ASSESSMENT OF THERAPEUTIC VALUE OF ALOE VERA (*Aloe barbadensis*) INCORPORATED JUICES

Thesis

Submitted to the

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By

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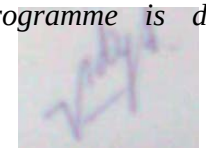

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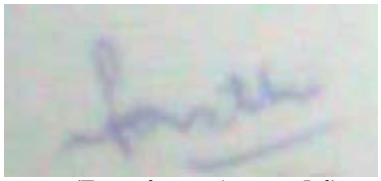
C E R T I F I C A T E

This is to certify that the thesis entitled **"ASSESSMENT OF THERAPEUTIC VALUE OF ALOE VERA (*Aloe barbadensis*) INCORPORATED JUICES"** submitted in partial fulfilment of the requirements for the degree of **DOCTOR OF PHILOSOPHY** with major in **HUMAN NUTRITION** and minor in **FOOD TECHNOLOGY** of the College of Post-Graduate Studies, G.B. Pant University of Agriculture and Technology, Pantnagar, is a record of *bona-fide* research carried out by **Ms. VIDYA KUMARI, Id. No. 34020** under my supervision and no part of the thesis has been submitted for any other degree or diploma.

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



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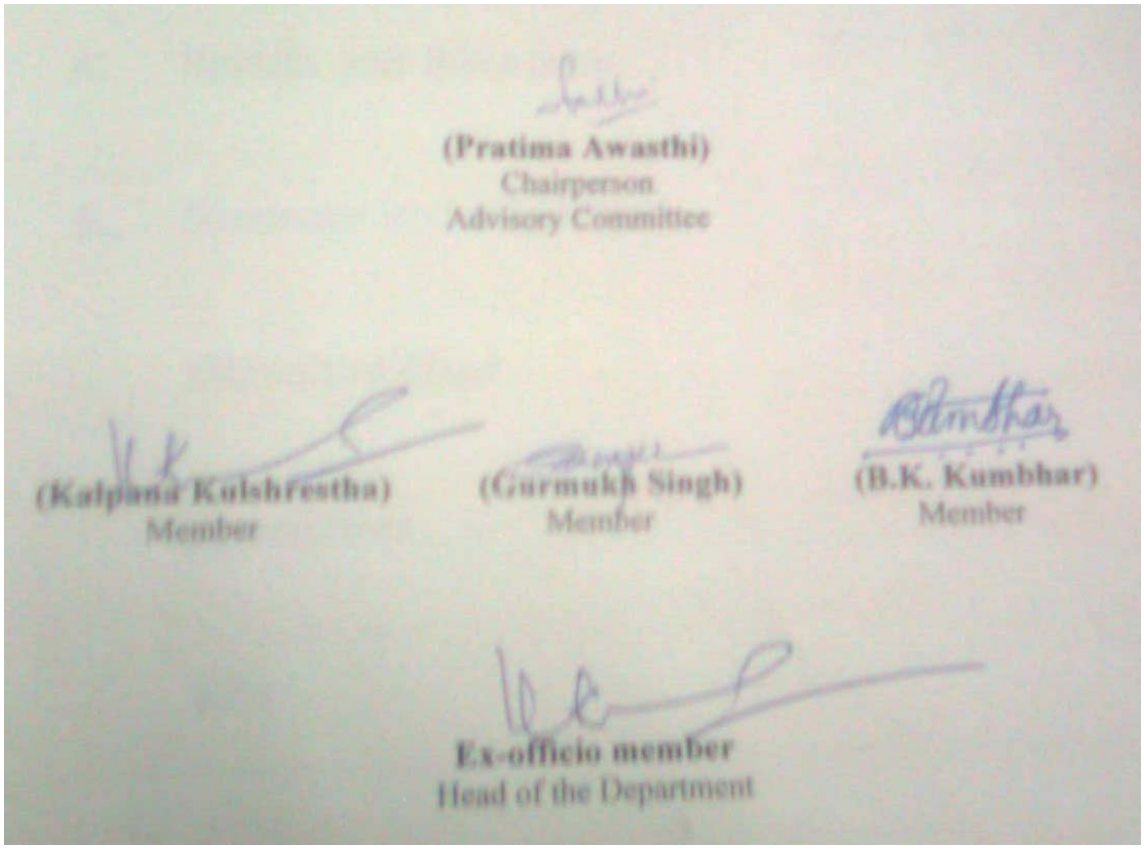
We, the undersigned, members of the Advisory Committee of **Ms. VIDYA KUMARI, Id. No. 34020** a candidate for the degree of **DOCTOR OF PHILOSOPHY** with major in **HUMAN NUTRITION** and minor in **FOOD TECHNOLOGY**, agree that the thesis entitled **"ASSESSMENT OF THERAPEUTIC VALUE OF ALOE VERA (*Aloe barbadensis*) INCORPORATED JUICES"** may be submitted in partial fulfilment of the requirements for the degree.



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INTRODUCTION

Chapter 1 INTRODUCTION

Fruit juice is a good tasting, convenient food that is favorably priced compared to milk or soda pop for today's eat-on-the-run lifestyle. It is also perceived and promoted as a healthy, non fat, often natural, nutritious drink. Recent national public health programs and manufacturer's marketing efforts are now designed to promote increased consumption of fruits and vegetables through increases in fruit juice consumption **(Dennison, 1996).** Juices contain all the goodness of whole product in a condensed form. Juicing is an excellent way of increasing fruits and vegetable consumption. The nutrients are generally present in dense form and quickly assimilated since the body does not have to separate out fiber. Fresh fruit juices cleanses system, purify the blood, cast out accumulated toxins from the cells whereas vegetable juices help in the production of new cells and replaces those which have either depreciated or have been destroyed by disease and faulty dietary habits. Raw juices have none of the dangerous side effects associated with many allopathic drugs and they can eliminate many health problems caused by the fast pace of modern life. Soluble fibers in fruits and vegetables form gel in the stomach and speed up digestion by stimulating peristaltic waves. Regular consumption of juice not only speeds up elimination of toxins from the body, it also strengthens and tonifies the immune system by providing wide range of nutrients like vitamin C, vitamin E, the B group, beta carotene, chlorophyll and zinc. Antioxidants in juices protect against the free radicals which contribute to the development of various degenerative diseases. Fresh juice puts the digestive system

under far less strain than whole fruits and vegetables. With juices, one can eliminate or prevent many of the chronic and degenerative diseases, revitalize blood, sharpen nerves, rejuvenate glandular activity, improve bowel functions and help restore the acid- alkaline balance of the body. Moreover home made fresh juices can be consumed all year round **(Wheater, 1993; http://www.livstrong.com; http://www.bestofjuicing.com/, www.starhealthylife.com; and http://www. juicing-for-health.com/fruit-juicing.html).**

