.33**	**26.31**	**26.33**		
Mean (M)		**25.63**	**26.35**	**26.33**	**26.34**		
$CD_{0.05}$	Method of Preservation (M)		0.02				
	Storage intervals (S)		0.02				
	Packaging (P)		0.02				
	(MxS)		0.04				
	(MxP)		0.03				
	(SxP)		NS				
	(MxSxP)		0.05				

4.2.10.2 Body

A perusal of data given in Table 4.8 show that body of ash gourd juice subjected to different preservation treatments during storage of 90 days varied from 6.43 to 6.73, among two types of packaging *viz*. glass and PET bottles. There was a general decrease in body score of ash gourd juice during storage from 6.71 to 6.50.

4.2.10.3 Flavour

Data given in Table 4.9 show that flavour of ash gourd juice subjected to different preservation treatments during storage of 90 days varied from 5.62 to 6.16 among two types of packaging *viz*. glass and PET bottles. The ash gourd juice showed gradual decrease in its flavour score (6.05 to 5.71) with the increase in storage period.

4.2.10.4 Overall acceptability

It is evident from Table 4.9 that overall acceptability of ash gourd juice subjected to different preservation treatments during storage of 90 days varied from 6.15 to 6.63, among two types of packaging *viz*. glass and PET bottles. The juice preserved by adding KMS @ 350 ppm SO_2 was rated superior among all combinations for its overall acceptability

Table 4.8 Effect of different preservation methods on colour and body score of ash gourd juice (9 point hedonic scale)

Packaging material (P)	Storage intervals (S) (Days)	Colour: Methods of Preservation (M)				Mean (P)	Mean (S)	Body: Methods of Preservation (M)				Mean (P)	Mean (S)
		Pasteurization	KMS@ 350 ppm SO_2	Sodium benzoate @ 600 ppm	KMS@ 250 ppm SO_2 + Sodium benzoate @ 100 ppm			Pasteurization	KMS@ 350 ppm SO_2	Sodium benzoate @ 600 ppm	KMS@ 250 ppm SO_2 + Sodium benzoate @ 100 ppm		
Glass bottle	**0**	7.00	7.01	7.01	7.01	**7.01**	**6.93**	6.73	6.72	6.68	6.72	**6.71**	**6.71**
	45	6.50	6.58	6.46	6.52	**6.52**	**6.49**	6.69	6.71	6.65	6.67	**6.68**	**6.62**
	90	6.33	6.40	6.27	6.23	**6.31**	**6.28**	6.54	6.63	6.52	6.53	**6.55**	**6.50**
	Mean	**6.61**	**6.66**	**6.58**	**6.59**			**6.65**	**6.69**	**6.62**	**6.64**		
PET bottle	**0**	6.70	7.00	6.69	7.02	**6.85**		6.70	6.71	6.71	6.71	**6.71**	
	45	6.53	6.50	6.47	6.33	**6.46**		6.43	6. 63	6.56	6.60	**6.55**	
	90	6.21	6.27	6.10	6.39	**6.24**		6.49	6.52	6.36	6.44	**6.45**	
	Mean	**6.48**	**6.59**	**6.42**	**6.58**			**6.54**	**6.62**	**6.54**	**6.58**		
Mean (M)		**6.55**	**6.55**	**6.63**	**6.50**			**6.60**	**6.65**	**6.58**	**6.61**		

$CD_{0.05}$

Method of preservation (M)	=	NS
Storage intervals (S)	=	0.14
Packaging (P)	=	NS
MxS	=	NS
MxP	=	NS
SxP	=	NS
MxSxP	=	NS

$CD_{0.05}$

Method of preservation (M)	=	NS
Storage intervals (S)	=	0.05
Packaging (P)	=	0.04
MxS	=	NS
MxP	=	NS
SxP	=	0.07
MxSxP	=	NS

Table 4.9 Effect of different preservation methods on flavour and overall acceptability score of ash gourd juice (9 point hedonic scale)

Packaging material (P)	Storage intervals (S) (Days)	Flavour: Methods of Preservation (M)				Mean (P)	Mean (S)	Overall acceptability: Methods of Preservation (M)				Mean (P)	Mean (S)
		Pasteurization	KMS@ 350 ppm SO_2	Sodium benzoate @ 600 ppm	KMS@ 250 ppm SO_2 + Sodium benzoate @ 100 ppm			Pasteurization	KMS@ 350 ppm SO_2	Sodium benzoate @ 600 ppm	KMS@ 250 ppm SO_2 + Sodium benzoate @ 100 ppm		
Glass bottle	**0**	5.97	6.16	6.00	6.04	**6.04**	**6.05**	6.57	6.63	6.46	6.59	**6.56**	**6.56**
	45	5.80	5.84	5.78	5.82	**5.81**	**5.80**	6.33	6.37	6.30	6.34	**6.33**	**6.30**
	90	5.68	5.77	5.72	5.78	**5.74**	**5.71**	6.16	6.27	6.11	6.18	**6.18**	**6.16**
	Mean	**5.82**	**5.92**	**5.83**	**5.88**			**6.35**	**6.43**	**6.29**	**6.37**		
PET bottle	**0**	6.00	6.10	6.04	6.06	**6.05**		6.57	6.61	6.59	6.49	**6.57**	
	45	5.76	5.82	5.74	5.80	**5.78**		6.23	6.26	6.26	6.31	**6.27**	
	90	5.62	5.74	5.62	5.76	**5.68**		6.15	6.22	6.08	6.14	**6.15**	
	Mean	**5.79**	**5.89**	**5.80**	**5.88**			**6.32**	**6.36**	**6.31**	**6.31**		
Mean (M)		**5.80**	**5.91**	**5.82**	**5.88**			**6.33**	**6.40**	**6.30**	**6.34**		

$CD_{0.05}$

Method of preservation (M)	=	NS
Storage intervals (S)	=	0.11
Packaging (P)	=	NS
MxS	=	NS
MxP	=	NS
SxP	=	NS
MxSxP	=	NS

$CD_{0.05}$

Method of preservation (M)	=	0.07
Storage intervals (S)	=	0.06
Packaging (P)	=	NS
MxS	=	NS
MxP	=	NS
SxP	=	NS
MxSxP	=	NS

up to 90 days of storage period. The decrease in sensory attributes of product might be due to loss of flavour and deterioration of taste and effect of temperature on biochemical changes in the products which leads to development of off flavour during storage reported by Pandey and Singh (1999).

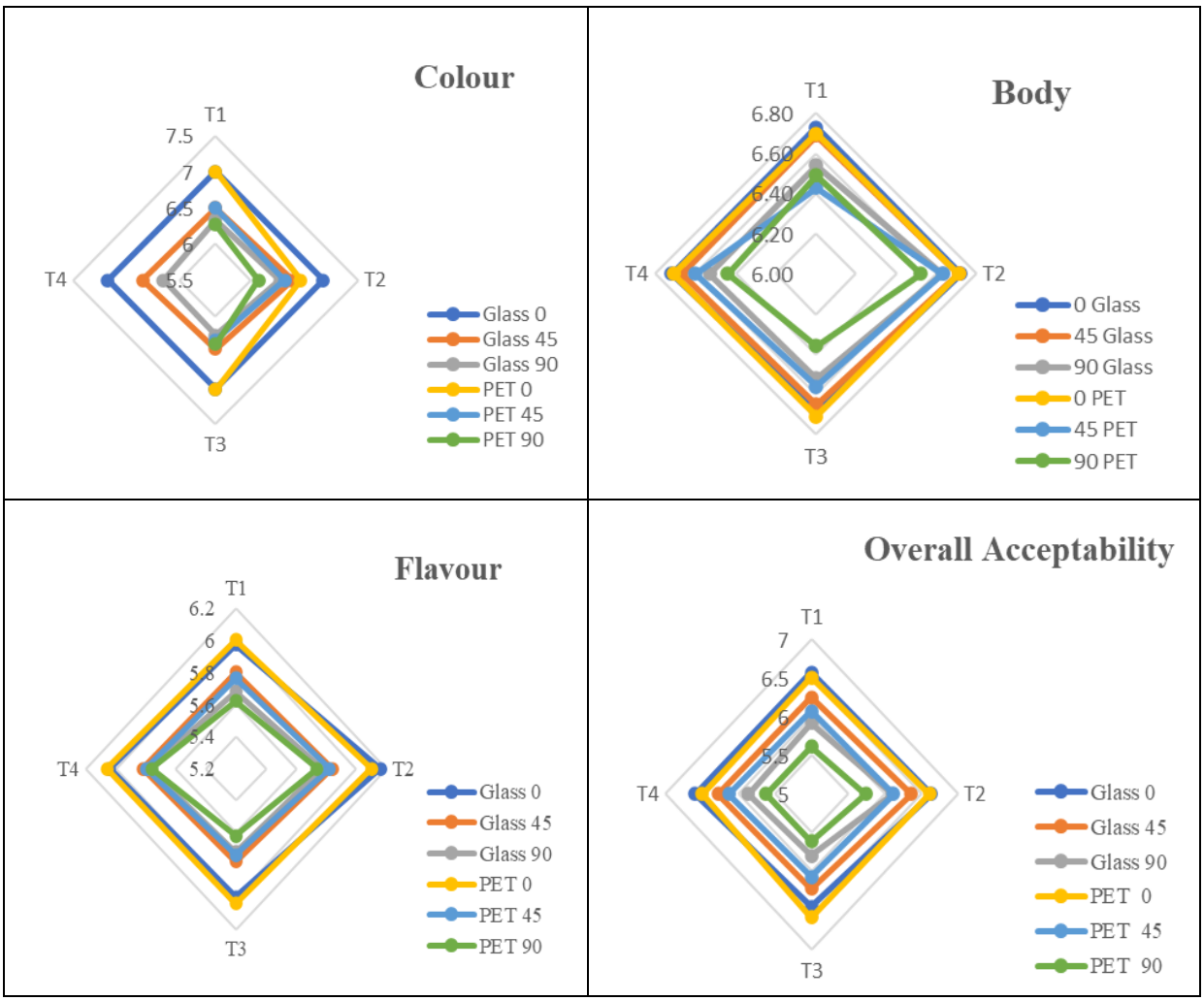

Figure 4.1 Sensory scores (9-point hedonic scale) of ash gourd juice at ambient storage

4.3 PRODUCT DEVELOPMENT

4.3.1 Sweetened beverage

4.3.1.1 Sensory evaluation of sweetened beverage

Suitability of incorporation of various proportions of juice and sugar on sensory qualities of the prepared sweetened beverage is presented in Table 4.10 and Figure 4.2. The different combinations of sweetened beverage were subjected to sensory evaluation by a panel of ten judges. The addition of sugar in ash gourd juice brought about significant

changes on sensory colour acceptability score of the resultant beverage. The mean score for colour in sweetened beverage ranged from 7.42 to 7.53 on a 9-point hedonic scale. The beverage prepared by using 85 per cent juice and 15 per cent sugar had the maximum acceptability for colour. With the addition of sugar in the natural juice, the colour score registered a consistent decrease. However, the score remained more than 7.0 indicating that all the beverages were within acceptable range with respect to colour.

Table 4.10 Effect of addition of various proportions of juice and sugars on sensory characteristics (9-point hedonic scale) of sweetened beverage

Proportions of juice and sugar	Colour	Body	Flavour	Overall acceptability
T_1 (Natural)	7.48	7.77	6.63	7.29
T_2 (Natural:10)	7.42	7.87	7.35	7.55
T_3 (Natural:15)	7.44	7.68	7.89	7.67
T_4 (85:10)	7.51	7.98	7.84	7.78
T_5 (85:15)	**7.53**	**8.09**	**8.02**	**7.88**
$CD_{0.05}$	0.03	0.23	0.15	0.09

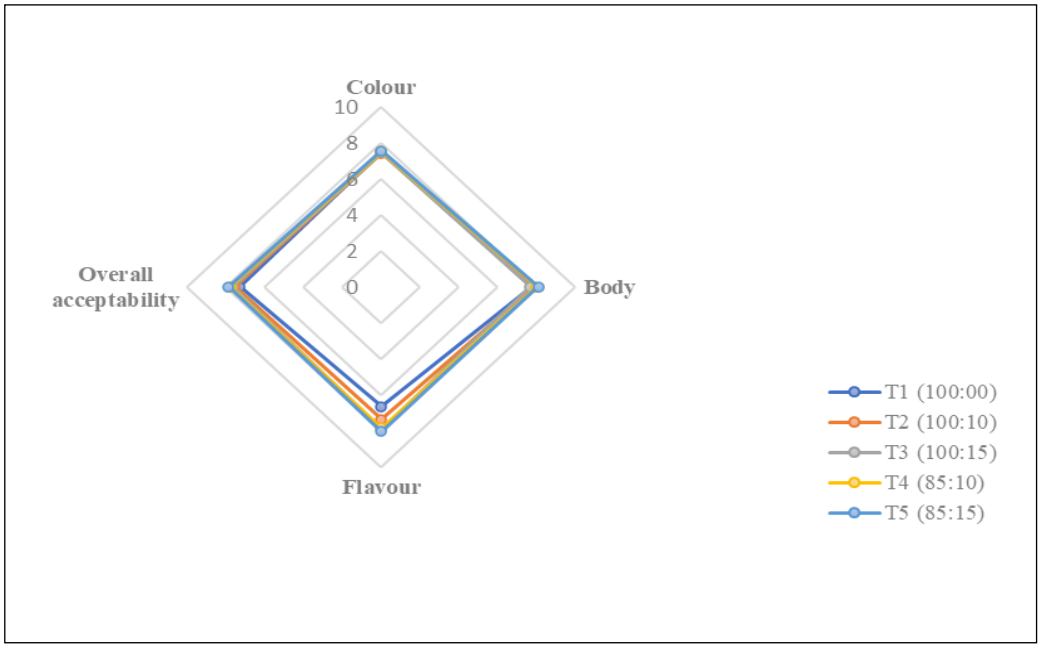

Figure 4.2 Sensory scores (9-point hedonic scale) for ash gourd sweetened beverage prepared with various proportions of juice and sugar

The flavour score of the ash gourd sweetened beverage ranged from 6.63 to 8.02. The highest mean score was obtained in sweetened beverage having 85 per cent ash gourd juice (8.02). The lowest flavour score was awarded to combinations having 100 per cent juice (6.63) thus, indicating the slightly liking of the sweetened beverage. Sensory evaluation of

the beverage indicated that the drink prepared by using 85 per cent ash gourd juice and 15 per cent sugar had highest liking for body. Though, with the incorporation of juice and corresponding increase in ash gourd juice the acceptability of the beverage for body of the beverage decreased. The drinks having 100:0, 100:10, 100:15 85:10 and 85:15 per cent ash gourd juice and sugar were statistically significant with respect to sensory attributes. As expected, the ash gourd beverage having 85 per cent juice with 15 per cent TSS had highest acceptability among the panelist with a mean score of 7.29 to 7.88 on a 9-point hedonic scale.