Diabetes mellitus is a group of diseases characterized by high blood glucose concentration resulting from defects in insulin secretion, insulin action or both **(Mahan and Stump, 2000).** There is a steady rise in the rate of diabetes mellitus worldwide. It is estimated that one in five may be diabetic by 2025 **(King *et al.*, 1998).** Diabetes in India is slowly becoming a killer disease next to coronary heart disease. Studies suggest that 10-13% of urban population and 4-6% rural population of India have diabetes **(Ramachandran, 2001).** Synthetic hypoglycemic drugs cannot fully control glucose level as well as cause adverse side effects such as cutaneous and gastrointestinal reactions, hypoglycemic coma and disturbances of liver and kidney functions which prompts the patients to stop medication **(Alarcon-Aguilara *et al.*, 2000 and Yagi *et al.*, 2009).** Since the complications of diabetes are such that no single available oral hypoglycemic agent would be enough to combat the multiple disorders of the disease. Thus there is a need to launch a drug discovery program against diabetes **(Irfan and Khanum, 2002).**

Hypertension on the other hand is the leading cause of cardiovascular disease worldwide. According to an estimate, 972 million people in the world

are suffering from this problem. Incidence rate of hypertension ranges from 3 to 18% depending on the age, gender, ethnicity and body size of the population. Despite advances in hypertension treatment, control rates continue to be suboptimal. Therefore, programmes to improve hypertension control rates and prevent hypertension are urgently needed **(Hajjar *et al.,* 2006).**

Constipation is a common condition affecting millions of people worldwide and it is a common morbidity factor in otherwise healthy persons as well as in patients with various predisposing diseases **(Higgins and Johanson, 2004).** Chronic constipation is not a benign, easily treated condition and lowers one's health related quality of life while imposing an economic burden on the individual and society in terms of cost of labor and medication. Thus, efficient instructions to patients for management and particularly prevention are needed **(Dennison, 2005).**

Diet-related non-communicable disease like diabetes, hypertension imposes a significant burden on healthcare services in terms of hospitalization costs, consultation costs, costs of investigations and prescription drugs. Productivity losses associated with premature death are also costly and on the rise **(Popkin *et al.,* 2001).**

In view of increasing health hazards and toxicity associated with the excessive use of synthetic drugs, coupled with a rapid expansion of pharmaceutical industries, the demand for medicinal plants has increased tremendously **(Prabhuji, 2005).** Plants have played a significant role in maintaining human health and improving the quality of human life for thousands

of years, and have served humans well as valuable components of seasonings, beverages, cosmetics, dyes, and medicines **(Craig, 1999).** The World Health Organization has also recommended the evaluation of the effectiveness of plants in conditions where there is lack of safe modern drugs **(WHO, 1980).**

In this regard bitter gourd *(Momordica charantia)* and bottle gourd *(Lagenaria siceraria)* were reported to have hypocholesterolemic, antidiabetic activity and anti-oxidant potential **(Kar *et al.*,2003; Ghule *et al.*, 2006; Yadav *et al.*, 2010; Kudbe *et al.*, 2010).** *Aonla (Emblica officinalis)* is widely used in the Indian system of medicine against diabetes, heart diseases, liver treatment, anemia, hypercholesterolemia, constipation and is believed to increase defense against diseases. It is one of the richest sources of vitamin C and has antioxidant activity also **(Khan, 2009).** Rhizome of the plant ginger (*Zingiber officinale)* is effective against anemia, heart disease, heart palpitations, chest pain, poor circulation and reduces atherosclerotic lesions through antioxidant effects **(Leonard, 2006).** Carrots *(Daucus Carota)* besides containing high amount of beta carotene are also credited with many medicinal properties. Carrot is rich in alkaline elements which purify and revitalize the blood. Carrots, especially carrot juice, are beneficial for stomach and gastrointestinal health. Carrots improve a variety of digestive problems, such as upset stomach, peptic ulcers, gastritis, crohn's disease, diarrhea, celiac disease, intestinal colic, colitis, appendicitis **(Dweck, 2001).**

Carrots contain a great deal of roughage and thus work as natural laxative and are very effective in the treatment of constipation and intestinal

inflammation. It is a good source of pectin and coats the intestines to allay inflammation. Regular consumption of carrot helps in reviving liver health **(http://flavoursofindia.tripod.com/carrot.html).** Oranges are recognized by Commonwealth Scientific and Industrial Research Organisation (CSIRO) for prevention of cancer and other degenerative disease. A daily intake of orange juice provides vitamin C, anti-oxidants and other important phytochemicals. Orange juice has been found to induce hypocholesterolemic responses **(Briggs, 1997 and Kurowska *et al.*, 2000).**

Among all the medicinal plants, aloe vera *(Aloe barbadensis*) is one of the most important versatile medicinal plants having purgative, anti-burn, antimicrobial, anti-hypercholesterolemic and anti-hyperglycemic effect **(Grewal, 2000).** Besides medicinal uses, the leaves of aloe vera are also eaten as vegetables, pickles and salad. The fresh leaves help in the treatment of indigestion and constipation **(Singh, 2007).**

Now-a-days aloe vera is used as a potential source to develop a wide variety of food products to enhance their therapeutic value **(Chauhan *et al.*, 2007).** The potential use of aloe vera products often involves some types of processing, e.g. heating, dehydration which may cause irreversible modifications to the active substances, affecting their original structures, which may in turn promote important changes in the physiological and pharmacological properties of these components **(Thibault *et al.*, 1992 and Chang *et al*., 2006).** Since heat processing may be detrimental to the active ingredients in aloe gel, it was justified to consider developing products incorporating untreated, fresh aloe gel.

Beside this, due to bitter taste and slimy nature, aloe vera juice is seldom consumed. Hence, blending of aloe vera juice with fresh fruit and vegetable juices may be done to gain health benefits and improve nutritional status of the beverage.

Several studies indicate health benefits of aloe vera and various fruits and vegetables. However, scientific information on formulation of fresh juice blends with the incorporation of aloe vera juice is limited. Systematic studies are not available on higher levels of juice substitution with the addition of aloe vera juice. Therefore, in view of these considerations and keeping the urgency of new age health system in mind, the present study entitled "Assessment of therapeutic value of aloe vera *(Aloe barbadensis)* incorporated juices" has been undertaken with the following objectives -

1. To optimize preparation of fruit and vegetable juice blends incorporated with aloe vera juice.
2. To evaluate organoleptic qualities of juice blends.
3. To evaluate important physico-chemical characteristics in optimized juice blends preparations.
4. To study keeping quality of the optimized juice blends.
5. To study the therapeutic role of juice blends on constipated, hypertensive and diabetic patients.