4.3.1.2 Changes in chemical and sensory characteristics of ash gourd sweetened beverage during storage

The sweetened beverage prepared by 85 per cent juice with 15 per cent TSS and 0.3 per cent acidity as per earlier experiment (Table 4.10) was evaluated at periodic intervals of 0, 45 and 90 days after preserving either by heat processing or by adding KMS @ 350 ppm SO_2 or sodium benzoate @ 600 ppm either singly or in combination of KMS @ 350 ppm and sodium benzoate 350 ppm in 1:1 ratio after packing PET in bottles (each 200 ml capacity) prior to storage at ambient temperature. The changes in physico-chemical as well as sensory attributes during storage of the beverages presented in Tables 4.11 to 4.17, Plate 4.2 and Figure 4.3 are explained as under:

4.3.1.2.1 Total soluble solids (TSS)

The effect of different preservation methods on TSS of ash gourd sweetened beverage during storage at ambient temperature is presented in Table 4.11. The TSS of ash gourd juice subjected to different preservation treatments during storage of 90 days varied from 14.94 to 15.00 °B packed in PET bottles. A significant loss in TSS of sweetened beverage was observed during storage with 15 °B TSS on 0^{th} day, which continued to decrease to 14.96 °B on 90^{th} day. Among various methods of preservation, the maximum mean value of total soluble solids of sweetened beverage (14.99 °B) was observed in treatment T_2 (KMS @ 300 ppm) while mean minimum TSS (14.97 °B) in T_3 (Sodium benzoate @ 600 ppm). The interaction between storage intervals and method of preservation was found to be significant. Similarly, Boghani *et al.* (2012) and Babu (2015) has observed changes in papaya-aloevera RTS and ripe pumpkin RTS beverage, respectively during storage.

4.3.1.2.2 pH

There was a significant decrease in pH of ash gourd sweetened beverage from 3.60 to 3.56 during 90 days storage at ambient temperature (Table 4.11). The pH of ash gourd juice

subjected to different preservation treatments during storage of 90 days varied from 3.55 to 3.60 packed in PET bottles. Mean maximum pH of sweetened beverage (3.59) was observed in treatment T_2 (KMS @ 350 ppm SO_2) whereas, minimum pH (3.57) in treatment T_1 (pasteurization). The interaction between storage intervals and methods of preservation was found to be non-significant. Similarly, a decreasing trend in the pH has been observed by Barman and Barooah (2016) in jamun RTS beverages.

4.3.1.2.3 Titrable acidity

The effect of different preservation methods on titrable acidity (per cent) of ash gourd sweetened beverage during storage at ambient temperature is presented in Table 4.12. The titrable acidity of ash gourd juice subjected to different preservation treatments varied between 0.30 to 0.37 per cent during storage of 90 days, packed in PET bottles. The presence of mean acid content ranging between 0.30 to 0.35 per cent during entire period of storage indicate that level of acidity was appropriate to have acceptable acid-sugar balance in the prepared beverages. Among various methods of preservation, treatment T_1 (pasteurization) received the maximum mean value (0.34 per cent) while mean minimum value (0.32 per cent) was observed in beverage preserved with KMS @ 350 ppm SO_2 + with sodium benzoate @ 350 ppm. A significant effect on titratable acidity of ash gourd sweetened beverage was observed during storage The increase in acidity during storage might be attributed due to the breakdown of pectin into pectinic acid. Similarly, decrease in acidity may be due to degradation of organic acids during storage which cause conversion of acids into sugar and salt (Jain *et al.*,1986).

4.3.1.2.4 Ascorbic acid

The storage of ash gourd sweetened beverage at ambient temperature exhibited significant influence on ascorbic acid retention (Table 4.12). However, the ash gourd sweetened beverage preserved with KMS @ 350 ppm SO_2 showed better retention of ascorbic acid (8.85 mg/100g) as compared to other methods of preservation. However, at the end of storage period, the level of ascorbic acid in ash gourd sweetened beverage was found to be 8.37 mg/100g against its initial value of 9.15 mg/100g thus registering at total loss of about 0.88 per cent. However, the interaction between methods of preservation and storage intervals was found to be significant. The degradation of ascorbic acid upon storage has been implicated partially to its oxidation and partially to its involvement in browning reactions in the presence of high acidic environment (Clegg, 1964). While, comparatively better retention

Sweetened beverage
(Pasteurized)

Sweetened beverage
(KMS @ 350 ppm SO_2)

Sweetened beverage
(Sodium benzoate @ 600 ppm)

Sweetented beverage
(KMS @ 350 ppm: Sodium benzoate @ 350 ppm)

Plate 4.2 Ash gourd sweetened beverage

of vitamin C in the leather from the sulphited pulp was due to the possible antioxidative property of sulphur dioxide which is known to retard the oxidative reactions and prevents non-enzymatic reactions (Teotia and Pruthi, 1987).The decreasing trend in ascorbic acid during storage might be due to its breakdown in to dehydroascorbic acid or unstable nature of ascorbic acid by the action of heat, light and air or conversion to dehydroascorbic acid by its participation in browning (Sood *et al.*, 2009). A significant decrease has also been observed in ripe pumpkin RTS by Babu (2015) and by Barman and Barooah (2016) in jamun RTS beverage during storage of 90 days.

4.3.1.2.5 Reducing sugars

The effect of different preservation methods on reducing sugars of ash gourd sweetened beverage during storage at ambient temperature is presented in Table 4.13. The reducing sugars of ash gourd juice subjected to different preservation treatments varied from 8.13 to 8.20 per cent during storage of 90 days, packed in PET bottle. Mean value for reducing sugars increased from 8.13 to 8.18 per cent during storage period of 90 days. The maximum mean value (8.17 per cent) was recorded in treatment T_1 (pasteurization) while mean minimum (8.14 per cent) in treatment T2 (preserved with KMS @ 350 ppm SO_2). The interaction between different methods of preservation and storage intervals was found to be non-significant. The changes in different treatments of reducing sugars might be due to hydrolysis of polysaccharides like starch and inversion of non-reducing sugar into reducing sugar. A significant increase was found by Babu (2015) in ripe pumpkin RTS and also by Barman and Barooah (2016) in jamun RTS beverage from the initial day of preparation during 90 days of storage.

4.3.1.2.6 Total sugars

The total sugars of ash gourd juice subjected to different preservation treatments varied from 13.92-13.99 per cent during storage of 90 days, packed in PET bottles. The effect of different preservation methods on total sugars of ash gourd sweetened beverage during storage at ambient temperature is presented in Table 4.13**.** A significant increase was recorded in total sugars of sweetened beverage from 13.92 to 13.97 per cent during storage of 90 days. The mean maximum value (13.96 per cent) was observed in treatment T_1 (pasteurization) while mean minimum value (13.94 per cent) was noticed in treatment T_2 that is at par with treatment T_4 (KMS @ 350 ppm SO_2 + sodium benzoate @ 350 ppm). However, the interaction between storage intervals and methods of preservation was found to be non

significant. Increase in total sugars during storage might be attributed due to the hydrolysis of starch into sugars (Heikal *et al.,* 1964). Earlier, similar trends were also have been noticed by Aruna *et al.* (1997), Satkar *et al.* (2013 *et al.* (2014 in papaya drink, bitter gourd and guava-mango drink respectively during storage.

4.3.1.2.7 Total phenols

The effect of different preservation methods on Total Phenolic Content of ash gourd sweetened beverage during storage at ambient temperature is presented in Table 4.14. The total phenolic content of ash gourd sweetened juice subjected to different preservation treatments varied between 24.21 to 25.27 24 mgGAE/100g during storage of 90 days packed in PET bottles. A significant decrease (25.23 to 24.24 mgGAE/100g) was noticed in total phenolic content of ash gourd sweetened beverage during 90 days storage. The maximum mean value of total phenolic content (24.80 mg/100g) was recorded in preservation method T_2 (KMS @ 350 ppm SO_2) while mean minimum value of 24.68 mg/100g in treatment T_1 (pasteurization). The interaction between methods of preservation and storage intervals was found to be significant. Significant decrease in total phenols of sweetened beverage might be due to their involvement in formation of polymeric compound, complex formation of phenols with protein and their subsequent precipitation. Our findings are agreed with the reports of Sonia *et al.* (2010) and Hamid (2015) who have noticed decreasing trend in jamun drink and mulberry drink, respectively during storage.

4.3.1.2.8 Non-enzymatic browning

The Non-enzymatic browning (NEB) of ash gourd sweetened juice subjected to different preservation treatments varied between 0.010 to 0.012 during storage of 90 days packed in PET bottles (Table 4.14). Non-enzymatic browning in ash gourd sweetened juice gradually increases with the progress of storage period. Mean non-enzymatic browning value of sweetened beverage increased from 0.010 to 0.012 during storage of 90 days. However, the interaction between different methods of preservation and storage intervals was found to be non-significant. According to Ross *et al.* (1945several factors such as temperature, pH, moisture, organic acid, water activity, oxygen, sulphitation and sugars are known to influence the non-enzymatic browning in foods). Bhardwaj and Nandal (2014) had reported a liner

increase in non-enzymatic browning during storage of blended juice of kinnow for 6 months.

4.3.1.2.9 Antioxidant activity

The effect of different preservation methods on antioxidant activity of ash gourd sweetened beverage during storage at ambient temperature is presented in Table 4.15. The antioxidant activity of ash gourd juice subjected to different preservation treatments during storage of 90 days varied from 25.65 to 24.43 per cent packed in PET bottles**.** Our results indicate that antioxidant activity in the beginning was about 25.65 per cent on 0^{th} day which decreased to 24.63 per cent towards the end of storage of 90 days. The mean maximum antioxidant activity value (25.23 per cent) was observed with KMS @ 350 ppm SO_2 and in combination with sodium benzoate @ 350 ppm while mean minimum value (25.12 per cent) in T_1 i.e. heat processing. However, the interaction between different methods of preservation and storage intervals was found to be significant. Similar decrease in antioxidant activity has been recorded by Barman and Barooah (2016) in jamun RTS beverage during the storage period.

4.3.1.2.10 Sensory evaluation

Changes in sensory quality of ash gourd sweetened beverage were evaluated during storage at ambient temperature at periodic intervals of 0, 45 and 90 days for various attributes *viz.* colour, body, flavour and over all acceptability. Sensory evaluation of ash gourd sweetened beverage indicated that the storage, has significantly influenced the colour acceptability score of beverages. With the increase in storage period, the colour acceptability score decreased. The colour of ash gourd juice subjected to different preservation treatments during storage of 90 days varied from 7.54 to 7.48 on a 9-point hedonic scale packed in PET bottles. The highest score was awarded to treatment T_2 (KMS @ 350 ppm SO_2) for colour (7.58), body (7.89), flavour (6.93) and overall acceptability (7.46). However, there was a decreasing trend in all the treatments during storage period of 90 days but found to be well above the acceptable limits. The mean score was found to be decreased from 7.54 to 7.48 for colour, 8.31 to 7.50 for body, 7.54 to 6.36 for flavour and 7.80 to 7.11 for overall acceptability. According to Pandey and Singh (1999) the decrease in sensory characteristics of product might be due to loss of flavour and deterioration of taste and effect of temperature on biochemical changes in the product which leads to development of off flavour during storage.

Table 4.11 Effect of different methods of preservation on total soluble solids (°B) and pH of ash gourd sweetened beverage during storage at ambient temperature

Storage intervals (S) (Days)	Total soluble solids (°B)				Mean (S)	pH				Mean (S)
	Methods of Preservation (M)					Methods of Preservation (M)				
	Pasteurization	KMS@ 350 ppm SO_2	Sodium benzoate @ 600 ppm	KMS@350 ppm SO_2 + Sodium benzoate @ 350 ppm		Pasteurization	KMS@ 350 ppm SO_2	Sodium benzoate @ 600 ppm	KMS@350 ppm SO_2 + Sodium benzoate @ 350 ppm	
0	15.00	15.00	15.00	15.00	**15.00**	3.60	3.61	3.60	3.60	**3.60**
45	14.98	14.99	14.98	14.98	**14.98**	3.57	3.59	3.57	3.57	**3.57**
90	14.97	14.97	14.94	14.95	**14.96**	3.55	3.58	3.55	3.56	**3.56**
Mean (M)	**14.98**	**14.99**	**14.97**	**14.98**		**3.57**	**3.59**	**3.57**	**3.58**	
$CD_{0.05}$						$CD_{0.05}$				
Method of preservation (M)		NS				Method of preservation (M)		0.007		
Storage intervals (S)		0.01				Storage intervals (S)		0.006		
MxS		0.01				MxS		NS		

Table 4.12 Effect of different methods of preservation on titrable acidity (per cent) and Ascorbic acid (mg/100g) of ash gourd sweetened beverage during storage at ambient temperature

Storage intervals (S) (Days)	Titrable acidity (per cent)				Mean (S)	Ascorbic acid (mg/100g)				Mean (S)
	Methods of Preservation (M)					Methods of Preservation (M)				
	Pasteurization	KMS@ 350 ppm SO_2	Sodium benzoate @ 600 ppm	KMS@350 ppm SO_2 + Sodium benzoate @ 350 ppm		Pasteurization	KMS@ 350 ppm SO_2	Sodium benzoate @ 600 ppm	KMS@350 ppm SO_2 + Sodium benzoate @ 350 ppm	
0	0.30	0.30	0.30	0.30	**0.30**	8.92	9.23	9.23	9.23	**9.15**
45	0.34	0.32	0.33	0.32	**0.33**	8.84	8.88	8.85	8.86	**8.86**
90	0.37	0.33	0.34	0.34	**0.35**	8.24	8.46	8.38	8.40	**8.37**
Mean (M)	**0.34**	**0.32**	**0.33**	**0.32**		**8.66**	**8.85**	**8.82**	**8.83**	
$CD_{0.05}$						$CD_{0.05}$				
Method of preservation (M)		0.01				Method of preservation (M)		0.06		
Storage intervals (S)		0.01				Storage intervals (S)		0.05		
MxS		0.01				MxS		0.10		

Table 4.13 Effect of different methods of preservation on reducing sugars (per cent) and total sugars (per cent) of ash gourd sweetened beverage during storage at ambient temperature

Storage intervals (S) (Days)	Reducing sugars (per cent)				Mean (S)	Total sugars (per cent)				Mean (S)
	Methods of Preservation (M)					Methods of Preservation (M)				
	Pasteurization	KMS@ 350 ppm SO_2	Sodium benzoate @ 600 ppm	KMS@350 ppm SO_2 + Sodium benzoate @ 350 ppm		Pasteurization	KMS@ 350 ppm SO_2	Sodium benzoate @ 600 ppm	KMS@350 ppm SO_2 + Sodium benzoate @ 350 ppm	
0	8.13	8.13	8.13	8.13	**8.13**	13.92	13.92	13.92	13.92	**13.92**
45	8.17	8.14	8.16	8.15	**8.16**	13.96	13.93	13.94	13.93	**13.94**
90	8.20	8.15	8.19	8.18	**8.18**	13.99	13.96	13.98	13.97	**13.97**
Mean (M)	**8.17**	**8.14**	**8.16**	**8.15**		**13.96**	**13.94**	**13.95**	**13.94**	
$CD_{0.05}$						$CD_{0.05}$				
Method of preservation (M)			0.02			Method of preservation (M)		NS		
Storage intervals (S)			0.01			Storage intervals (S)		0.02		
MxS			NS			MxS		NS		

Table 4.14 Effect of different methods of preservation on total phenols (mg GAE/g) and Non-enzymatic browning (O.D) of ash gourd sweetened beverage during storage at ambient temperature

Storage intervals (S) (Days)	Total phenols (mg GAE/g)				Mean (S)	Non-enzymatic browning (O.D)				Mean (S)
	Methods of Preservation (M)					Methods of Preservation (M)				
	Pasteurization	KMS@ 350 ppm SO_2	Sodium benzoate @ 600 ppm	KMS@350 ppm SO_2 + Sodium benzoate @ 350 ppm		Pasteurization	KMS@ 350 ppm SO_2	Sodium benzoate @ 600 ppm	KMS@350 ppm SO_2 + Sodium benzoate @ 350 ppm	
0	25.21	25.27	25.21	25.21	**25.23**	0.010	0.010	0.010	0.010	**0.010**
45	24.62	24.86	24.74	24.81	**24.74**	0.010	0.011	0.011	0.010	**0.011**
90	24.21	24.28	24.23	24.24	**24.24**	0.012	0.011	0.012	0.011	**0.012**
Mean (M)	**24.68**	**24.80**	**24.73**	**24.75**		**0.011**	**0.011**	**0.011**	**0.010**	
$CD_{0.05}$						$CD_{0.05}$				
Method of preservation (M)			0.02			Method of preservation (M)		NS		
Storage intervals (S)			0.01			Storage intervals (S)		0.01		
MxS			0.04			MxS		NS		