REVIEW OF LITERATURE

Chapter 2 REVIEW OF LITERATURE

The available literature on the present investigation and related aspect have been thoroughly reviewed and presented under following heads and subheads-

2.1 Juices

The manufacture of juices from fruits and vegetables is as old as agriculture. With the development of agriculture over the last 10 millennia, the cultivation of crops provided a fairly reliable source of food, including fruits and vegetables appropriate for juice and beverage use **(FAO Agricultural Services Bulletin 146, 2001).**

Juice is defined in the most general sense as the extractable fluid contents of cells or tissues **(Merriam-Webster, 1981).** Codex Alimentarius defines juice as "unfermented but fermentable juice, intended for direct consumption, obtained by the mechanical process from sound, ripe fruits, preserved exclusively by physical means. The juice may be turbid or clear. The juice may have been concentrated and later reconstituted with water suitable for the purpose of maintaining the essential composition and quality factors of the juice. The addition of sugars or acids can be permitted but must be endorsed in the individual standard **(FAO, 1992).** Juice is the liquid naturally contained in fruit or vegetable tissue and is prepared by mechanically squeezing or macerating fresh fruits or vegetables without the application of heat or solvents. **(www.wikipedia.com/wiki/juice).**

2.2 Types of juice

There are basically many types of juices depending on the source mainly vegetables and fruits. Some of them are :

- **Acid fruits juice** includes juice extracts from high water content fruits like water melon, orange, lemon, grapefruit, pineapple and strawberry.
- **Sub-acid fruit juice** like that of pear, apples, apricot, cherry, peach and plum.
- **Vegetables juices** from tomato, cucumber, onion, bitter gourd etc. are known for their remedial effect on various diseases. For e.g. antibiotic elements present in fresh juices of garlic, tomatoes and onion are particularly good for clean out body system. Cucumber and onion juices contain natural substances that are effective in creation of insulin by pancreas.
- **Root vegetable juices** include juices of radish, beet root and carrot.
- **Green juice** comes from juicing leafy greens such as parsley, kale or spinach leaf. Other good greens to juice include beet greens. Adding carrot and/or apple juice to the blend helps them taste better.
- **Cruciferous vegetable juice**s usually contain a lot of fiber. Cabbage, celery and broccoli are good vegetables to juice and adding some fruit juice to these vegetables make them more palatable.
- **Herb Juice** like cassava root helps reduce inflammation, like arthritis. Juicing fennel, spearmint, peppermint, basil, ginger, garlic, green onion, chili pepper and small amounts of fresh turmeric root are excellent herbal juice.

  (http://www.ayushveda.com/tipson/how-fresh-juices-help-you-remain-healthy/ and www.livstrong.com)

2.3 Importance of seasonal availability of fruits and vegetables

The seasonal availability of fruit is the major determinants for juice manufacturing. In general, fruit destined for juicing should be of good edible quality, full flavoured and substantially more mature than fresh market fruit. This favors softer tissues (more easy to extract juice and higher yield), higher sugar content, deeper colour and a lesser amount of acid. However, over ripe fruit quality is inappropriate as the flavour and acidity may suffer. Also, the fruit's defense mechanisms are diminishing, so initial spoilage and microbial loads are apt to be higher (**FAO agricultural services bulletin 146, 2001).**

2.4 Difference between fruit juice and vegetable juice

In terms of power, fruit juices are stronger cleanser than vegetable juice because they are more acidic. But this acidity is turned into alkalinity when it reaches the gut. This quality enables them to scour the gastro-intestinal tract from harmful bacteria and waste, and they also have mild laxative effect. Citrus fruits are particularly powerful because they contain citric acid- the strongest of the fruit acids. Other non-citrus fruit contain either tartaric or malic acid which have a gentle scouring effect. Vegetable juices are generally seen as good restorative liquids but they also have a gentle cleansing effect, and are efficient at rebalancing the acid/base balance of the body. By consuming vegetables in juice form, 100 percent of the available nutrients, particularly minerals are assured. Fruits are the revitalizers and cleansers of the body. Vegetable juice doesn't raises insulin level the way that fruit juice does **(http://www.mindfuleats.com/ mindfuleats/2009/05/vegetable-juicing.html**).

2.5 Blending of juices

Despite the strong appeal and tradition that many pure fruit juices have, there are logical reasons for producing single fruit and mixed pure juice blends and juice products containing less than 100 per cent juice. These are:

- Maintaining a single juice's uniformity within and between seasons by blending multiple cultivars to insure a consistent product.
- Blending of different juices to overcome the high cost of some juices (exotic fruits).
- Overcoming scarcity and/or seasonal availability of certain juice components.
- Balancing out excessively strong flavours, primarily high acidity, astringency, or bitterness.
- Correcting low soluble solids level.
- Balancing juices with weak or bland flavour, but possessing other positive attributes.
- Improving poor colour or colour stability, of otherwise desirable juices attributes,
- Balancing extremely good, stable colour, with other positive attributes.
- Emphasizing unique nutritional or photochemical properties.
- Overcoming undesirable single strength juice consistency.

Blending offers the opportunity to adjust sugar/acid ratios and compensate for other imbalances in juice from a single harvest or cultivar, since many factors influence the composition and quality of juice. By blending several batches of juice with complementary compositions a uniform, standard juice is obtained.

Adjusting 100 per cent juices is much more of a challenge than manipulating acid and sugar in juice beverage blends. In a similar sense defects in many juice quality or nutritional attributes can be overcome by proper combination of juices. Further adjustments call for additional ingredients. Extremely acidic and/or strong flavoured juices completely mask more subtle juices **(FAO Agricultural Services Bulletin 146, 2001).**

2.6. Physico-chemical characteristics of juices

2.6.1 Moisture

Fruits and vegetables provide one of the most essential substances that are absolutely essential for good health that is water. Fruits and vegetables are high in moisture, ranging between 80 to 98 per cent. Water in the cells is responsible for the crispness of fruits and vegetables. The moisture content of foods besides influencing engineering properties of fruits and vegetables also have profound role in determining the shelf-life of unprocessed and processed fruit and vegetables and their products since it affects physico-chemical properties, microbiological spoilage and enzymatic changes **(Ikegwu and Ekwu, 2009).** The moisture content of different fruits and vegetables and honey are presented in Table 2.1(a), 2.1(b) and 2.1(c).

2.6.2 Total solids

The total solids content of a substance is the amount of material left as a residue upon drying at 105^{o}C to constant weight. In case of juice it defines the strength of juice. The total solids content is a measure of the amount of solids

Table 2.1 (a) Physico-chemical composition of carrot and orange

Investigator and year	Moisture	Total Solid	TSS	PH	TA	B:A	RS	NRS	TS
CARROT	-	-	-	-	-	-	-	-	-
Koca and Karadeniz, 2008	-	-	9.64	6.59	0.04	-	-	-	-
Khan *et al.,* 1988	-	-	7.00	-	0.16	-	-	-	4.09
Kalra *et al.,* 1987	88.82-92.43	-	-	-	-	-		-	-
Kaur *et al.,* 1976	-	7.57-10.05	-	-	-	-	1.67-3.35	1.02-1.18	2.71-4.53
Gothwal *et al.,* 1998	87.50	-	-	-	-	-	-	-	7.50
Lingappa and Naik, 1999	87.00	-	-	-	-	-	-	-	-
Sharma *et al.,* 2009	-	-	-	6.22	0.148	-	3.39	-	-
Anand kumar *et al.,* 2008	-	6.96	7.30	-	-	-	-	-	6.96
Madan and Dhawan, 2005	91.25	-	7.48	6.26	0.14	-	2.20	3.52	5.72
Grewal and Jain, 1982	-	6.4	6.00	5.20	0.099	60.60	-	-	-
Pandey *et al.,* 2003	92.77	-	6.00	5.32	0.125	-	3.40	-	5.13
Sahota *et al.,* 2009	-	-	7.00-8.50	7.1-7.3	0.22-0.25	19.45-34.00	-	-	-
Vandresen *et al., al.,* (2009)	-	8.94	7.57	-	0.14	-	2.44	-	5.47
Zhou *et al.,* (2009)	-	-	4.3- 5.1	6.55 -6.74	-	-	-	-	-
Branco *et al.,* 2007	-	-	10.0	5.92	0.80	-	2.94	-	3.21
Tsukakoshi *et al.,* 2009	88.55-90.09	-	-	-	-	-	-	-	5.41-6.26
Gopalan *et al.,* 2004	86.00	-	-	-	-	-	-	-	-
ORANGE	-	-	-	-	-		-	-	-
Tanushree *et al.,* 2009	90.49	-	-	-	-	-	-	-	-
Gopalan *et al.,* 2004	87.6-97.7	-	-	-	-	-		-	-
Kaveri and Gupta, 2001	-	10.5	10.00	3.55	0.78	12.8	5.30	4.30	9.60
Ying *et al.,* 2008	-	-	8.7-10.8	3.81-4.31	5.12-7.0	-	-	-	-
Ladaniya *et al.,* 2004	-	-	11.40	4.03	0.22	51.81	-	-	-
Jain *et al.,* 1984	-	-	11.00	3.50	0.65	16.9	4.98	4.11	9.09
Beerh and Rane, 1983	-	-	8.40-10.20	4.00-4.20	0.80 -0.50	20.40	5.20 -5.40	-	8.00 -9.70
Shiv kumar *et al.,* 2006	-	-	10.80	3.53	0.34	31.76	3.76	5.20	8.96

suspended or dissolved in a process of liquid or slurry. The solid contents of food products are related to their food values. The greater the solid content (lower moisture content) of the fruits, the greater is its nutritional value **(Ikegwu and Ekwu, 2009).** The total solid content of different fruits and vegetables and honey are presented in Table 2.1(a), 2.1(b) and 2.1(c).

2.6.3 Total soluble solids (TSS)

Sweetness is normally referred as the total soluble content in °Brix. Fruit juice or pulp contains more sugar than any other soluble constituents and hence degree brix provides useful guide of soluble solids or sugar content **(Deka *et al.*, 2002).** The TSS content of different fruits and vegetables and honey are presented in Table 2.1(a), 2.1(b) and 2.1(c).

2.6.4 pH

pH is the equilibrium measure of hydrogen ion concentration in a juice. pH of juice can be very different at similar levels of titrable acidity depending on the amounts and proportion of acid. pH is an indirect measure of sweetness or sourness of fruit. It is of importance as a measure of the acidity which not only influences the flavor or palatability of a product but also affects the keeping quality and the processing requirement of a product **(Deka *et al.*, 2002).**. The pH content of different fruits and vegetables and honey are presented in Table 2.1(a), 2.1(b) and 2.1(c).

2.6.5 Titrable acidity

The acidity of fruit juices or pulp plays an important role in the preparation of beverages. In juice, titrable acidity is a quick snapshot of the major acids

Table 2.1 (b) Physico-chemical composition of orange, *aonla*, ginger and *lawki*

Investigator and year	Moisture	Total Solid	TSS	PH	TA	B:A	RS	NRS	TS
ORANGE	-	-	-	-	-	-	-	-	-
Goyle and Ojha, 1998	-	-	-	3.50	1.80	-	-	-	-
Tiwari *et al.,* 2009	-	-	9.60	3.41	0.68	14.11	-		
Supraditareporn and Pinthong, 2007	-	-	11.93 - 11.46	-	0.65-0.52	22.03	3.46-2.83	-	-
Ying *et al.,* 2008	-	-	8.7- 10.8	3.81- 4.31	-	-	-	-	-
AONLA									
Chaudhary *et al.,* 2003	86.93	13.07	9.00	2.90	2.18	-	2.36	0.74	3.10
Daisy and Gehlot, 2006	86.50-86.80	13.2-13.5	10.10-12.80	2.60-2.90	1.85-2.07	-	5.14-7.85	3.39-2.74	8.53-10.59
Mehta *et al.,* 2002	85.2-88.1	11.9-14.8	10.33-13.06	-	1.36-2.49	4.52-9.60	5.18-8.48		7.64-10.87
Premi *et al.,* 2002	80.98-87.17	12.83 – 19.02	8.76-10.56	2.50-2.82	2.75-3.35	-	-	-	-
Teotia *et al.,* 1968	-	-	9.00 -15.2	-	2.17-2.58	-	1.03-4.08		7.0- 9.6
Kalra *et al.,* 1988	-	-	12.0	-	2.03	-	3.20	-	5.0
Bhosle *et al.,* 2000	-	-	11.2	-	2.34	-	6.82	1.22	-
Garg *et al.,* 2008	-	-	10.2 -12.4	-	2.2-2.8	-	3.7-4.8	-	5.5-6.5
Throat *et al.,* 2007	-	-	15.2 -15.7	2.45-2.8	2.05-2.08	-	5.01-5.11	0.87-0.88	5.95-5.98
GINGER									
Tripathi and Nath, 2004	68.60	-	-	-	-	-	-	-	-
Singh *et al.,* 2005	-	-	2.67-3.17	-	0.09-0.14	-	-	-	-
Gopalan *et al.,* 2004	80.90	19.1		-	-	-	-	-	-
Krishnapulai , 2005	78.71	-	5.05	-	-	-	-	-	-
Odebunmi *et al.,* 2010	76.86	-		-	-	-	-	-	-
Phoungchandang & Sertwasana, 2010	82.64-93.37	-	-	-	-	-	-	-	
Policegoudra *et al.,* 2007	-	-	-	-	-	-	0.42	0.53	0.95
LAWKI				-					
Gopalan *et al.,* 2004	96.10	-	-	-	-	-	-	-	-
Sawate *et al.,* 2009	96.30	3.70	3.00	-	0.12	25.00	1.80	1.00	2.80
Babar *et al.,* 1998	96.50	3.50	3.50	-	-	43.66	1.20	1.80	3.00
Deore *et al.,* 2008	96.10	3.90	5.24	-	0.12	-	-	-	3.50
Kubde *et al.,* 2010	96.30	3.70	-	-	-	-	-	-	-
Siddique *et al.,* 1990	-	--	-	5.30	-	-	-	0.20	-