Table 4.15 Effect of different methods of preservation on antioxidant activity (per cent) of ash gourd sweetened beverage during storage at ambient temperature

Antioxidant Activity (per cent)					
Storage intervals (S) (Days)	**Methods of Preservation (M)**				**Mean (S)**
	Pasteurization	**KMS @ 350 ppm SO_2**	**Sodium benzoate @ 600 ppm**	**KMS @ 350 ppm SO_2 + Sodium benzoate @ 350 ppm**	
0	25.65	25.65	25.65	25.65	**25.65**
45	25.28	25.33	25.31	25.33	**25.31**
90	24.43	24.71	24.68	24.70	**24.63**
Mean (M)	**25.12**	**25.23**	**25.21**	**25.23**	
$CD_{0.05}$					
Method of Preservation (M)		0.04			
Storage intervals (S)		0.03			
MxS		0.06			

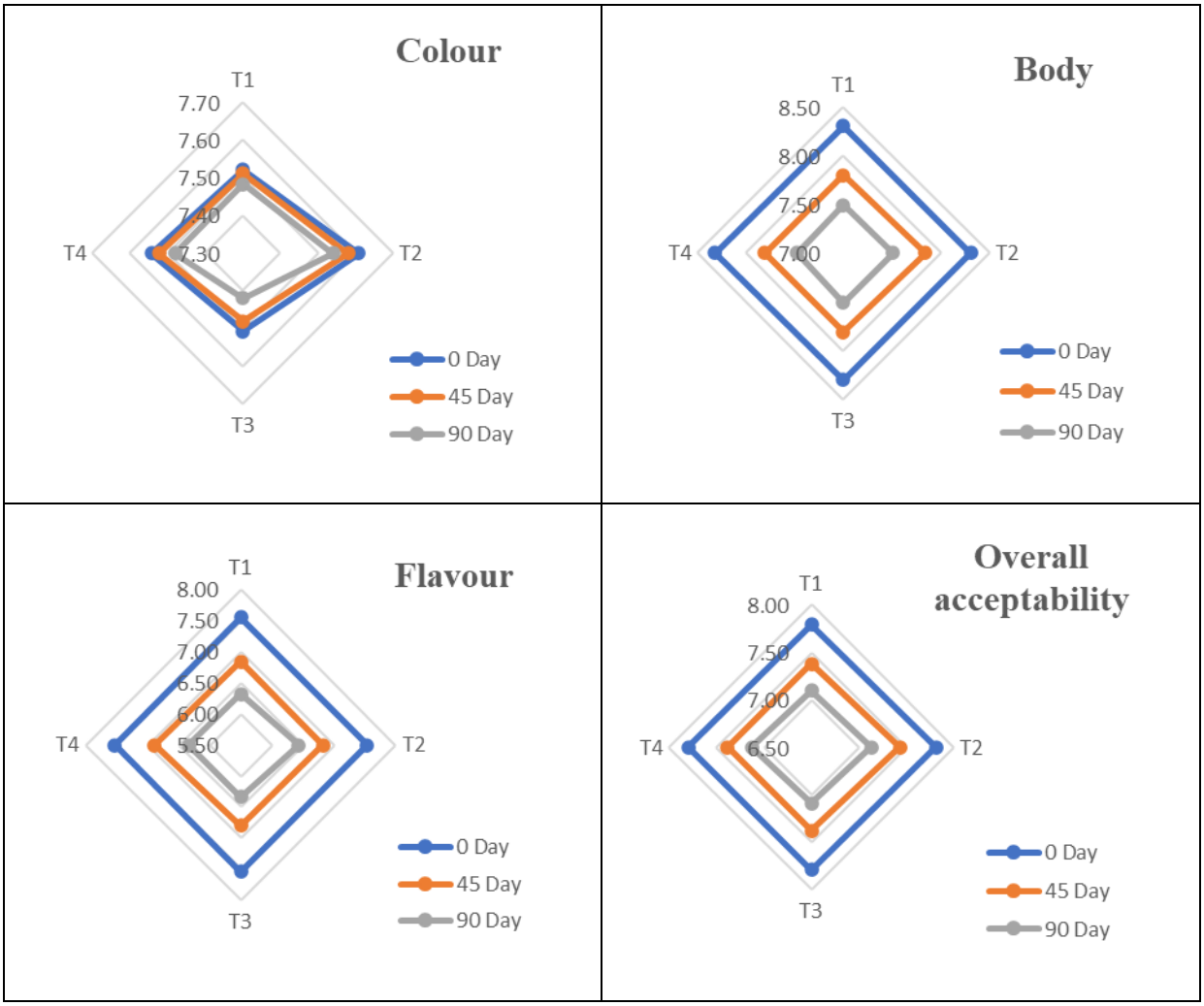

Figure 4.3 Sensory scores (9-point hedonic scale) for ash gourd sweetened beverage

Table 4.16 Effect of different preservation methods on colour and body of ash gourd sweetened beverage (9 point hedonic scale)

Storage intervals (S) (Days)	Colour				Mean (S)	Body				Mean (S)
	Methods of Preservation (M)					Methods of Preservation (M)				
	Pasteurization	KMS@ 350 ppm SO_2	Sodium benzoate @ 600 ppm	KMS@350 ppm SO_2 + Sodium benzoate @ 350 ppm		Pasteurization	KMS@ 350 ppm SO_2	Sodium benzoate @ 600 ppm	KMS@350 ppm SO_2 + Sodium benzoate @ 350 ppm	
0	7.52	7.61	7.51	7.54	**7.54**	8.30	8.31	8.30	8.32	**8.31**
45	7.51	7.58	7.48	7.52	**7.52**	7.80	7.84	7.81	7.81	**7.82**
90	7.48	7.54	7.42	7.48	**7.48**	7.49	7.51	7.51	7.48	**7.50**
Mean (M)	**7.50**	**7.58**	**7.47**	**7.52**		**7.87**	**7.89**	**7.87**	**7.87**	
$CD_{0.05}$						$CD_{0.05}$				
Method of Preservation (M)		0.03				Method of Preservation (M)		0.02		
Storage intervals (S)		0.04				Storage intervals (S)		NS		
MxS		NS				MxS		NS		

Table 4.17 Effect of different preservation methods on flavour and overall acceptability of ash gourd sweetened beverage (9 point hedonic scale)

Storage intervals (S) (Days)	Flavour				Mean (S)	Overall acceptability				Mean (S)
	Methods of Preservation (M)					Methods of Preservation (M)				
	Pasteurization	KMS@ 350 ppm SO_2	Sodium benzoate @ 600 ppm	KMS@350 ppm SO_2 + Sodium benzoate @ 350 ppm		Pasteurization	KMS@ 350 ppm SO_2	Sodium benzoate @ 600 ppm	KMS@350 ppm SO_2 + Sodium benzoate @ 350 ppm	
0	7.55	7.53	7.54	7.54	**7.54**	7.79	7.81	7.79	7.80	**7.80**
45	6.84	6.82	6.80	6.89	**6.84**	7.38	7.43	7.38	7.39	**7.39**
90	6.32	6.43	6.33	6.34	**6.36**	7.10	7.13	7.09	7.13	**7.11**
Mean (M)	**6.91**	**6.93**	**6.89**	**6.92**		**7.42**	**7.46**	**7.42**	**7.44**	
$CD_{0.05}$						$CD_{0.05}$				
Method of Preservation (M)		0.05				Method of Preservation (M)		0.02		
Storage intervals (S)		NS				Storage intervals (S)		0.03		
MxS		NS				MxS		NS		

4.3.2 Squash

4.3.2.1 Sensory evaluation (9 point hedonic scale) of ash gourd squash.

Suitability of incorporation of various proportions of juice and sugar on the sensory qualities of the prepared squashes is presented in Table 4.18, Plate 4.3 and Figure 4.4-4.5. The different combinations of prepared squashes were subjected to sensory evaluation by a panel of ten judges. The addition of sugar in ash gourd juice brought about significant changes on sensory colour acceptability score of the resultant beverage. The mean score for colour in squash ranged between 7.69 to 8.00 on a 9-point hedonic scale. The beverage prepared by using 25 per cent juice and 40 per cent sugar had the maximum acceptability for colour. With the addition of sugar in the natural juice, the colour score registered a consistent decrease. However, the score remained more than 7.0 indicating that all the beverages were within acceptable range with respect to colour. The flavour score of the ash gourd squash ranged from 7.39 to 8.27. The highest mean score was obtained in squash having 25 per cent ash gourd juice (8.27) The lowest flavour score was awarded to combinations having 100 per cent juice (7.39), thus, indicating the liking moderately of the sweetened beverage. Sensory evaluation of the beverage indicated that the squash prepared by using 25 per cent ash gourd juice and 40 per cent TSS had highest liking for body. Though, with the incorporation of juice and corresponding increase in ash gourd juice the acceptability of the beverage for body of the beverage decreased. Thus, the squash having 25:40, 35:40, 45:40 and 55:40 per cent ash gourd juice and sugar were statistically significant with respect to sensory attribute except colour. As expected, the ash gourd beverage having 25 per cent juice and 40 per cent sugar had highest overall acceptability among the panelist with a mean score of 7.70 to 8.10 on a 9-point hedonic scale.

Table 4.18 Effect of addition of various proportions of juice and sugars on sensory characteristics (on 9 point hedonic scale) of squash

Treatment (T) (Juice:TSS)	Colour	Body	Flavour	Overall acceptability
T_1 (25:40)	**8.00**	**8.04**	**8.27**	**8.10**
T_2 (50:40)	7.73	7.85	7.58	7.72
T_3 (75:40)	7.69	7.90	7.58	7.73
T_4 (100:40)	7.90	7.82	7.39	7.70
$CD_{0.05}$	**NS**	**0.10**	**0.17**	**0.11**

Among different blending proportions, 25 per cent juice with 40 per cent TSS and 1.2 per cent acidity was found to be best for overall sensory score and selected for further storage studies. Based on sensory attributes of ash gourd squash the fruit juice:sugar (25:40) combination was superior to other combinations because it had good colour, body, flavour and overall acceptability compared to other combinations The selected treatment was taken as a base for preparation of ash gourd squash by maintaining acidity at 1.2 per cent.

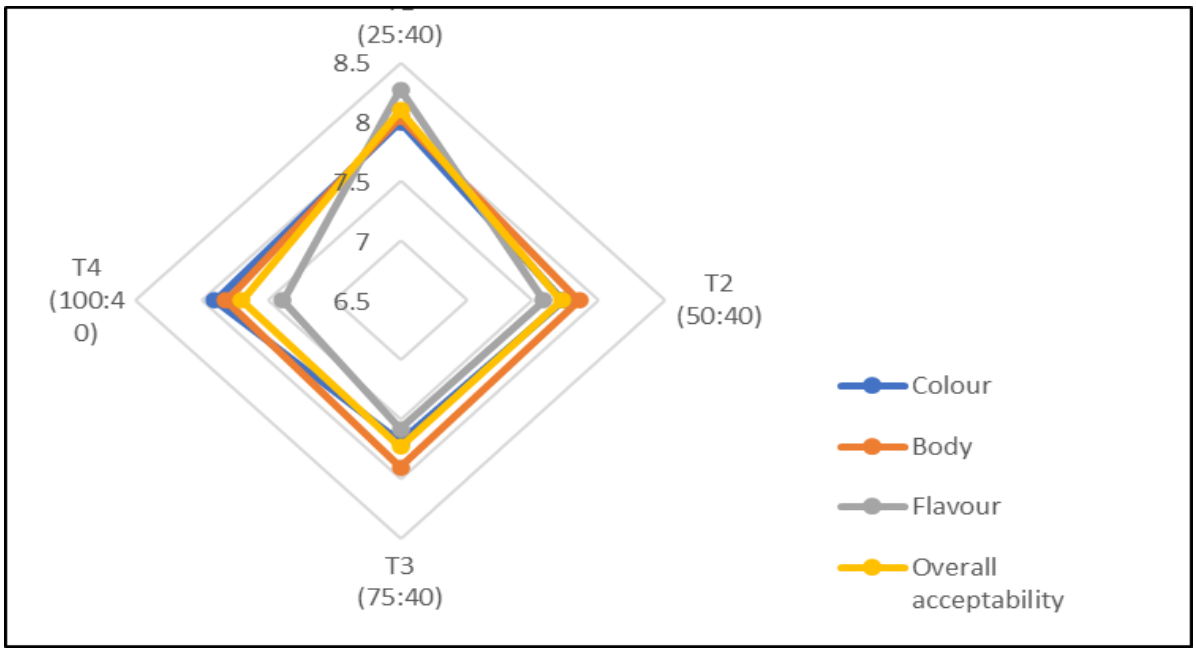

Figure 4.4 Sensory scores (9-point hedonic scale) for ash gourd squash prepared with various proportions of juice and sugar

4.3.2.2 Changes in chemical and sensory characteristics of ash gourd squash during storage

4.3.2.2.1 Total soluble solids

The effect of different preservation methods on TSS of ash gourd squash during storage at ambient temperature is presented in Table 4.19. The TSS of ash gourd squash subjected to different preservation treatments varied between 40.00 to 41.42 °B during storage of 90 days, packed in PET bottles. A significant increase in TSS of squash was observed during storage with 40.00 °B TSS on 0^{th} day, which continued to increase to 41.20 °B on 45th day. Among various methods of preservation, the maximum mean value of total soluble solids of squash (40.88 °B) was observed in treatment T_2 (sodium benzoate @ 350 ppm) while mean minimum TSS (40.87 °B) in treatments T_1 and T_3 (Sodium benzoate @ 600 ppm; and KMS @ 350 ppm + sodium benzoate @ 350 ppm). Moreover, different methods showed a non-significant effect on TSS. The interaction between storage intervals and

method of preservation was found to be significant. The TSS content of ash gourd squash increased slightly during storage and this increase during storage might be due to hydrolysis of polysaccharides into monosaccharide and soluble disaccharides (Gould, 1983) or might be due to the faster rate of reactions because of high temperature in ambient conditions. With increase in storage period, the total soluble solids have also been reported to increase in mango squash by Kumar (2018), in Karonda squash by Deen and Singh (2012), in ripe pumpkin squash by Babu (2015), in blended squash of mango and aloe vera by Chaudhary *et al.* (2017), in mulberry squash by Thakur and Hamid (2017) and in wild prickly pear squash by Thakur *et al.* (2018).

4.3.2.2.2 pH

There was a significant increase in pH of ash gourd squash during storage period of 90 days at ambient condition. It is evident from Table 4.19 that the mean maximum value (3.28) was observed in treatment T_2 (preserved with sodium benzoate @ 600 ppm) while mean minimum value (3.25) was recorded in T_1 (Preserved with KMS @ 350 ppm SO_2). The interaction between methods of preservation and storage intervals was found to be non-significant. The increase in pH of squash might be due to the degradation of acid during storage and may be due to the decrease in organic acid and due to co-polymerization of organic acids with sugars and amino acids. Similar increasing trend was reported by Relekar *et al*. (2013) in sapota squash and Hamid (2017) in mulberry squash.