present. Fruits and vegetables contain acids like formic, succinic, citric, acetic, malic, fumaric, tartaric and benzoic acids. The acidity varies from fruit to fruit and also depends on its maturity. Titrable acidity and pH defines acid balance **(Deka *et al.*, 2002 and Ranganna, 2009).** The titrable acidity content of different fruits and vegetables and honey are presented in Table 2.1(a), 2.1(b) and 2.1(c).

2.6.6 Brix: acid ratio

Brix : acid ratio indicates the sweetness or sourness of the acceptable product which depends on fruit variety, type and maturity. Higher the ratio more is the sweetness and vice versa **(Deka *et al.*, 2002)**. The brix acid ratio of different fruits and vegetables and honey are presented in Table 2.1(a), 2.1(b) and 2.1(c).

2.6.7 Sugars

All fruits and vegetables contain both soluble and insoluble carbohydrates either in digestible form or in indigestible form. Soluble part is readily expressed in the juice while insoluble consisting primarily of the press residue. Sweetness results from the release of simple sugars like glucose, fructose from starch or other reserve carbohydrate and inter-conversion of released sugars. Juices contain both reducing and non-reducing sugar **(Deka *et al.*, 2002).** The reducing sugar, non-reducing sugar and total sugar of different fruits and vegetables and honey are presented in Table 2.1(a), 2.1(b) and 2.1(c).

2.6.8 Chlorophyll content

Fruits and vegetables contain various chemical compounds responsible for the wide range of colors in their raw and cooked condition. The chief pigment

Table 2.1 (c) Physico-chemical composition of *karela*, honey and aloe vera

Investigator and year	Moisture	Total Solid	TSS	PH	TA	RS	NRS	TS
***KARELA* (Bitter gourd)**								
Barwal *et al.*, 2006	-	-	3.00	-	0.056	2.50	-	2.80
Aggarwal and Kaur, 1997	.	.	3.50	.	0.21	-	-	-
Khattak *et al.*, 2005	-	-	-	-	0.083- 0.25	-	-	-
Kalra *et al.*, 1983	79.50-82.80	17.2-20.5	-	-	-	3.00-3.80	0.4-0.60	3.50-4.40
Chaudhary, 1979	83.20	-	-	.	-	-	-	-
Mathur 1955	92.40	-	-	-	-	.	.	.
Gopalan et al., 2004	83.20	16.80	-	-		-	-	-
Kulkarni *et al.*, 2005	88.42	11.58	.	.	0.083	3.45	0.30	3.75
Horax *et al., al., al.*, 2010	91.2-92.4	7.6-8.8	-	-	-	-	-	-
Hussain *et al.*, 2009	89.58	10.42	-	-	.	-	-	-
Dhillon *et al.*, 2005	82.77-94.60	5.4-14.08	.	.	-	2.12-2.96	0.88-1.87	2.74-5.03
HONEY			-	-	-	-	-	-
Nanda *et al., al., al.*, 2009	13.33-19.45	-	-	3.51-4.03	.	60.6-68.02	.	.
Terrab *et al.*, 2004	14.2–19.8	.	78.8–84	3.56–4.79	-	-	-	-
Gomes *et al.*, 2010	15.9-17.2	-	-	3.7-4.3	-	67.7-73.7	-	-
Kamal *et al.*, 2002	17.1-17.9	-	.	3.3-6.3	.	66.00-79.2	2.43-3.46	69.46-81.63
Ahmed *et al.*, 2007	-	76-88	-	3.8-5.0	-	-	-	-
Juszczak *et al.*, 2009	15.8 -18.10	-	-	3.79-3.99	-	-	.	.
Kucuk *et al.*, 2007	17.0-19.7	.	.	-	.	-	-	-
Nalda *et al.*, 2005	15.0-21.0	-	-	-	-	60.46-75.72	-	-
Downey *et al.*, 2005	15.6-20.6	-	-	3.75-4.61	-	-	.	.
Meda , 2005	15.1-21.9	.	.	3.50-4.60	.	70.9-84.7	-	-
Chefrour *et al.*, 2009	16.0-20.4	-	-	3.5-4.7	-	-	-	-
ALOE VERA			-	-	-	-	-	-
Gautam and Awasthi, 2007	97.2	-	.	.	.	0.24-0.76	0.24- 0.76	1.52
Pachanon , 2005	99.5	0.50	-	-	-	-	-	-
Wang and Strong, 1995	-	0.69	0.55-0.62	4.4-4.7	-	0.15-0.24	.	.
Miranda *et al.*, 2009	.	-	-	-	0.065	-	-	-
Hernandez *et al.*, 2006	-	-	-	-	0.08	-	-	-
Ganesh & Alagukannan, 2009	99.2-99.38	0.62-0.81	0.52-0.71	3.93-4.49	-	0.099-0.15	-	.

includes chlorophyll (Chlorophyll-a and Chlorophyll-b) which is a green photosynthetic pigment that enables green plants to convert carbon dioxide and water into food. The chlorophyll molecule is remarkably similar to hemoglobin in human blood. Except that hemoglobin has an iron element in the center of the structure and chlorophyll has a magnesium element. Chlorophyll has been shown to have antiseptic properties and can build up red blood cells. Taken consistently in sufficient amounts, chlorophyll induces the powerful remedial effects like increases blood count, detoxifies and cleanses body system, alleviates blood sugar problems, reduces or eliminates body odors, relieves gastric ulcers, greatly relieves respiratory troubles like asthma and sinuses, kills bacteria in wounds and speeds up healing, reduces inflammation pain, improves bowel functions, improves milk production in lactating mothers and soothes painful hemorrhoids **(http://www.juicing-for-health.com/fruit-juicing.html).**

Deore *et al,* (2008) reported 5.60 mg/100g Chlorophyll in bottle gourd. *Aonla* leaves contain 0.5 mg/g of total chlorophyll (**Selvi *et al.,* 2007)** while cucumber contains 3.6 mg/100g chlorophyll-a **(Bohn *et al.,* 2004). Aggarwal and Kaur (1997)** reported 243.35 mg/100g total chlorophyll in bitter gourd while chlorophyll-a and chlorophyll-b content (mg/100g) of bitter gourd as 168.75 and 74.60 respectively.

2.6.9 Free acidity, lactonic acid and total acidity

Acidity in honey is calculated as free, lactonic and total acidity. Free acidity is due to the presence of organic acids, particularly gluconic acid, which is in equilibrium with the corresponding lactones and some inorganic ions such as

Table 2.2 Free acidity, lactonic acid and total acidity of honey

Investigator	Free acidity (meq/kg)	Lactonic acid (meq/kg)	Total acidity (meq/kg)
Nanda *et al.,* 2009	14.67-23.76	-	-
Terrab *et al.,* 2004	17.59-39.81	4.3-11.3	25.6-48.6
Chefrour *et al.,* 2009	7.25-63.5	3.0-39.98	10.25-87.46
Gomes *et al.,* 2010	-	-	16.0-32.0
Downey *et al.,* 2005	17.1–50.9	0.2–14.9	21.2–55.9
Meda *et al.,* 2005	25.4-59.0	-	-
Juszczak *et al.,* 2009	15.5-30.5	-	-
Nalda *et al.,* 2005	12.65-32.50	-	-
Kamal *et al.,* 2002	5.83-21.06	0.83-1.87	6.73-22.93
Kucuk *et al.,* 2007	-	-	29.4 to 36.7

phosphate or sulphate. Gluconic acid is the principal acid in honey produced by the action of the glucose oxidase enzyme present in the nectar and work on the glucose units. Gluconic acid also assists in preserving the nectar from spoilage. Lactonic acidity is considered as the acidity reserve when the honey becomes alkaline while total acidity is the sum of free and lactonic acidities. Variation in total acidity has been attributed to harvest season. Honey also contains acetic, butyric, lactic, pyroglutamic, citric, succinic, formic, maleic, malic, and oxalic acids **(Downey *et al.,* 2005; Chefrour *et al.,* 2009 and Gomes *et al.,* 2010)**. Free acidity, lactonic acid and total acidity of honey is presented in Table 2.2.

2.7 Nutritional composition of juices

2.7.1 Ascorbic acid

Ascorbic acid is an important nutrient which is not only a natural antioxidant but it has a medicinal value too. The ascorbic acid content of different fruits, vegetables, aloe vera and honey are presented in Table 2.3.

2.7.2 Beta carotene

More than 650 carotenoids have been described and isolated from natural sources, however, only about 60 are regularly present in the human diet, and about 20 carotenoids can be detected in human plasma and tissues **(During and Harrison, 2004).** The most abundant being β-carotene, lutein, lycopene, α-carotene, β-cryptoxanthin and zeaxanthin **(Khachilk *et al.,* 1992).** Beta carotene is an important antioxidant and also the precursor of vitamin A. Table 2.3 shows beta carotene content of different fruits and vegetables, aloe vera and honey.

Table 2.3 Ascorbic acid and beta carotene content of carrot, orange, *aonla*, ginger, lawki, karela, honey and aloe vera

Investigator	Vitamin C	Beta Carotene	Investigator	Vitamin C
CARROT	-	-	**GINGER**	
Gothwal et al 1998	9.50	-	Tripathi and Nath, 2004	3.10
Gopalan *et al.,* 2004	-	1.890	Singh *et al.,* 2005	2.83-5.11
Sharma *et al.,* 2009	5.68	3.408	Gopalan *et al.,* 1997	6.0
Anandkumar *et al.,* 2008	-	6.82	***LAWKI* (Bottle gourd)**	
Gębczyński, P. (2006)	8.90	-	Sawate *et al.,* 2009	12.50
Khan *et al.,* 1988	4.68	-	Babar *et al.,* 1998	14.00
Tsukakoshi *et al.,* 2009	-	5.97 -6.29	Deore *et al.,* 2008	12.42
Sethi and Anand, 1983	-	11.88	Rahman *et al.,* 2008	6.00
Lingappa and Naik, 1997	3.00	13.6	Okiei, *et al.,* 2009	12.40 -8.70
Pandey *et al.,* (2003)	1.83	-	**KARELA (Bitter gourd)**	
Grewal and Jain, 1982	1.81	4.27	Barwal *et al.,* 2006	88.40
ORANGE	-	-	Khattak *et al.,* 2005	15.19
Beerh and Rane, 1983	30.0-25.5	-	Kalra *et al.,* 1983	92.00-175.50
Tiwari *et al.,* 2009	46.62	-	Chaudhary, 1979	88.00
Shiv kumar *et al.,* 2006	27.56	-	Mathur 1955	88.00
Jain *et al.,* 1984	26.04	-	**HONEY**	
USDA, NDB-09206	-	0.33	Castro *et al.,* 2001	3.91
Mehta and Bajaj, 1983	-	2.13	Griebel *et al.,* 1938	1.60-208.0
Supraditareporn and Pinthong, 2007	25.33 -28.23	1.98-4.27	Kask *et al.,* 1938	4.88
AONLA			Werder and Anterer, 1938	1.1 -14.6
Teotia *et al.,* 1968	645-665	-	Becker and Kardos, 1938	31-89
Kalra *et al.,* 1998	237	-	Gribel and Hess, 1939	7.36-311.2
Bhosle *et al.,* 2000	492	-	**ALOE VERA**	
Garg *et al.,* 2008	494-585	-	Ross , 2005	0.63
Throat *et al.,* 2007	668.88-680	-	Gautam and Awasthi, 2007	0.87-27.0
Chaudhary *et al.,* 2003	420	-		
Daisy and Gehlot, 2006	629-662	-		
Mehta *et al.,* 2002	408.53-583.32	-		
Premi *et al.,* 2002	660			

2.8 Mineral composition of juices and honey

Mineral elements serve as structural components of tissues and as constituents of the body fluids and vital enzymes in major metabolic pathways and are essential for the function of all cells. Each element has their individual role in the structural and functional integrity of the living cells and organisms. The role of inorganic elements like zinc, iron, copper and manganese in the improvement of impaired glucose tolerance and their indirect role in management of diabetes mellitus are being increasingly recognized. Minerals are not particularly present in high amount in fruits. They are poor source of iron however sulphur, phosphorus and to certain extent, calcium found in good amount. While in case of vegetables, calcium and iron are present in significant amounts especially in green leafy vegetables. Sodium, potassium, copper, iron, manganese, zinc and calcium content of various fruits and vegetables, aloe vera and honey are presented in Table 2.4 (a) and Table 2.4 (b).