4.3.2.2.3 Titrable acidity

The data in Table 4.20 predicted a significant decrease (1.20 to 1.06 per cent) in acidity of squash during storage of 90 days. It also predicted that treatment T_1 and T_3 (Preserved with KMS @ 350 ppm and in combination with sodium benzoate @ 350 ppm) received the maximum mean value (1.14 per cent) of titrable acidity while minimum (1.12 per cent) was observed in treatment T_2 which was preserved with sodium benzoate @ 600 ppm. However, the interaction between methods of preservation and storage intervals was found to be significant. The decrease in titrable acidity during storage might be due to the co-polymerization of organic acids with sugars and amino acids and might be due to the faster rate of reaction because of high temperature in ambient conditions. The results are in conformity with the early findings of Chavan *et al.* (2011) in pomegranate squash, Syed *et al.*

Squash
(KMS @ 350 SO_2 ppm)

Squash
(Sodium benzoate @ 600 ppm)

Squash
(KMS @ 350 ppm + Sodium benzoate @ 350 ppm)

Plate 4.3 Ash gourd squash

(2012) in sweet orange squash, Bawa (2015) in ripe pumpkin squash, Thakur and Hamid (2017) in mulberry squash and Thakur *et al.* (2018) in wild prickly pear squash.

4.3.2.2.4 Ascorbic acid

A perusal of data shown in Table 4.20 reveals that there was a significant decrease in ascorbic acid content of all the treatments during storage period of 90 days and the mean value was found to decrease from 10.81 to 8.03 mg/100g. Among all the treatments mean maximum decrease in ascorbic acid was noticed in treatment T_2 (Preserved with sodium benzoate @ 600 ppm) while mean minimum (9.06) in treatment T_1 (Preserved with KMS @ 350 ppm). The interaction between methods of preservation and storage intervals was found to be non- significant. The reduction in ascorbic acid content of squash during storage might be due to thermal oxidation during processing and oxidation in storage. Decreasing trend in ascorbic acid during storage has also been noticed by Das (2009) in jamun squash, by Yadav *et al*. (2015) in squash from guava-mango blends, by Thakur and Hamid (2017) in mulberry squash, by Kumar (2018) in mango squash of different cultivars and by Thakur *et al.* (2018) in wild prickly pear squash, respectively.

4.3.2.2.5 Reducing sugars

An appraisal of data (Table 4.21) on reducing sugar content of ash gourd squash shows a significant increase in reducing sugars from 34.42 to 35.09 per cent during storage period of 90 days. The maximum mean value (34.92 per cent) was recorded in T_2 (Preserved with sodium benzoate @ 600 ppm) while minimum (34.54 per cent) in T_1 (Preserved with KMS @ 350 ppm SO_2). Significant difference was observed in combined effect of methods of preservation and storage intervals. The increase might be due to hydrolysis of starch into sugars as well as conversion of complex polysaccharides into simple sugars sugars and hydrolysis of non-reducing sugars like sucrose into reducing sugars (glucose and fructose). Similar findings have been reported by Sood *et al.* (2009) in mango squash, Babu (2015) in ripe pumpkin squash, Thakur and Hamid (2017) in mulberry squash and Thakur *et al.* (2018) in wild prickly pear squash.

4.3.2.2.6 Total sugars

Data presented on Table 4.21 indicate a significant increase in mean total sugars (36.70 to 37.99 per cent) of ash gourd squash during storage period of 90 days. The mean maximum value (37.47 per cent) was observed in T_2 (Preserved with sodium benzoate @ 600 ppm) while mean minimum value (37.39 per cent) was noticed in T_1 (Preserved with KMS @

350 ppm SO_2). The interaction between storage intervals and treatments was found to be non-significant. The increase in total sugar content of squash during storage might be due to hydrolysis of polysaccharides like pectin, starch etc. into simple sugars. Similar trends were observed by Babu (2015) in ripe pumpkin squash and Kumar (2018) in different mango cultivars squash.

4.3.2.2.7 Total phenols

The effect of different preservation methods on Total Phenolic Content of ash gourd squash during storage at ambient temperature is presented in Table 4.22. The total phenolic content of ash gourd squash subjected to different preservation treatments varied between 24.24 to 24.32 mg GAE/100g during storage of 90 days, packed in PET bottles. A significant decrease (24.32 to 24.25 mg GAE/100g) was noticed in total phenolic content of ash gourd squash during storage of 90 days at ambient temperature. The maximum mean value of total phenolic content (24.29 mg/100g) was recorded in preservation method T_1 (KMS @ 350 ppm SO_2) while mean minimum value of 24.27 mg/100g in treatment T_2 (sodium benzoate @ 600 ppm)). The interaction between methods of preservation and storage intervals was found to be significant. Significant decrease in total phenols of squash beverage might be due to their involvement in formation of polymeric compound, complex formation of phenols with protein and their subsequent precipitation (Premchandran, 1982). Our findings are agreed with the reports of Sonia *et al.* (2010) and Thakur and Hamid (2017) who have also reported decrease in jamun drink and in mulberry squash, respectively during storage.

4.3.2.2.8 Non-enzymatic browning

The Non-enzymatic browning (NEB) of ash gourd squash subjected to different preservation treatments varied between 0.010 to 0.011 during storage of 90 days, packed in PET bottles (Table 4.22). Non-enzymatic browning in ash gourd squash gradually increased with the progress of storage period. Mean non-enzymatic browning value of squash increased from 0.010 to 0.011 during storage of 90 days. However, the interaction between different methods of preservation and storage intervals was found to be non-significant. According to Ross *et al*. (1945) several factors such as temperature, pH, moisture, organic acid, water activity, oxygen, sulphitation and sugars are known to influence the non-enzymatic browning in foods. Earlier, Sharma *et al.* (2001) and Thakur (1996) also experienced less decrease in sulphur dioxide at low temperatures during storage of galgal and kinnow juice concentrates.

Table 4.19 Effect of different methods of preservation on total soluble solids (°B) and pH of ash gourd squash during storage at ambient temperature

Storage intervals (S) (Days	Total soluble solids (°B)			Mean (S)	pH			Mean (S)
	Method of Preservation (M)				Method of Preservation(M)			
	KMS@ 350 ppm SO_2	Sodium benzoate @ 600 ppm	KMS@350 ppm SO_2 + Sodium benzoate @ 350 ppm		KMS@ 350 ppm SO_2	Sodium benzoate @ 600 ppm	KMS@350 ppm SO_2 + Sodium benzoate @ 350 ppm	
0	40.00	40.00	40.00	**40.00**	3.25	3.25	3.25	**3.25**
45	41.20	41.21	41.20	**41.20**	3.23	3.28	3.26	**3.26**
90	41.40	41.42	41.41	**41.41**	3.26	3.30	3.28	**3.28**
Mean (M)	**40.87**	**40.88**	**40.87**		**3.25**	**3.28**	**3.26**	
$CD_{0.05}$					$CD_{0.05}$			
Method of preservation (M)		NS			Method of preservation (M)		0.015	
Storage intervals (S)		0.013			Storage intervals (S)		0.015	
MxS		0.022			MxS		NS	

Table 4.20 Effect of different methods of preservation on titrable acidity (per cent) and ascorbic acid (mg/100g) of ash gourd squash during storage at ambient temperature

Storage intervals (S) (Days)	Titrable acidity (per cent)			Mean (S)	Ascorbic acid (mg/100g)			Mean (S)
	Methods of Preservation (M)				Methods of Preservation (M)			
	KMS@ 350 ppm SO_2	Sodium benzoate @ 600 ppm	KMS@350 ppm SO_2 + Sodium benzoate @ 350 ppm		KMS@ 350 ppm SO_2	Sodium benzoate @ 600 ppm	KMS@350 ppm SO_2 + Sodium benzoate @ 350 ppm	
0	1.20	1.20	1.20	**1.20**	10.81	10.81	10.81	**10.81**
45	1.14	1.13	1.14	**1.13**	8.29	8.27	8.28	**8.28**
90	1.09	1.04	1.07	**1.06**	8.09	8.01	8.04	**8.03**
Mean (M)	**1.14**	**1.12**	**1.14**		**9.06**	**9.03**	**9.04**	
$CD_{0.05}$					$CD_{0.05}$			
Method of preservation (M)		0.01			Method of preservation (M)		NS	
Storage intervals (S)		0.01			Storage intervals (S)		0.20	
MxS		0.01			MxS		NS	

Table 4.21 Effect of different methods of preservation on reducing sugars (per cent) and total sugars (per cent) of ash gourd squash during storage

Storage intervals (S) (Days)	Reducing sugars (per cent)			Mean (S)	Total sugars (per cent)			Mean (S)
	Methods of Preservation (M)				Methods of Preservation (M)			
	KMS@ 350 ppm SO_2	Sodium benzoate @ 600 ppm	KMS@350 ppm SO_2 + Sodium benzoate @ 350 ppm		KMS@ 350 ppm SO_2	Sodium benzoate @ 600 ppm	KMS@350 ppm SO_2 + Sodium benzoate @ 350 ppm	
0	34.42	34.42	34.42	**34.42**	36.70	36.70	36.70	**36.70**
45	34.39	35.08	34.83	**34.77**	37.64	37.53	37.64	**37.61**
90	34.81	35.25	35.22	**35.09**	37.82	38.17	37.99	**37.99**
Mean (M)	**34.54**	**34.92**	**34.83**		**37.39**	**37.47**	**37.44**	
$CD_{0.05}$					$CD_{0.05}$			
Method of preservation (M)		0.11			Method of preservation (M)		NS	
Storage intervals (S)		0.11			Storage intervals (S)		0.18	
MxS		0.20			MxS		NS	

Table 4.22 Effect of different methods of preservation on Total phenols (mg GAE/g) and Non-enzymatic browning (O.D) of ash gourd squash during storage at ambient temperature

Storage intervals (S) (Days)	Total phenols (mg GAE/ml)			Mean (S)	Non-enzymatic browning (O.D)			Mean (S)
	Methods of Preservation (M)				Methods of Preservation (M)			
	KMS@ 350 ppm SO_2	Sodium benzoate @ 600 ppm	KMS@350 ppm SO_2 + Sodium benzoate @ 350 ppm		KMS@ 350 ppm SO_2	Sodium benzoate @ 600 ppm	KMS@350 ppm SO_2 + Sodium benzoate @ 350 ppm	
0	24.32	24.32	24.32	**24.32**	0.010	0.010	0.010	**0.010**
45	24.28	24.25	24.27	**24.27**	0.010	0.011	0.010	**0.010**
90	24.26	24.24	24.24	**24.25**	0.011	0.011	0.011	**0.011**
Mean (M)	**24.29**	**24.27**	**24.28**		**0.010**	**0.011**	**0.010**	
$CD_{0.05}$					$CD_{0.05}$			
Method of preservation (M)		0.014			Method of preservation (M)		NS	
Storage intervals (S)		0.014			Storage intervals (S)		0.18	
MxS		0.025			MxS		NS	

4.3.2.2.9 Antioxidant activity

The effect of different preservation methods on antioxidant activity of ash gourd squash during storage at ambient temperature is presented in Table 4.23. The antioxidant activity of ash gourd squash subjected to different preservation treatments varied between 20.82 to 22.26 per cent during storage of 90 days, packed in PET bottles**.** Our results indicate that antioxidant activity in the beginning was about 22.26 per cent on 0^{th} day which decreased to 20.84 per cent towards the end of storage of 90 days. The methods of preservation as well as storage intervals did not have significant effect on antioxidant activity. The interaction between different methods of preservation and storage intervals was also found to be non-significant. Similar decrease in antioxidant activity has been recorded by Barman and Barooah (2016) in jamun RTS beverage during the storage period

4.3.2.2.10 Sensory evaluation

The data pertaining to sensory evaluation of squash is represented in Table 4.24 to 4.25. The storage period and different methods of preservation had significantly affected the average score for colour, body, flavour and overall acceptability of ash gourd squash. The mean maximum score was observed in T_1 (preserved with KMS @ 350 ppm SO_2) for colour (8.02), body (8.16), flavour (7.89) and overall acceptability (8.02). However, the average score shown a decreasing trend during storage of 90 days. The mean score was found to be decreased from 8.01 to 7.57 for colour, 8.32 to 7.68 for body, 8.20 to 7.48 for flavour and 8.20 to 7.58 for overall acceptability during 90 days of storage period. This decrease in sensory score might be attributed to chemical changes or certain enzymatic and non-enzymatic reactions.

Table 4.23 Effect of different methods of preservation on antioxidant activity (per cent) of ash gourd squash during storage at ambient temperature

Antioxidant activity (per cent)				
Storage intervals (S) (Days)	**Methods of Preservation (M)**			**Mean (S)**
	KMS@ 350 ppm SO_2	**Sodium benzoate @ 600 ppm**	**KMS@350 ppm SO_2 + Sodium benzoate @ 350 ppm**	
0	22.26	22.26	22.26	**22.26**
45	21.61	21.57	21.60	**21.59**
90	20.86	20.82	20.84	**20.84**
Mean (M)	**21.58**	**21.55**	**21.57**	
$CD_{0.05}$				
Method of Preservation (M)		NS		
Storage intervals (S)		0.02		
MxS		NS		

Table 4.24 Effect of different preservation methods on colour and body score of ash gourd squash (9 point hedonic scale)

Storage intervals (S) (Days)	Colour				Body			
	Methods of Preservation (M)				Methods of Preservation (M)			
	KMS@ 350 ppm SO_2	Sodium benzoate @ 600 ppm	KMS@350 ppm SO_2 + Sodium benzoate @ 350 ppm	Mean (S)	KMS@ 350 ppm SO_2	Sodium benzoate @ 600 ppm	KMS@350 ppm SO_2 + Sodium benzoate @ 350 ppm	Mean (S)
0	8.20	8.01	8.25	**8.01**	8.58	8.15	8.22	**8.32**
45	8.15	7.57	8.08	**7.57**	8.09	7.90	8.07	**8.02**
90	7.71	7.57	7.69	**7.57**	7.81	7.54	7.69	**7.68**
Mean (M)	**8.02**	**7.72**	**8.01**		**8.16**	**7.86**	**8.00**	
$CD_{0.05}$					$CD_{0.05}$			
Method of Preservation (M)	0.25				Method of Preservation (M)	0.25		
Storage intervals (S)	0.25				Storage intervals (S)	NS		
MxS	NS				MxS	NS		

Table 4.25 Effect of different preservation methods on flavour and overall acceptability of ash gourd squash (9 point hedonic scale)

Storage intervals (S) (Days)	Flavour				Overall acceptability			
	Methods of Preservation (M)				Methods of Preservation (M)			
	KMS@ 350 ppm SO_2	Sodium benzoate @ 600 ppm	KMS@350 ppm SO_2 + Sodium benzoate @ 350 ppm	Mean (S)	KMS@ 350 ppm SO_2	Sodium benzoate @ 600 ppm	KMS@350 ppm SO_2 + Sodium benzoate @ 350 ppm	Mean (S)
0	8.18	7.96	8.21	**8.20**	8.34	8.10	8.15	**8.20**
45	7.97	8.05	7.99	**7.98**	8.05	8.03	7.88	**7.98**
90	7.53	7.24	7.43	**7.48**	7.68	7.50	7.57	**7.58**
Mean (M)	**7.89**	**7.75**	**7.88**		**8.02**	**7.88**	**7.86**	
$CD_{0.05}$					$CD_{0.05}$			
Method of Preservation (M)	0.26				Method of Preservation (M)	0.15		
Storage intervals (S)	NS				Storage intervals (S)	NS		
MxS	NS				MxS	NS		