2.8.1 Sodium (Na) and Potassium (K)

Sodium and Potassium ions play an important role in the disease related to renal disorder. Normal potassium concentration is necessary for optimal insulin secretion. Deficiencies arise in abnormal conditions such a diabetic acidosis. Potassium depletion can result in reduced glucose tolerance **(Rajendran *et al.*, 2007).**

2.8.2 Copper

The primary function of copper in the body is to serve as constituents of many biologically important enzymes, thus enzymes, which contain copper in the active site, catalyze the oxidation of ferrous iron to ferric iron. Copper is required

Table 2.4 (a) Mineral composition of carrot, orange, *aonla* and ginger

Investigator	Sodium	Potassium	Copper	Iron	Manganese	Zinc	Calcium
CARROT							
Koca and Karadeniz, 2008			-	-	-	-	62.20
Kaur *et al.,* 1976			0.09-0.11	2.39-3.11	0.26-0.35	0.25-0.28	55.94-72.86
Gothwal *et al.,* al 1998				13.50			19.5
Gopalan *et al.,* 2004	35.6	108.0	0.10	1.03	0.16	0.36	80.00
USDA, NDB-11124	69.09	320.0	0.047		0.15		32.72
Singh *et al.,* 2001				1.9	1.8	2.2	1.0
Bergqvist *et al.,* 2005				3.5	0.8	1.5	0.4
Hanif *et al.,* 2006	32.0	102.0		1.40			39.0
ORANGE							
Gopalan *et al.,* 2004	4.50	9.30	0.58	0.32		-	26.00
Ying *et al.,* 2008	0.24-1.28	123.37-156.58	0.019-0.078	0.068- 0.009	0.17	0.005-0.08	2.046-12.53
Simpkins , 2000	0.058-7.1	77.7-234.5	0.004-0.084	0.002-0.18	0.01- 0.047	0.012-0.068	3.5-16
USDA, NDB-09206	1.16	200	0.044	0.19	0.013	0.046	10.46
AONLA							
Gopalan *et al.,* 1996	5.0	225.00		1.2			50.00
Chaudhary *et al.,* 2003							20.00
Mehta *et al.,* 2002							
Premi *et al.,* 2002	19.05-25.68	179.76 –243.84					14.24-16.76
Misra *et al.,* 2009				49.26–88.03			
Shukla and Kumar, 2009				1.2			12-50
Khan , 2009				1.2			
GINGER							
Vasala , 2003	30	1400	-	11.3	-	-	0.1
Gopalan *et al.,* 2004	-	-	0.74	3.5	5.56	1.93	20.0
Obiajunwa *et al.,* al., 2002		0.183	9.49	121.92	36.79	4.38	
Kara , 2009	10.30	880.80	0.40	8.68	12.70	1.32	94.40
Hussain *et al.,* al., 2009	0.933		3.68	5.18		5.44	1.196
Bhowmik *et al.,* al., 2008	17.00	563.00	0.50	-	78.03	5.62	0.04
USDA, NDB-11216	13.00	415.0	0.23	0.60	0.229	0.34	16.0

for absorption and transport of iron, and it plays a key role in hemoglobin synthesis. High plasma copper concentrations are found in people with diabetes mellitus. Enzymes that do not contain a trace element as an integral part but are activated by metals such as copper **(Rajendran *et al.*, 2007).**

2.8.3 Iron

Iron has several vital functions in the body, which mainly involved in oxidation-reduction reactions (ETC), hemoglobin-oxygen transport and also a co-factor for numerous other enzymes. Studies in experimental animals have clearly shown that iron deficiency has several negative effects on important functions of the body. However, excessive intake of iron may cause tissue damage, especially in liver. High dietary iron can inhibit Zn absorption, while iron and zinc added to a meal seems not to affect zinc absorption **(Rajendran *et al.*, 2007).**

2.8.4 Manganese

Manganese cannot be stored, but function as a key constituent of metallo-enzymes activator. In experimental animals, pancreatectomy and diabetes have been correlated with decreased manganese levels in blood. Further, manganese supplements have reversed the impaired glucose utilization induced by manganese deficiency in guinea pigs. Manganese may act like insulin in increasing the transport of glucose into adipose tissue either by enhancing an existing low level of insulin. Manganese requirement are low, and many plant foods contain significant amounts of this trace mineral deficiencies are therefore unlikely **(Rajendran *et al.*, 2007).**