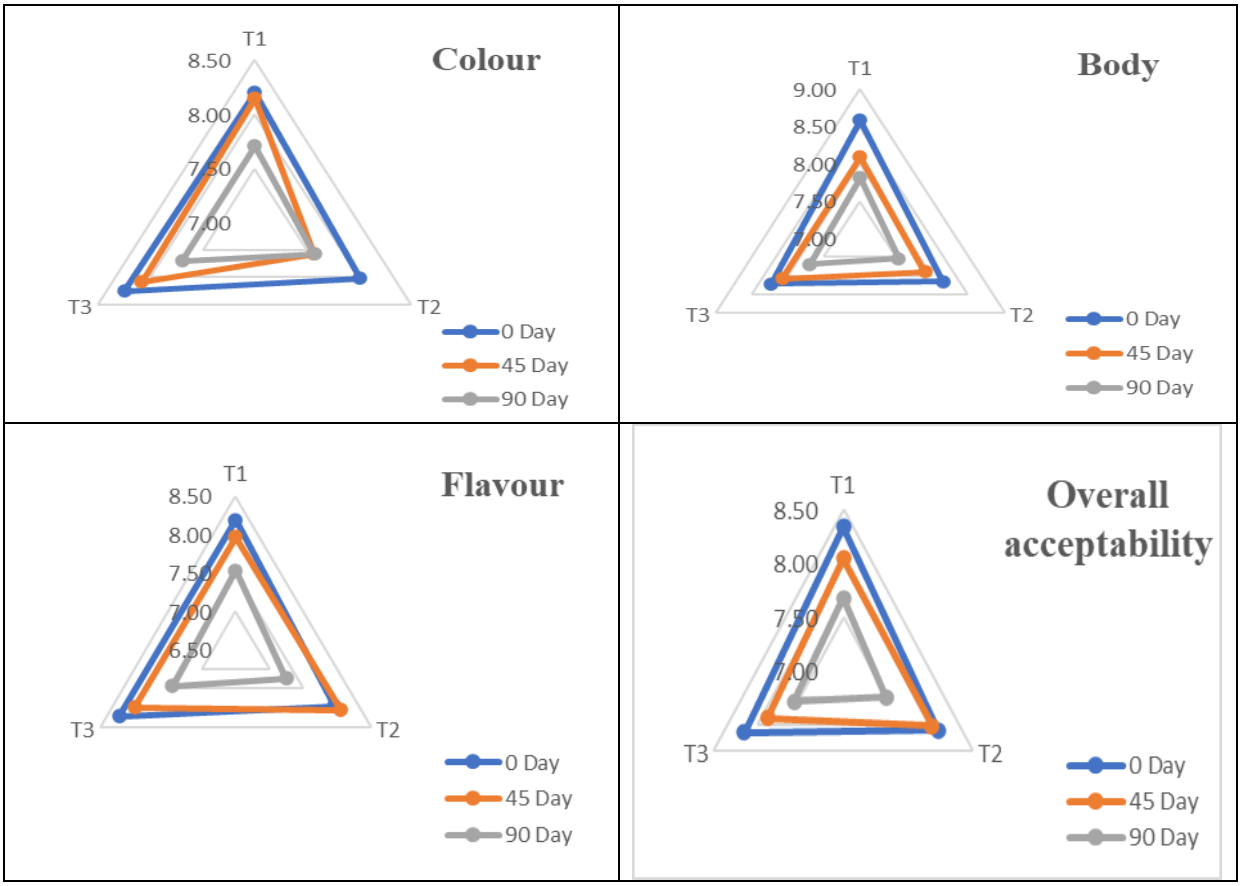

Figure 4.5: Sensory score of ash gourd squash at ambient storage

4.4.4 Microbiological examination

Microbiological quality measured in terms of total plate count (TPC) in beverages prepared from ash gourd juice and preserved by different chemicals during storage period of 90 days, has shown the absence of any apparent microbial growth on Tryptone Soya Agar during the entire period at ambient condition. Thus, exhibiting good stability of the products.

4.5 COST OF PRODUCTION

The cost incurred on preparation of ash gourd juice, sweetened beverage and squash was calculated by taking into consideration the cost of all the inputs used and expenditure involved in the extraction of juice from ash gourd fruit. It is evident from Table 4.26 that the cost of production of 200 ml each of ash gourd juice, sweetened juice and squash packed in g PET bottles were found to be Rs. 29.96, 26.13 and 16.55, respectively. The unit cost per kg of ash gourd beverages was determined by taking into consideration the cost of raw materials for example ash gourd fruits and are other inputs i.e. sugar, KMS, sodium benzoate, packaging materials, including electricity, labour, processing charges etc. Work and handling charges comprised of 20 per cent of cost of raw materials.

Table 4.26 Cost of production of ash gourd based beverages

Particulars	Quantity (kg)	Rate (Rs)	Amount (Rs)	Juice (10kg)		Sweetened beverage (5 kg)		Squash (5 kg)	
				Quantity	Amount	Quantity	Amount	Quantity	Amount
Ash gourd fruit	100.00kg	50.00/kg	5000.00	-	-	-	-	-	-
Juice extraction charges @20%	-	10.00/kg	1000.00	-	-	-	-	-	-
Juice recovery	64.09kg	-	6000.00	-	-	-	-	-	-
Juice cost/kg	-	-	93.66	-	-	-	-	-	-
Juice	-	-	-	10.00 kg	936.60	4.20 kg	393.37	1.25 kg	117.08
Sugar	-	-	40.00/kg	-	-	622.5 g	24.90	1.96 kg	78.40
KMS@350ppm	-	-	1194/kg	3.50 g	4.18	1.75 g	2.09	1.75 g	2.09
Citric acid	-	-	1186/kg	-	-	11.22 g	13.31	58.89 g	69.84
Total cost	-	-	-	-	940.18	-	433.67	-	267.41
Processing charges/overhead charges @20%	-	-	-	-	188.04	-	86.73	-	53.48
Packaging cost	-	-	-	-	-	-	-	-	-
Glass bottles (200 ml)	-	-	2/each	48.00	96.00	-	-	-	-
PET bottles (200 ml)	-	-	1/each	24.00	24.00	24.00	24.00	24.00	24.00
Grand total cost	-	-	-	-	1248.22	-	544.4	-	344.89
Sale price (including 20 % profit)	-	-	-	-	1497.86	-	653.28	-	413.87
Sale price/kg	-	-	-	-	149.78	-	130.65	-	82.77
Sale price/200ml	-	-	-	-	29.96	-	26.13	-	16.55

Chapter-5

SUMMARY AND CONCLUSION

The present study entitled "**Development and evaluation of beverages from ash gourd fruit"** was undertaken in the Department of Food Science and Technology, College of Horticulture and Forestry, Dr. YS Parmar University of Horticulture and Forestry, Neri, Hamirpur, HP. The summary and conclusions of the experiments conducted to achieve the objectives are summarized and concluded as follows:

1 The ash gourd fruit (*Benincasa hispida* Thunb.) used for the study was light green in colour weighed 7.50 kg with the respective size parameters of 29.67 cm (length) and 22.00 cm (diameter). Different components of fruit accounted for 10.67 per cent peel, 4.00 per cent seed and 85.33 per cent edible portion. The average juice recovery and pomace of ash gourd fruits were recorded as 64.06 per cent and 21.87 per cent, respectively.

2 The ash gourd fruit was regarded as rich source of bioactive substances as they have a substantial proportion of ascorbic acid (10.63 mg/100mg), total phenols (29.74 mg GAE/100g) and crude fibre (3.22 per cent). The average total soluble solids (TSS), total solids and titratable acidity of ash gourd fruits were recorded as 3.00 °B, 4.58 per cent and 0.13 per cent, respectively. Other physico-chemical attributes in ash gourd fruit were recorded as 95.29 per cent moisture, 4.49 pH, 0.50 per cent reducing sugars, 2.43 per cent total sugar, 0.04 non enzymatic browning and 27.49 (% free radical scavenging activity) antioxidant activity. Thus, on the basis of physico-chemical attributes, the ash gourd fruit was found suitable for obtaining juice and development of different value- added products.

3 Screw type method of ash gourd juice extraction resulted in juice recovery of 64.06 per cent with TSS (3.00 °B), pH (5.06), titrable acidity (0.13 per cent), ascorbic acid (8.13mg/100g), reducing sugars (0.15 per cent), total sugars (2.19 per cent), total phenols 24.28 (mgGAE/g), non-enzymatic browning (0.10) and antioxidant activity (25.05 per cent).

4 The preservation of ash gourd fruit juice by heat processing or addition of KMS (350 ppm SO_2) or sodium benzoate (600 ppm) either singly or in combination packed in glass and PET bottles showed good storage stability up to 90 days under ambient

conditions of storage. However, the juice preserved by using KMS @ 350 ppm SO_2 and packed in glass bottles stored at ambient temperature were rated superior to those preserved by using other combinations in various quality attributes packed in PET bottles.

5 The glass bottle packed juice preserved by using KMS @ 350 ppm SO_2 contained 3.08 °B TSS, 5.04 pH, 0.14 per cent titrable acidity, 0.23 per cent reducing sugars, 2.27 per cent total sugars, 7.31 mg/100g ascorbic acid , 23.91 mgGAE/100g total phenols, 0.025 non enzymatic browning (O.D) and 26.36 per cent antioxidant activity.The ash gourd juice preserved with addition of KMS @ 350 ppm SO_2 remained shelf stable with good retention of ascorbic acid, total phenols and other nutrients up to 90 days of storage and resulted in a juice of excellent sensory qualities than that those preserved with heat processing or sodium benzoate (600 ppm) either singly or in combination.

6 Acceptable and palatable ash gourd sweetened beverage developed by using 85 per cent juice and with a minimum TSS of 15 °B was found appropriate to meet the FSSA1, 2006 specifications for the sweetened beverage on basis of sensory attributes

7 The PET bottle packed sweetened beverage preserved by using KMS @ 350 ppm SO_2 contained 14.99 °B TSS, 3.59 pH, 0.32 per cent titrable acidity, 8.85 mg/100g ascorbic acid, 8.14 per cent reducing sugars, 13.94 per cent total sugars, 24.80 mgGAE/100g total phenols, 0.010 non enzymatic browning (O.D) and 25.23 per cent antioxidant activity.The ash gourd juice preserved with addition of KMS @ 350 ppm SO_2 remained shelf stable with good retention of ascorbic acid, total phenols and other nutrients up to 90 days of storage and resulted in a juice of excellent sensory qualities than that those preserved with heat processing or sodium benzoate (600 ppm) either singly or in combination.

8 For preparation of ash gourd squash four different treatment combinations were tried and on the basis of sensory evaluation ash gourd squash with 25 per cent juice and 40 °B TSS was found to be best. It could be stored safely with chemical preservative KMS @ 350 ppm SO_2 for period of 90 days under ambient conditions.

9 Ash gourd squash could be stored safely with KMS @ 350 ppm SO_2 and its combination with sodium benzoate @ 350 ppm than other preservation method for a period of 90 days under ambient conditions in PET bottles with TSS, pH, titrable acidity, ascorbic acid, reducing sugars, total sugars, total phenols, non-enzymatic browning and antioxidant activity 40.87 °B, 3.25, 1.14 per cent, 9.06 mg/100g, 34.54

per cent, 37.39 per cent, 24.29 mgGAE/100g, 0.010 (O.D) and 21.58 per cent, respectively.

10 The sensory score for colour, body, flavour and overall acceptability was found to be 8.02, 8.16, 7.89 and 8.02, respectively on 9-point hedonic scale for ash gourd juice preserved with KMS @ 350 ppm SO_2 during storage.

11 The cost of production of 200 ml ash gourd juice, sweetened beverage and squash packed in glass and PET bottles after adding 20 per cent profit margin was found to be Rs. 29.96, 26.13 and 16.55, respectively.

CONCLUSIONS

The present investigations have, therefore, shown that ash gourd fruit having good nutritional and medicinal properties can successfully be utilized for the preparation of juice, sweetened beverage and squash with excellent qualities. The product can successfully be stored up to 90 days at ambient temperature (20-25°C) without any microbial growth. After juice extraction the preservation of juice with KMS @ 350 ppm at ambient temperature was found optimum for the preservation and storage of the ash gourd beverages. Further, the sweetened beverage with 85 per cent juice and 15 °B TSS with 0.3 per cent acidity and squash having 25 per cent juice and 40 °B TSS with 1.2 per cent acidity were found most acceptable with respect to sensory attributes. Intake of fresh juice helps to meet daily requirement of vitamins and minerals. The pilot plant and market studies for consumer acceptability needs to be undertaken for better utilization of ash gourd fruits.

LITERATURE CITED

Abdullah N, Kamarudin W S S W, Samicho Z, Zulkifli K S and Nurain A. 2012. Study on antioxidant capacity and phenolic content of various parts of wax gourd (*Benincasa hispida*). *World Applied Sciences Journal* **19**(7):1051-56.

Ahmad F H B. 2013. Antioxidant activity and total phenolic content of *Benincasa hispida* fruit extracts from various extraction solvents. B.Sc. Thesis. Chemical & Natural Resources Engineering Universitiy, Malaysia. 53p.

Akhtar S, Ali J, Javed B and Khan F A. 2013. Studies on the preparation and storage stability of pomegranate juicebased drink. *Middle-East Journal of Scientific Research* **16**(2):191-95.

Aleem S. 2007. Development of ash gourd (*Benincasa hispida* (Thunb) Congn) and pumpkin (*Cucurbita moschata* Poir) based ready-to-serve (RTS) beverage. M.Sc. Thesis. Department of Home Science, College of Agriculture, Vellayani. 164p.

Ali Z, Korekar G, Mundra S, Yadav A and Stobdan T. 2011. Quality attributes of seabuckthorn squash during storage. *Indian Journal of Horticulture* **68**(4):479-83.

Amerine M A, Pangborn R M and Roessler E B. 1965. Principles of sensory evaluation of food. Academic Press: London. pp. 236-68.

Anita K and Dhaliwal Y S. 2012. Nutritional quality, functional properties and value addition of underutilized fruits of Himachal Pradesh. Ph.D. Thesis. Chaudhary Sarwan Kumar Himachal Pradesh Krishi Vishvavidyalaya, Palampur. 265p.

Anonymous. 1962. *The Wealth of India*: *Raw Materials*. Publications and Information Directorate. Council of Scientific and Industrial Research, New Delhi. 132p.

Aruna K, Dhanalakshmi K and Vimla V. 1998. Development and storage ability of cereal based papaya powder. *Journal of Food Science and Technology*. **35**(3):250-54.

Aruna K, Vimla V, Giridhar N and Raio D G. 1997. Studies on preparation and storage of nectar prepared from papaya. *Beverage and Food World* **24**(1):29-32.

Babu G N. 2015. Development of beverages from ripe pumpkin (*Cucurbita moschata* duch ex poir) pulp. M.Sc. Thesis. Dr. Yashwant Singh Parmar University of Horticulture and Forestry, Solan. 116p.

Badhani S, Kainth A, Kabra A and Parashar B. 2013. Evaluation of Antioxidant Activity of *Benincasa hispida* Fruit Extracts. *American Journal of Pharmtech Research* **3**(2):335-45.

Bansal M and Dhawan S S. 1993. Preservation and keeping quality of Bhadri lemon (*Citrus limon* L. Burm.) juice. *Haryana Journal of Horticulture Science*. **22**(3):188-94.

Barman N and Barooah M S. 2016. Development of Functional RTS Beverage from Jamun (*Syzygium cumini* L.) and *Melastoma malabathricum*. *Journal of Agricultural Engineering and Food Technology* **3**(4):293-98.

Barwal V S, Singh T K and Alkesh. 2005. Studies on processing and development of ready-to-serve drink from bitter gourd fruit. *Journal of Food Science and Technology* **42**(3):217-20.

Bhalodia Y, Kanzariya N, Patel R, Patel N, Vaghasiya J and Jivani N. 2009. Renoprotective activity of *Benincasa cerifera* fruit extract on Ischemia/Reperfusion-Induced renal damage in rat. *Iranian Journal of Kidney Diseases* **3**(2):80-85.

Bhardwaj R L. 2013. Physico-chemical, sensory and microbiological quality of kinnow juice stored in refrigerated storage condition. *Asian Journal Dairy and Food Research* **32**:203-13.

Bhattacherjee A K, Dikshit A, Kumar S and Tandon D K. 2011. Effect of Pasteurization temperature on quality of Aonla juice during storage. *Journal of Food Science and Technology* **48**(3):269-73.

Bimakar M, Rahman R A, Taip F S, Adjahan N M, Sarker M Z I and Ganjloo A. 2012. Optimization of ultrasound-assisted extraction of crude oil from winter melon (*Benincasa hispida*) seed using response surface methodology and evaluation of its antioxidant activity, total phenol content and fatty acid composition. *Molecules* **17**(10):11748-62.

Bisht R, Sharma S K and Yadav V K. 2008. Studies on preparation and storage evaluation of seabuckthorn (*Hippophae salicifolia* D. Don.) ready-to-serve beverage. *The Asian Journal of Horticulture* **3**(1):117-21.

Boghani A H, Raheem A and Hashmi S I. 2012. Development and storage studies of blended papaya-aloe vera ready-to-serve (RTS) beverage. *Journal of Food Processing and Technology* **3**:10.

Brand Williams W, Cuvelier M E and Berset C. 1995. Use of a Free Radical Method to evaluate antioxidant activity. *Lebensm-Wiss u-Technology* **28**:25-30.

Bray H G and Thorpe W V. 1954. *In: Standard Methods of Biochemical Analysis*. (Thimmaiah S K (eds). Kalyani Publishers. New Delhi. 287-88p.

Busuioc A C, Botezatu A V D, Furdui B, Vinatoru C, Filippo M, Caprioli G and Dinica R M. 2020. Comparative study of the chemical compositions and antioxidant activities of fresh juice from Romanian Cucurbitaceae varieties. *Molecules* **25**:5468.

Cautela D, Vella F M, Castaldo D and Laratta B. 2019. The effect of processing methods on phytochemical composition in bergamot juice. *Foods* **8**(10):474.

Chandra N, Sarkar S, Sinha R and Sharma B. 2018. Development and Evaluation of Ready-to-Serve beverage (RTS) from blend of Amla, Aloe-Vera, Mint and Ginger. *International Journal of Current Microbiology and Applied Sciences* **7**:3467-72.

Chauhan A S, Rekha M N, Ramteke R S and Eipeson W E. 2001. Preparation and quality evaluation of processed products from sea buckthorn (*Hippophaė rhamnoides* L in.) berries. *Beverage and Food World* **1**(27):31-34.

Chauhan D K, Puranik V and Rai G K. 2012. Development of functional herbal RTS beverage. *Open Access Scientific Reports* **1**(12):541-45.

Chavan A, Patil M G and Imamsaheb S J. 2011. Utilization of pomegranate fruits (*Punica granatum* L.) cv. Kesar for preparation of squash. *Indian Horticulture Journal* **1**(1):41-43.

Chobbe R S. 1999. Studies on extraction and clarification of pomegranate (*Punica granatum* L.) juice. M.Tech. Thesis. Mahatma Phule Krishi Vidyapeeth Rahuri, Maharashtra.

Choudhary B. 2017. *Vegetables*, National Book Trust, New Delhi. 133p.

Choudhary M L, Verma I M, Singh J, Chandra A and Godara S L. 2013. Studies on biochemical changes in aonla (*Emblica officinalis* Gaertn) squash under storage condition. *Progressive Horticulture* **45**(2):281-85.

Choudhury M, Deen B, Gautam D K and Mishra K K. 2017. Studies on development of squash from mango (*Mangifera indica* L.) pulp and aloe vera (*Aloe barbadensis* Miller.) gel blend. *International Journal of Current Microbiology and Applied Sciences* **6**(7):1962-69.

Clegg M J. 1964. Non-enzymatic browning of lemon juice. *Journal of the Science of Food Agriculture.* **15**:878-85.

Cochran W G and Cox C M. 1967. Experimental designs. John Wiley & Sons, New York CRC press, London, UK.

Curi P N, De Almeida A B, Tavares B D S, Nunes C A, Pio R, Pasqual M and De Sduza V R. 2017. Optimization of tropical fruit juice bases on sensory and nutritional characteristics. *Food Science and Technology* **37**:308-14.

Dabhade R S and Khedkar D M. 1980. Studies on drying and dehydration of raw mangoes for preparation of mango powder (amchur). *Indian Food Packer*. **34**(3):35-54.

Das J N. 2009. Studies on storage stability of Jamun beverage. *Indian Journal of Horticulture* **66**(4):508-10.

Deen B and Singh I S. 2012. Development of Karonda (*Carissa carandas* L.) squash. *Beverage and Food World* **39**(2):37-39.

Deka B C, Sethi V, Suneja P and Shrivastava V K. 2004. Physico-chemical changes of lime-aonla spiced beverage during storage. *Journal of Food Science and Technology* **41**(3):329-32.

Devaki C S and Premavalli K S. 2012. Development of fermented beverage using RSM and nutrient evaluation-I fermented ash gourd beverage. *Journal of Food Research* **1**(3):138-47.

Dhaliwal M and Hira C K. 2004. Effect of storage on physico-chemical and nutritional characteristics of carrot-spinach and carrot-pineapple juices. *Journal of Food Science and Technology* **41**(6):613-17.

Dhaygude G S. 2010. Value added products from wild pomegranate (*Punica granatum* L.). M.Sc. Thesis. Dr. Yashwant Singh Parmar University of Horticulture and Forestry, Solan.

Dhillon N P S, Sanguansil S, Singh S P, Masud M A T, Kumar P, Bharathi L K, Yetisir H, Huang R, Canh D X and McCreight J D. 2016. Gaurds: bitter, bottle, wax, snake, sponge and ridge. *Genetics and genomics of Cucurbitaceae*. 155-72.

Dhiman A K, Babu G N, Surekha A and Preethi R. 2017. Development and standardization of ripe pumpkin based squash and its stability during storage. *International Journal of Current Microbiology and Applied Sciences* **6**(10):821-31.

Duke J A and Ayensu E S. 2010. Medicinal plants of China. 218p.

Durrani Y, Ayub M, Muhammad A and Ali A. 2010. Physico chemical response of apple pulp to chemical preservatives and antioxidant during storage. *Internet Journal of Food Safety* **12**: 20-28.

Franke A A, Custer L J, Arakaki C and Murphy S P. 2004. Vitamin C and flavonoid levels of fruits and vegetables consumed in Hawaii. *Journal of Food Composition and Analysis* **17**:1-35.

Anonymous. 2006. FSSAI www.fssai.gov.in

Gajera R R and Joshi D C. 2015. Development and quality evaluation of bottle gourd, *Lagenaria siceraria* (Mol.) Standl. Based blend juice. *Indian Journal of Natural Products and Resources* **6**(3):194-99.

George T E. 2008. Ash gourd, High Nutritional. *Kerala Calling* **28**(11):35-37.

Gopalan C, Ramashashtri B V and Balasubramanian S C. 2007. *Nutritive value of Indian Foods*. National Institute of Nutrition, Indian Council of Medical Research, Hyderabad-69.

Gould W A. 1978. Food quality assurance. The Avi Publishing Company, Westport, Connecticut, pp. 314.

Hamid, Thakur N S, Kumar P and Thakur A. 2017. Studies on Preparation and Preservation of Ready-To-Serve (RTS) Beverage from Underutilized Mulberry (*Morus alba* L.) Fruits and Its Quality Evaluation during Storage. *International Journal of Current Microbiology and Applied Sciences* **6**(9):1067-79.

Haque M E, Sarkar M A R, Mahmud M A, Rezwana D and Sikdar B. 2008. In vitro propagation of pumpkin and ash gourd through nodal segments. *Journal of Biotechnology Science* **16**:67-71.

Hashmi M S, Alam S, Riaz A and Shah A S. 2007. Studies on microbial and sensory quality of mango pulp storage with chemical preservatives. *Pakistan Journal of Nutrition* **6**(1):85-88.

Heikal H A, Wakeil E L, Foda I O and Ashmawi H. 1964. Preservation of lemon juice. *Agriculture Research Review* **42**:68

Hossain M N, Fakruddin M and Islam M N. 2011. Effect of chemical additives on the shelf life of tomato juice. *American Journal of Food Technology* **6**(10):914-23.

Hussain I, Gilani S N, Khan M R, Khan M T and Shakir I. 2005. Varietal suitability and storage stability of mango squash. *International Journal of Agriculture and Biology* **7**(6):1038-39.

Hussain I, Zeb A and Ayub M. 2010. Quality attributes of apple and apricot blend juice preserved with potassium sorbate during storage at low temperature. *Internet Journal of Food Safety* **12**:80-86.

Ibrahim G22 E, Hassan I M, Abd-Elrashid A M, El-Massry K F, Eh-Ghorab A H, Ramadan Manal M and Osman F. 2011. Effect of clouding agents on the quality of apple juice during storage. *Food Hydrocolloids* **25**:91-97.

Jain P K and Asati A. 2009. Evaluation guava cultivars for pulp preparation. *Journal of Food Science and Technology* **41**(6):684-86.

Jain S P, Tripathi V K, Ram H B and Singh S. 1986. Effect of storage conditions on storage life of some important squashes. *Indian Food Packer* **2**:36-41.

Jaiswal R, Singh G and Singh A K. 2008. Evaluation of aonla (*Emblica officinalis* G.) cultivars for squash making. *Progressive Agriculture* **8**(1):29-31.

Julia F M. 1971. The wax gourd, a year-round florida vegetable with unusual keeping quality. *Proceedings of the Florida State Horticultural Society* **84**:104-09.

Jyothi M L and Narayanankutty M C 2010. *Variability in ash gourd*. First Indian Biodiversity Congress. *Book of Abstracts.* pp. 180.

Kadam D and Lele S. 2016. Studies on the physicochemical and nutritional characteristics of ash gourd-carrot juice. *Nutrafoods* **15**:39-47.

Kapaleshwar G. 2010. Standardization and characterization of value-added ash gourd Ready-to-Serve beverages. M.Sc. Thesis. Dharwad, Karnataka. 61p.

Karishnaveni A, Megalai G M and Saravanikumar R. 2001. Storage stability of Jackfruit (*Artocarpus heterophyllus*) RTS beverage. *Journal of Food Science Technology* **38**:601-02.

Kaur G and Aggarwal P. 2014a. Storage studies on bitter gourd juice preserved with different chemical preservatives. *International Journal of Research in Engineering and Technology* **3**(1):223-27.

Kaur G and Aggarwal P. 2014b. Storage studies on bottle gourd juice preserved with different chemical additives. *Indian Journal of Applied Research* **4**(2):39-41.

Kaur G, Aggarwal P and Javed M. 2014. Effect of chemical additives on the shelf life of cucumber juice. *International Journal of Engineering Research and Applications* **4**(1):206-09.

Kaushal M. 2004. Utilisation of seabuckthorn (*Hippophae* sp.) for preparation and evaluation of some value-added products. PhD. Dr. Yashwant Singh Parmar University of Horticulture and Forestry, Solan. 156p.

Kavitha C, Kuna A, Sagar S B, Supraja T, Padmavathi T V N and Prabhakar B N. 2014. Evaluation of physicochemical and antioxidant properties of ber (*Zizyphus mauritiana* Lam.) and RTS ber beverage. *Biochemical and Cellular Archives* **14**(1):217-22.

Kayshar M S, Rahman A, Sultana M S, Fatema K and Kabir M F. 2014. Formulation, preparation and storage potentiality study of mixed squashes from papaya, banana and carrot in Bangladesh. *Journal of Agriculture and Veterinary Science* **7**(2):47-51.

Khamrui K and Pal D. 2004. Effect of potassium metabisulphite and storage conditions on physico-chemical and microbiological changes in whey-based kinnow juice concentrate. *Journal of Food Science and Technology* **41**(4):401-04.

Khurdiya D S and Roy S K. 1974. Studies on guava powder by cabinet drying. *Indian Food Packer* **28**(5):5-8.

Kinh S A E H, Dunne C P and Hoover D G. 2001. Preparation and preservation of apple pulp with chemical preservatives and mild heat. *Journal of Food Protection* **28**:111-14.

Klimczak I, Malecka M, Szlachta M and Gliszczynska-Swiglo A. 2007. Effect of storage on the content of polyphenols, vitamin C and the antioxidant activity of orange juices. *Journal of Food Compostion and Analysis* **20**(3-4):313-22.

Kumar M. 2019. Extraction and utilization of papaya leaf extract for preparation of ready-to-serve beverages. M.Sc. Thesis. Dr. Yashwant Singh Parmar University of Horticulture and Forestry, Solan. 72p.

Kumar S, Godara R K, Kumar S and Singh J. 2018. Studies on physico-chemical characteristics in squash prepared from different mango cultivars. *International Journal of Current Microbiology and Applied Science* **7**(1):827-33.

Kumar V, Chandra S, Yadav A and Kumar S. 2013. Quality evaluation of mixed fruit based Ready-to-serve beverage. *International Journal of Agricultural Engineering* **6**(1):195-200.

Lal G, Siddappa G S and Tandon G L. 1986. *Preservation of Fruit and Vegetables.* Publication and Information Division. Indian Council of Agricultural Research, New Delhi. 488p.

Lane J H and Eynon L. 1923. Determination of reducing sugars by means of fehling solution with methylene blue as internal indicator. *Journal of the Chemical Society, Transactions* **42**:32-36.

Lee K H, Choi H R and Kim C H. 2005. Anti-angiogenic effect of the seed extract of *Benincasa hispida* fruit. *Journal of Ethnopharmacology* **97**:509-13.

Li J, Miao S and Jiang Y. 2009. Changes in quality attributes of longan juice during storage in relation to effects of thermal processing. *Journal of Food Quality* **32**:48-57.

Madhukar D P. 2008. Processing of Bottle Gourd (*Lagenaria siceraria*) into Juice and Powder. M.Sc. Thesis. Mahatma Phule Krishi Vidyapeeth, Rahuri, Ahmednagar. 99p.

Mahadeviah M. 1999. Modern trends in food packaging for globalization. *Indian Food Packer.* **53**(1):44-48.

Majumdar T K, Vasudhish C R, Premavalli K S and Bawa A S. 2009. Preservation of functional vegetable juices: ashgourd juice and ashgourd-pudina blended juice. *Beverage and Food World* **36**(4):48-50.

Majumdar T K, Vasudish C R, Premavalli K S and Bawa A S. 2010. Studies on processing and storage stability of ashgourd-mint leaves juice. *Journal of Food Processing and Preservation* **3**(2):549-56.

Majumdar T K, Wadikar D and Bawa A S. 2012. Development and storage stability of aseptically processed ash gourd-mint leaves juice. *International Food Research Journal* **19**(3):823-28.

Majumdar T K, Wadikar D D, Vasudish C R, Premavalli K S and Bawa A S. 2011. Effect of storage on physico-chemical, microbiological and sensory quality of bottle gourd-basil leaves juice. *American Journal of Food Technology* **6**(3):226-34.

Manimegalai G, Krishnaveni A and R S Kumar. 2001. Processing and preservation of jack fruit (*Artocarpus heterophyllus* L.) bar (Thandra). *Journal of Food Science and Technology.* **38**(5):529-31.

Mathad V S M, Chadanam S, Setty S A T, Ramaiyan D, Veerana B M and Setty L N A V. 2005. Anti-diarrheal evaluation of *Benincasa hispida* fruit extracts. *Iranian Journal of Pharmacology and Therapeutics* **41**:24-27.

Mehmood Z, Alam Z, Mohammad A, Bibi N, Amal B and Ihsanullah I. 2008. Effect of pasteurization and chemical preservatives on the quality and shelf stability of apple juice. *Americal Journal of Food Technology* **3**(2):147-53.

Mingyu D, Mingzhang L, Qinghong Y, Weiming F, Jianxiang X and Weiming X. 1995. A study on *Benincasa hispida* contents effective for protection of kidney. *Jiangsu Journal of Agricultural Sciences* **11**:46-52.

Mortan J F. 1971. The wax gourd, a year-round Florida Vegetables with unusual keeping quality. *Florida State Horticulture Society* **84**:104-09.

Murtaza M A, Huma N, Javaid J, Shabbir M A, Uddin G M and Mahmood S. 2004. Studies on stability of strawberry drink stored at different temperatures. *International Journal of Agriculture and Biology* **6**(1):58-60.

Nadhiya K and Vijayalakshmi K. 2014. Evaluation of total phenol, flavonoid contents and in-vitro antioxidant activity of *Benincasa hispida* fruit extracts. *International Journal of Pharmaceutical, Chemical and Biological Sciences* **4**(2):332-38.

Nath A and Yadav D S 2005. Standardization of ginger-kinnow, a blended beverage from kinnow mandarin juice. *Indian Journal of Citrus* **29**:189-92.

Nirmal V S. 2006. Studies on Processing of wood apple into RTS beverage. M.Sc. Thesis. Mahatma Phule Krishi Vidyapeeth, Rahuri, Ahmednagar. 81p.

Nisar R, Baba W N and Masoodi F A. 2015. Effect of chemical and thermal treatments on quality parameters and antioxidant activity of apple (pulp) grown in high Himalayan regions. *Cogent Food and Agriculture* **1**:1-13.

Nurul A M Z, Anwar F, Hamid A A and Saari N. 2011. Kundur (*Benincasa hispida*): A potential source for valuable nutrients and functional foods. *Food Research International* **44**(7):2368-76.

Palamthodi S and Lele S S. 2014. Neutraceutical applications of gourd family vegetables: *Benincasa hispida*, *Lagenaria sicernaria* and *Momordica charantia*. *Biomedicine and Preventive Nutrition* **4**(1):15-21.

Palamthodi S, Kadam D and Lele S S. 2019. Physicochemical and functional properties of ash gourd/bottle gourd beverages blended with jamun. *Journal of Food Science and Technology* **56**(1):473-82.

Pandey A K and Singh I S. 1999. Studies on preparation and preservation of guava ready to serve beverage. *Indian Journal of Horticulture* **56**:130-32.

Pandey A K, Bhardwaj D R, Dubey R K, Singh V and Pandey S. 2015. Botany, diversity, utilization and improvement of ash gourd (*Benincasa hispida* Thunb. Ex Murray Cogn)-a review. *Annals of Horticulture* **8**:1-15.

Pandey A K. 2004. Study about the storage stability of guava beverage. *Progressive Horticulture* **2**(5):45-47.

Panesar P S, Sharma H K and Rai R. 2000. Preservation of kinnow juice. *Indian Food Packer* **24**(4):25-27.

Pareek S, Paliwal R and Mukherjee S. 2010. Effect of juice extraction method and processing temperature-time on juice quality of Nagpur mandarin (*Citrus reticulate* Blanco) during storage. *Journal of Food Science and Technology* **48**(2):197-203.

Patil S M, Raut V U, Kumar P and Lavania P. 2011. Standardization of recipes for production of custard apple squash. *Progressive Horticulture* **11**(2):472-74.

Peter K V. 1998. *Genetics and Breeding of Vegetables*. ICAR, New Delhi. 133p.

Prachi G and Premavalli K S. 2010. Effect of particle size reduction on physicochemical properties of ash gourd (*Benincasa hispida*) and radish (*Raphanus sativus)* fibres. *International Journal of Food Sciences and Nutrition* **61**(1):18-28.

Pradhan K, Nandi A, Tripathy B and Rout S. 2020. Nutrient uptake of ash gourd [*Benincasa hispida* (Thunb.) Cogn.] germplasm. *Journal of Plant Development Sciences* **12**(6):361-64.

Prasad R N and Mali P C. 2000. Changes in physico-chemical characteristics of pomegranate squash during storage. *Indian Journal of Horticulture* **57**(1):18-20.

Premachandran U. 1982. Studies on the utilization of apple juice concentrate for nectar preparation. Ph.D. Thesis, Division of Fruits and Horticulture Technology, IARI, New Delhi.

Pushpa T H, Jagadeesh S L and Suresha G J. 2016. Influence of blending of natural extract on physico-chemical and sensory qualities of aloe vera squash. *The Bioscan* **11**(1):113-17.

Rana S and Suttee A. 2012. Phytochemical investigation and evaluation of free radical scavenging potential of *Benincasa hispida* peel extracts. *International Journal of Current Pharmaceutical Review and Research* **3**(3):43-46.

Ranganna S. 2014. *Handbook of Analysis and Quality Control for Fruit and Vegetable Products*. Tata McGraw Hills Publishing Co. Ltd., New Delhi. 1112p.

Rashinkar N M, Kotecha P M and Thorat S S. 2013. Studies on preparation of ready to serve beverages from ash gourd. *Beverage and Food World* **40**(2):26-27.

Rashinkar N M. 2012. Studies on preparation of ready-to-serve beverage and powder from ash gourd. M.Sc. Thesis. Mahatma Phule Krishi Vidyapeeth, Rahuri, Maharashtra. 66p.

Reddy A H and Chikkasubbanna V. 2008. Standardization of recipe and storage behavior of lime blended amla squash. *The Asian Journal of Horticulture* **3**(2):203-07.

Relekar P P, Naik A G and Padhiar B V. 2013. Effect of recipe on qualitative changes in sapota squash during storage. *Indian Journal of Horticulture* **3**(6):22-27.

Ross A F, Hillborn M J and Jenness L L. 1945. Discolouration can be avoided. *Indian Food Packer*. **18**(10):30-42.

Satkar K P, Kulthe A A and Chalke P R. 2013. Preparation of bitter gourd ready-to-serve beverage and effect of storage temperature on its keeping quality. *The Bioscan* **8**(1):115-17.

Selvamuthukumaran M and Khanum F. 2013. Development of spiced seabuckthorn [*Elaeagnus rhamnoides* (L.) A. Nelson syn. *Hippophae rhamnoides* L.] mixed fruit squash. *Indian Journal of Traditional Knowledge* **13**(1):132-41.

Sew, Chew C, Zaini N A M, Hamid A A and Saari N. 2010. Nutritional composition and oil fatty acids of kundru [*Benincasa hispida* (Thunb.) Cogn.] seed. *Pakistan Journal of Botany* **42**(5):3247-45.

Sharma A and Singh K. 2005. Effect of different treatments on TSS, sugars, viscosity and suspended pulp of lime juice during storage. *Haryana Journal of Horticulture Science* **33**(1-2):45-46.

Sharma P C, Sharma S K and Kaushal B B L. 2001. Preparation and evaluation of some value added products from lemon {*Citrus pseudolimon* Tan.) fruits. *Indian Journal of Agricultural Sciences* **71**(11):691-94.

Sharma S. 2020. Standardization of method for extraction and storage of aonla juice. M.Sc. Thesis. Dr. Yashwant Singh Parmar University of Horticulture and Forestry, Solan. 69p.

Shelar S D, Kad V P, Kanawade V L, Patil A P and Unde P A. 2017. Ready-to-Serve Beverage from Spray Dried Pomegranate Juice Powder. *Journal of Krishi Vigyan* **6**(1):166-71.

Sheshadri, V S. 1993. *Cucurbits: Vegetable crops*, IInd ed. (Bose T K, Som M G and Kabir J (eds). Naya Prakash, Culcutta. pp. 40-124.

Shivani. 2011. Preparation and quality evaluation of nectarine (*Prunus persica*) based value added products. M.Sc. Thesis. CSK Himachal Pradesh Krishi Vishwavidyalaya, Palampur. 115p.

Sindumathi G and Premalatha M R. 2015. Development and Storage studies of naturally flavored papaya-pineapple blended ready-to-serve (RTS) beverages. *International Journal of Science and Research* **4**(2):856-60.

Sonia, Gehlot R, Singh R and Yadav B S. 2010. Changes in chemical constituents and overall acceptability of jamun ready-to- serve (RTS) drink and nectar during storage. *Haryana Journal of Horticultural Sciences* **39**(1&3):142-44.

Sood S, Minhas S, Kalia M and Katoch S.2009. Storage study of mango squash by using cheese whey and soy whey. *Beverage and Food World* **36**(4):44-46.

Sreenivas K M and Lele S S. 2013. Prebiotic activity of gourd family vegetable fibres using in vitro fermentation. *Food Bioscience* **1**:26-30.

Sunita. 2019. Process development for the production of ash gourd based whey beverage. B. Tech. Thesis. Karnataka Veterinary, Animal and Fisheries Science University, Bidar. 145p.

Swamy S, Kumar J P and Kumar R. 2012. Processing and quality evaluation of watermelon squash. *Journal of Scientific and Applied Research* **3**(1):79-85.

Syed H M, Ghatge P U, Machewad G and Pawar S. 2012. Studies on preparation of squash from sweet orange. *Open Access Scientific Reports* **1**(6):185-87.

Tee E S, Noor M I, Azudin M N and Idris K. 1997. *Nutrient composition of Malaysian foods* (Komposisi zat dalam makanan Malaysia). Malaysian Food Composition Database Programme. 4th ed., Institute for Medical Research, Kuala Lumpur. pp. 46-47.

Teotia M S and Pruthi J S. 1987. Techno-economic aspects of amchur manufacture. *Indian Food Packer.* **41**(6):26-30.

Thakur A. 2014. Development of value-added products from box myrtle (*Myrica nagi*). M.Sc. Thesis. Dr Y S Parmar University of Horticulture and Forestry, Solan. 189p.

Thakur N S and Hamid. 2017. Development of squash from mulberry (*Morus alba* L.) and its quality evaluation during storage. *International Journal of Farm Sciences* **7**(2):136-41.

Thakur N S, Chauhan M and Thakur A. 2018. Development of squash from wild prickly pear (*Opuntia dilleniid* Haw.) fruit and its quality evaluation during storage. *International Journal of Current Microbiology and Applied Sciences* **7**(7):1942-54.

Thakur N S, Dhaygude G S, Thakur A, Kumar P and Hamid. 2018. Studies on preparation and preservation of squash from wild pomegranate (*Punica granatum* L.) fruits and its quality evaluation during storage. *International Journal of Bio-resources and Stress Management* **9**(1):7-12.

Upale K B. 2005. Studies on processing of jamun juice and its beverages. M.Sc. Thesis. University of Agricultural and Sciences Dharwad.

Vallverdu-Queralt A, Arranz S, Medina-Remon A, Casals-Ribes I and Lamuela-Raventos R M. 2011. Changes in phenolic content of tomato products during storage. *Journal of Agriculture and Food Chemistry* **59**(17):9358-65.

Vijayanand P, Deepu E and Kulkarni S G. 2013. Physico-chemical characterization and the effect of processing on the quality characteristics of Sindura, Mallika and Totapari mango cultivars. *Journal of Food Science and Technology* **52**:1047-53.

Walters T W. 1989. Historical overview on domesticated plants in China with special emphasis on the cucurbitaceae. *Economy Botany* **43**(3):297-313.

Wilczynski K, Kobus Z and Dziki D. 2019. Effect of press construction on yield and quality of apple juice. *Sustainbility* **11**(13):3630.

Wills R B H, Wong A W K, Scriven F M and Greenfield H. 1984. Nutrient composition of Chinese vegetables. *Journal of Agriculture and Food Chemistry* **32**:413-16.

Xie D, Xu Y, Wang J, Zhou Q, Luo S, Huang W, He X, Li Q, Peng Q, Yang X, Yuan J, Yu Jigao, Wang X, Lucas W J, Huang S, Jiang B and Zhang Z. 2019. The wax gourd genomes offer insights into the genetic diversity and ancestral cucurbit karyotype. *Nature communications* **10**(1):1-12.

Yadav S, Gehlot R, Siddiqui S and Grewal R B. 2014. Changes in chemical constituents and overall acceptability of guava-mango Ready-to-Serve (RTS) drink and squash. *Beverage and Food World* **41**(4):30-33.

Yenda B, Rao B V and Rao B G. 2014. Biological and Chemical Sciences In vitro antioxidant activity studies on leaves of *Benincasa hispida* (Thunb.) Cogn. *Research Journal of Pharmaceutical, Biological and Chemical Sciences* **5**(3):141.

Zaini N A M, Anwar F, Abdul Hamid A and Saari N. 2011. Kundur [*Benincasa hispida* (Thunb) Cogn.]: a potential source for valuable nutrients and functional foods. *Food Research International* **44**(7):2368-76.

Ziadi S and Khan M A. 2008. Scope of fruits and vegetables for beverages production in India. *Beverage and Food World* **56**(2):63-64.

APPENDIX - I

HEDONIC RATING TEST
SENSORY EVALUATION OF ASH GOURD BEVERAGES

NAME: _____ Date: _____
PRODUCT: _____

Please evaluate the following samples as per the standard scale.

Parameters / Treatments	Colour	Body	Flavour	Overall acceptability

Nine point Hedonic scale

1 = Dislike extremely
2 = Dislike very much
3 = Dislike moderately
4 = Dislike slightly
5 = Neither like nor dislike
6 = Like slightly
7 = Like moderately
8 = Like very much
9 = Like extremely

Signature of Evaluator

APPENDIX – II

Anova 1: Physico-chemical characteristics of fresh Ash gourd fruit

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated
Treatment	7	17,715.523	2,530.789	124.581
Error	16	325.031	20.314	
Total	23	18,040.554		

Anova 2: Chemical characteristics of fresh Ash gourd fruit

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated
Treatment	12	25,001.374	2,083.448	15,410.667
Error	26	3.515	0.135	
Total	38	25,004.889		

Anova 3: Effect of different methods of preservation on TSS of ash gourd fruit juice

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated
Method of preservation (M)	3	0.094	0.031	121.393
Storage intervals (S)	2	0.617	0.308	1,194.372
Packing (P)	1	0.006	0.006	23.810
MxS	6	0.049	0.008	31.817
MxP	3	0.001	0.000	1.436
SxP	2	0.003	0.002	6.027
MxSxP	6	0.001	0.000	0.803
Error	48	0.012	0.000	
Total	71	0.784		

Anova 4: Effect of different methods of preservation on pH of ash gourd fruit juice

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated
Method of preservation (M)	3	0.339	0.113	673.848
Storage intervals (S)	2	0.270	0.135	803.540
Packing (P)	1	0.082	0.082	488.482
MxS	6	0.726	0.121	720.298
MxP	3	0.303	0.101	602.470
SxP	2	0.221	0.111	659.085
MxSxP	6	0.676	0.113	671.302
Error	48	0.008	0.000	
Total	71	2.626		

Anova 5: Effect of different methods of preservation on titrable acidity (per cent) of ash gourd fruit juice

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated
Method of preservation (M)	3	0.005	0.002	49.061
Storage intervals (S)	2	0.035	0.017	501.748
Packing (P)	1	0.002	0.002	70.543
MxS	6	0.003	0.001	16.430
MxP	3	0.000	0.000	4.006
SxP	2	0.002	0.001	23.529
MxSxP	6	0.001	0.000	3.996
Error	48	0.002	0.000	
Total	71	0.050		

Anova 6: Effect of different methods of preservation on ascorbic acid (mg/100g) of ash gourd fruit juice

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated
Method of preservation (M)	3	5.188	1.729	2,280.826
Storage intervals (S)	2	80.187	40.094	52,876.889
Packing (P)	1	0.264	0.264	348.692
MxS	6	7.755	1.293	1,704.690
MxP	3	0.226	0.075	99.337
SxP	2	0.230	0.115	151.507
MxSxP	6	4.807	0.801	1,056.539
Error	48	0.036	0.001	
Total	71	98.694		

Anova 7: Effect of different methods of preservation on reducing sugars (per cent) of ash gourd fruit juice

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated
Method of preservation (M)	3	0.264	0.088	120.998
Storage intervals (S)	2	2.271	1.135	1,563.048
Packing (P)	1	0.232	0.232	319.855
MxS	6	0.462	0.077	106.004
MxP	3	0.050	0.017	23.056
SxP	2	0.138	0.069	95.171
MxSxP	6	0.034	0.006	7.848
Error	48	0.035	0.001	
Total	71	3.486		

Anova 8: Effect of different methods of preservation on total sugars (per cent) of ash gourd fruit juice

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated
Method of preservation (M)	3	0.043	0.014	98.526
Storage intervals (S)	2	0.579	0.290	2,007.808
Packing (P)	1	0.011	0.011	77.027
MxS	6	0.083	0.014	96.397
MxP	3	0.002	0.001	4.435
SxP	2	0.005	0.003	18.713
MxSxP	6	0.002	0.000	1.838
Error	48	0.007	0.000	
Total	71	0.732		

Anova 9: Effect of different methods of preservation on total phenols (mg GAE/g) of ash gourd fruit juice

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated
Method of preservation (M)	3	0.023	0.008	21.793
Storage intervals (S)	2	16.709	8.355	23,763.268
Packing (P)	1	0.019	0.019	54.630
MxS	6	-0.009	-0.002	-4.335
MxP	3	-0.021	-0.007	-20.019
SxP	2	-0.015	-0.007	-21.311
MxSxP	6	0.020	0.003	9.461
Error	48	0.017	0.000	
Total	71	16.743		

Anova 10: Effect of different methods of preservation on non-enzymatic browning (O.D) of ash gourd fruit juice

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated
Method of preservation (M)	3	0.003	0.001	329.712
Storage intervals (S)	2	0.023	0.011	3,331.468
Packing (P)	1	0.000	0.000	129.330
MxS	6	0.002	0.000	92.582
MxP	3	0.000	0.000	4.455
SxP	2	0.000	0.000	32.636
MxSxP	6	0.000	0.000	2.629
Error	48	0.000	0.000	
Total	71	0.029		

Anova 11: Effect of different methods of preservation on antioxidant activity (per cent) of ash gourd fruit juice

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated
Method of preservation (M)	3	6.798	2.266	2,172.956
Storage intervals (S)	2	24.041	12.020	11,526.796
Packing (P)	6	4.238	0.706	677.395
MxS	1	0.027	0.027	26.099
MxP	3	-0.014	-0.005	-4.561
SxP	2	-0.015	-0.008	-7.234
MxSxP	6	0.020	0.003	3.140
Error	48	0.050	0.001	
Total	71	35.145		

Anova 12: Sensory evaluation of ash gourd fruit juice

Colour

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated
Method of preservation (M)	3	0.179	0.060	1.055
Storage intervals (S)	2	5.357	2.679	47.373
Packing (P)	1	0.000	0.000	0.007
MxS	6	0.152	0.025	0.449
MxP	3	0.202	0.067	1.193
SxP	2	0.037	0.018	0.326
MxSxP	6	0.205	0.034	0.603
Error	48	2.714	0.057	
Total	71	8.847		

Body

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated
Method of preservation (M)	3	0.053	0.018	2.659
Storage intervals (S)	2	0.520	0.260	39.053
Packing (P)	1	0.109	0.109	16.373
MxS	6	0.047	0.008	1.169
MxP	3	0.008	0.003	0.419
SxP	2	0.050	0.025	3.758
MxSxP	6	0.039	0.007	0.986
Error	48	0.320	0.007	
Total	71	1.146		

Flavour

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated
Method of preservation (M)	3	0.129	0.043	1.219
Storage intervals (S)	2	1.460	0.730	20.743
Packing (P)	1	0.011	0.011	0.318
MxS	6	0.026	0.004	0.124
MxP	3	0.003	0.001	0.028
SxP	2	0.010	0.005	0.141
MxSxP	6	0.014	0.002	0.068
Error	48	1.690	0.035	
Total	71	3.344		

Overall acceptability

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated
Method of preservation (M)	3	0.086	0.029	2.900
Storage intervals (S)	2	1.985	0.993	100.963
Packing (P)	1	0.021	0.021	2.108
MxS	6	0.025	0.004	0.430
MxP	3	0.018	0.006	0.626
SxP	2	0.015	0.008	0.788
MxSxP	6	0.032	0.005	0.535
Error	48	0.472	0.010	
Total	71	2.655		

Anova 13. Sensory evaluation for selecting best treatment for preparation of ash gourd sweetened beverage

Colour

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated
Treatment	4	0.027	0.007	33.308
Error	10	0.002	0.000	
Total	14	0.029		

Body

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated
Treatment	4	0.325	0.081	5.452
Error	10	0.149	0.015	
Total	14	0.474		

Flavour

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated
Treatment	4	3.899	0.975	139.996
Error	10	0.070	0.007	
Total	14	3.969		

Overall acceptability

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated
Treatment	4	0.617	0.154	66.250
Error	10	0.023	0.002	
Total	14	0.640		

Anova 14: Effect of different methods of preservation on TSS of ash gourd sweetened beverage

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated
Method of preservation (M)	2	0.010	0.005	93.761
Storage intervals (S)	3	0.000	0.000	2.742
MxS	6	0.002	0.000	5.415
Error	24	0.001	0.000	
Total	35	0.013		

Anova 15: Effect of different methods of preservation on pH of ash gourd sweetened beverage

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated
Method of preservation (M)	2	0.009	0.004	80.573
Storage intervals (S)	3	0.002	0.001	11.630
MxS	6	0.000	0.000	1.502
Error	24	0.001	0.000	
Total	35	0.012		

Anova 16: Effect of different methods of preservation on titrable acidity (per cent) of ash gourd sweetened beverage

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated
Method of preservation (M)	2	0.014	0.007	99.983
Storage intervals (S)	3	0.002	0.001	9.259
MxS	6	0.001	0.000	3.443
Error	24	0.002	0.000	
Total	35	0.019		

Anova 17: Effect of different methods of preservation on ascorbic acid (mg/100g) of ash gourd sweetened beverage

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated
Method of preservation (M)	2	3.739	1.870	555.249
Storage intervals (S)	3	0.202	0.067	19.956
MxS	6	0.099	0.017	4.902
Error	24	0.081	0.003	
Total	35	4.121		

Anova 18: Effect of different methods of preservation on reducing sugars (per cent) of ash gourd sweetened beverage

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated
Method of preservation (M)	2	0.016	0.008	32.239
Storage intervals (S)	3	0.005	0.002	5.940
MxS	6	0.002	0.000	1.491
Error	24	0.006	0.000	
Total	35	0.029		

Anova 19: Effect of different methods of preservation on total sugars (per cent) of ash gourd sweetened beverage

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated
Method of preservation (M)	2	0.018	0.009	22.317
Storage intervals (S)	3	0.001	0.000	0.810
MxS	6	0.000	0.000	0.077
Error	24	0.010	0.000	
Total	35	0.028		

Anova 20: Effect of different methods of preservation on total phenols (mg GAE/g) of ash gourd sweetened beverage

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated
Method of preservation (M)	2	5.809	2.904	5,648.952
Storage intervals (S)	3	0.074	0.025	48.109
MxS	6	0.039	0.006	12.621
Error	24	0.012	0.001	
Total	35	5.934		

Anova 21: Effect of different methods of preservation on non-enzymatic browning (O.D) of ash gourd sweetened beverage

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated
Method of preservation (M)	2	0.002	0.001	10.657
Storage intervals (S)	3	0.000	0.000	1.656
MxS	6	0.000	0.000	0.310
Error	24	0.002	0.000	
Total	35	0.004		

Anova 22: Effect of different methods of preservation on antioxidant activity (per cent) of ash gourd sweetened beverage

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated
Method of preservation (M)	2	6.546	3.273	2,511.420
Storage intervals (S)	3	0.076	0.025	19.521
MxS	6	0.093	0.015	11.844
Error	24	0.031	0.001	
Total	35	6.747		

Anova 23: Sensory evaluation of ash gourd sweetened beverage

Colour

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated
Method of preservation (M)	2	0.025	0.012	9.883
Storage intervals (S)	3	0.053	0.018	14.060
MxS	6	0.002	0.000	0.303
Error	24	0.030	0.001	
Total	35	0.110		

Body

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated
Method of preservation (M)	2	3.996	1.998	6,359.787
Storage intervals (S)	3	0.002	0.001	2.327
MxS	6	0.003	0.001	1.731
Error	24	0.008	0.000	
Total	35	4.009		

Flavour

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated
Method of preservation (M)	2	8.509	4.255	1,311.429
Storage intervals (S)	3	0.008	0.003	0.813
MxS	6	0.029	0.005	1.487
Error	24	0.078	0.003	
Total	35	8.624		

Overall acceptability

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated
Method of preservation (M)	2	2.865	1.433	2,224.651
Storage intervals (S)	3	0.008	0.003	4.190
MxS	6	0.002	0.000	0.477
Error	24	0.015	0.001	
Total	35	2.890		

Anova 24: Sensory evaluation for selecting best treatment for preparation of ash gourd squash

Colour

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated
Treatment	3	0.185	0.062	2.830
Error	8	0.175	0.022	
Total	11	0.360		

Body

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated
Treatment	3	0.084	0.028	9.583
Error	8	0.024	0.003	
Total	11	0.108		

Flavour

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated
Treatment	3	1.344	0.448	58.509
Error	8	0.061	0.008	
Total	11	1.405		

Overall acceptability

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated
Treatment	3	0.331	0.110	36.316
Error	8	0.024	0.003	
Total	11	0.356		

Anova 25: Effect of different methods of preservation on TSS (°B) of ash gourd squash

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated
Method of preservation (M)	2	10.441	5.220	32,999.037
Storage intervals (S)	2	-0.002	-0.001	-6.035
MxS	4	0.003	0.001	4.422
Error	18	0.003	0.000	
Total	26	10.444		

Anova 26: Effect of different methods of preservation on pH of ash gourd squash

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated
Method of preservation (M)	2	0.005	0.002	10.752
Storage intervals (S)	2	0.004	0.002	9.718
MxS	4	0.002	0.001	2.474
Error	18	0.004	0.000	
Total	26	0.016		

Anova 27: Effect of different methods of preservation on titrable acidity (per cent) of ash gourd squash

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated
Method of preservation (M)	2	0.083	0.041	1,597.173
Storage intervals (S)	2	0.002	0.001	38.454
MxS	4	0.002	0.001	21.115
Error	18	0.000	0.000	
Total	26	0.087		

Anova 28: Effect of different methods of preservation on ascorbic acid (mg/100g) of ash gourd squash

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated
Method of preservation (M)	2	42.580	21.290	520.736
Storage intervals (S)	2	0.005	0.003	0.064
MxS	4	0.008	0.002	0.046
Error	18	0.736	0.041	
Total	26	43.329		

Anova 29: Effect of different methods of preservation on reducing sugars (per cent) of ash gourd squash

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated
Method of preservation (M)	2	2.016	1.008	76.850
Storage intervals (S)	2	0.701	0.350	26.710
MxS	4	0.417	0.104	7.945
Error	18	0.236	0.013	
Total	26	3.370		

Anova 30: Effect of different methods of preservation on total sugars (per cent) of ash gourd squash

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated
Method of preservation (M)	2	10.441	5.220	135.972
Storage intervals (S)	2	1.067	0.533	13.891
MxS	4	0.621	0.155	4.044
Error	18	0.691	0.038	
Total	26	12.819		

Anova 31: Effect of different methods of preservation on total phenols (mgGAE/100g) of ash gourd squash

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated
Method of preservation (M)	2	0.027	0.014	67.570
Storage intervals (S)	2	0.002	0.001	4.837
MxS	4	-0.001	-0.000	-1.012
Error	18	0.004	0.000	
Total	26	0.032		

Anova 32: Effect of different methods of preservation on non-enzymatic browning (O.D) of ash gourd squash

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated
Method of preservation (M)	2	0.000	0.000	1.209
Storage intervals (S)	2	0.000	0.000	0.721
MxS	4	0.000	0.000	0.267
Error	18	0.003	0.000	
Total	26	0.004		

Anova 33: Effect of different methods of preservation on antioxidant activity (per cent) of ash gourd squash

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated
Method of preservation (M)	2	9.056	4.528	11,728.400
Storage intervals (S)	2	0.002	0.001	2.986
MxS	4	0.003	0.001	2.052
Error	18	0.007	0.000	
Total	26	9.068		

Anova 34: Sensory evaluation of ash gourd squash

Colour

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated
Method of preservation (M)	2	1.114	0.557	8.844
Storage intervals (S)	2	0.523	0.261	4.150
MxS	4	0.207	0.052	0.823
Error	18	1.133	0.063	
Total	26	2.977		

Body

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated
Method of preservation (M)	2	1.839	0.919	15.105
Storage intervals (S)	2	0.406	0.203	3.338
MxS	4	0.097	0.024	0.400
Error	18	1.096	0.061	
Total	26	3.439		

Flavour

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated
Method of preservation (M)	2	2.653	1.326	20.389
Storage intervals (S)	2	0.114	0.057	0.875
MxS	4	0.142	0.036	0.546
Error	18	1.171	0.065	
Total	26	4.080		

Overall acceptability

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated
Method of preservation (M)	2	1.754	0.877	37.332
Storage intervals (S)	2	0.141	0.070	2.995
MxS	4	0.061	0.015	0.646
Error	18	0.423	0.023	
Total	26	2.378		

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ABSTRACT

The suitability of ash gourd fruits was evaluated for preparation of beverages like juice, sweetened beverage and squash. The ash gourd juice was extracted by screw type juice extractor and resulted in juice recovery of 64.06 per cent with good physico-chemical attributes like 3.00 °B TSS, 5.06 pH, 0.13 per cent titrable acidity, 8.13mg/100g ascorbic acids, 0.15 per cent reducing sugars, 2.19 per cent total sugars, 24.28 mgGAE/g total phenols, 0.10 non-enzymatic browning and 25.05 per cent antioxidant activity. On the basis of 9-point hedonic scale, different combinations for preparation of ash gourd beverages were tried, out of which the sweetened beverage developed by using 85 per cent juice, 15 °B TSS and 0.3 % acidity while, squash with 25 per cent juice, 40 °B TSS and 1.2 per cent acidity was found most appropriate. All these beverages were preserved with different methods of preservation *viz.* pasteurization, KMS @ 350 ppm, sodium benzoate @ 600 ppm and their combinations, out of which beverages preserved with KMS was found to be best *viz.* juice, sweetened beverage and squash with TSS (3.08, 14.99 and 40.87 °B), ascorbic acid (7.31, 8.85 and 9.06 mg/100g), reducing sugars (0.23, 8.14, 34.94 per cent), total sugar (2.27, 13.94 and 37.39 per cent), total phenols (23.91, 24.80 and 24.29 mgGAE/100g), NEB (0.025, 0.011 and 0.010) and antioxidant activity (26.36, 25.23 and 21.58 per cent), respectively. Though, sensory scores decreased with the advancement of storage but processed beverages preserved with different preservation methods were well above the acceptable limits between like slightly to like very much. The study indicated that processed beverages can be safely stored up to a period of 90 days with minimal changes in chemical and sensory attributes. Henceforth, it is concluded that ash gourd juice which otherwise is processed to a limited extent, can be successfully utilized for the production of good quality and nutritionally enriched beverages of remunerative cost.

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