Table 2.4 (b) Mineral composition of *lawki, karela,* honey and aloe vera

Investigator	Sodium	Potassium	Copper	Iron	Manganese	Zinc	Calcium
***LAWKI* (Bottle gourd)**							
Sawate *et al.,* 2009	-	86.00	-	0.80	-	-	-
Rahman *et al.,* 2008	1.8	87	0.03	0.7	-	-	120
Gopalan *et al.,* 2004	1.8	87.0	0.03	0.46	0.06	0.22	20.0
Kou 2002	-	-	-	0.30	-	-	7.0
Jansen *et al.,* 1990	1.0	63.0	0.03	0.1	0.1	0.20	16.0
Kubde *et al.,* 2010	1.1	86.0	-	0.7	-	-	-
***KARELA* (Bitter gourd)**			-	-	-	-	-
Sethi *et al.,* 2003	-	161.5	0. 95	1.30	0.08	0.43	21.5
Chaudhary, 1979	.	-	-	9.40	-	-	50.00
Mathur 1955	-	.	-	1.80	-	-	20.00
Kosanovic *et al., al.,* 2009		-	79.03	-	0.25	0.50	3.90
Hussain *et al.,* 2009 ppm	4.54	-	1.40	13.9	-	72.4	1.60
Gopalan *et al.,*2004	2.4-17.8	-	0.09-0.10	0.61- 2.00	0.08	0.39-0.46	20-23
Horax *et al.,* 2010	15.8-26.4	3240-5750	1.6-1.3	5.5– 4.5	3.1-3.2	5.7-4.1	5.5– 4.5
HONEY							
Nanda *et al.,* 2009	11.2.6-30.13	35.95-82.19	0.129-0.276	0.689-1.892	-	0.474-1.764	3.229-4.306
Ku¨c¸u¨k *et al.,* 2007	7.3-16.3	50.0-381.8	0.009-0.042	0.17 -0.264	0.059-0 .969	0.054- 0.068	16.0-90.0
Terrab *et al.,* al., 2004	30.7–50.1	26.1–138.0	-	-	-	-	11.0–24.8
Chudzinska *et al.,* 2010	0.421	314.0	0.166	.	0.487	1.998	4.118
Joseph *et al.,* 2007	0.62	20.0	0.02	-	0.03	-	22.68
Juszczak *et al.,* 2009	3.79-6.65	5.16-131.35	0.016-0.073	-	0.053-0.698	0.12-1.20	4.53-12.80
Madejczyk *et al., al.,* 2008	0.038-8.96	0.77 -365.9	0.026- 0.182	0.11-1.61	-	0.028-0.993	0.33-8.25
Hernandez *et al., al.,* 2005	0.942- 25.8	21.4- 316.6	0.010 -0.173	0.040-5.251	.	0.018 -1.91	2.07- 19.3
ALOE VERA					-	-	
Jahan *et al.,* 2008	66.53- 277.80	68-278	-	-	-	0.01-0.04	26.60- 74.4
Bouchey and Gjerstad,1969	1.45	-	-	.	0.0122	-	-
NASC, 1982	30	-	.	-	-	31	30
Wang and Strong, 1995	18.7	37.8	-	0.015	-	-	-
Henry, 1979	5.1		-	0.39	0.059	0.10	46
Rajasekaran *et al.,* 2005	8.1	19.85	.	-	31.55	-	-
Rajendran *et al.,* 2007	-	-	-	0.018-0.012	0.00069	-	.
Smita and Awasthi, 2007	.	.	0.025-0.81	2.1	-	0.07	-
Pachanon 2005	-	-	-	-	163.8-165.5	-	-

2.8.5 Zinc

Zinc is versatile, which has been well known to be an important trace element in diabetes as a cofactor for insulin. Abnormal zinc metabolism has been suggested to play a role in the pathogenesis of diabetes and /or its complications. Patients with diabetes mellitus tend to have low serum zinc and increased urinary excretion. Zinc has numerous targets to modulate insulin activity, including its antioxidant capacity. Zinc enhances the effectiveness of insulin **(Rajendran *et al.*, 2007).**

2.8.6 Calcium

Vegetables contain significant amount of calcium. In human body they are important constituents of bones and teeth. Calcium plays an important role in maintaining quality and reducing physiological disorders that cause wastage in fruits and vegetables during storage.

2.9 Microbial status and shelf life of juices

Micro-organisms use food material for their own growth. They utilize more nutrients and cause enzymatic changes, contributing off flavour by breakdown or synthesis of new compounds spoiling the food. These organisms are either present in fruit or get incorporated into the product during processing and multiply tremendously during storage, if proper care and treatments are not taken. Absence of pathogens, chemicals and extraneous matter defines safety of juices while low microbial load is associated with quality and shelf life of juices.

The microbial specification allows less than 5000 bacteria/ml for a commercial single strength orange juice **(Kimball, 1991).** According to **IS:**

5401(1969), the permissible limit for Coliform in juices is $<10^2$ cfu / ml while the permissible limit for TPC of juices is $<10^5$ cfu/ml **(IS: 5402, 1969).** The permissible standards for yeast and mold count in juices is $<10^5$ cfu / ml **(Frazier, 1967).**

Total plate counts (cfu/ml) of fresh squeezed orange juice were found to be 5.4×10^3 while total yeast and mold counts (cfu/ml) were 2.8×10^3 **(Jia *et al.,* 1999).** The initial populations of viable aerobic bacteria, and yeast and moulds in Valencia orange juice were 7.8 and 4.8×10^1 cfu/ml, respectively. The high initial microbial populations of the untreated Valencia juice limited the shelf-life of untreated juice stored at 4° C to 2 weeks and juice stored at 10^{0} C to 7 days. Similarly the initial populations of viable aerobic bacteria, and yeast and moulds in Navel orange juice were 4.5 and 3.1×10^1 cfu/ml, respectively, thus untreated juice stored at 4^{0} C was found to be microbiologically acceptable for 14 days and juice stored at 10° C for 7 days **(Michelle *et al.,* 2004).**

Halls and Hicks (1977) reported that carrot juices stored at 20, 25, 30, 35° C for 0, 2, 4, or 8 days had higher bacterial count in juice stored for longer period and at high temperature. Fresh carrot juice, not thermally treated, should generally be consumed within 1–2 days **(Nguyenthe and Carlin, 1994).** Carrot juice is a low-acid food of approximately pH 6.0; it has a higher risk of bacterial contamination than other acidic foods **(Park *et al.,* 2002).** The populations of the total plate counts observed by **Hsieh and Ko (2008)** in the carrot juice were about 3.4×10^3.

Nagpal and Rajalakshmi (2009) showed increase in microbial load of RTS beverages on 60 days storage. **Pandey *et al.* (2003)** reported the TPC of

carrot juice (1.5×10^1 to1.7×10^5) kept at ambient temperature is higher than the carrot juice kept at refrigeration temperature (1.5×10^1 to 2.6×10^4) during 90 days storage period. **Pandey *et al,* (2003)** further reported that carrot juice kept at ambient temperature had higher TPC (2.7×10^3) than juice kept at refrigeration temperature (3.0×10^2) after 45 days of storage. They further reported increase in YMC from 0 to 29.0 cfu/ml and from 0 to 21.0 cfu/ml in carrot juice stored at ambient and refrigeration temperature for 90 days.

Fresh orange juice has a limited shelf-life (12–14 days at 4 °C). Although acid concentration and the low pH of fruit juices may be antagonistic towards most pathogenic bacteria **(Fernandez *et al.,* 2001).** The natural acid also helps to preserve the juice's natural colour and essential nutrients. **Ladaniya *et al,* (2004)** also reported higher YMC in orange juice kept at ambient temperature than at refrigerated temperature for 180 days. **Goyal and Ojha (1998)** reported increase in TPC (cfu / ml) of orange juice with time kept at refrigerated temperature for 4 weeks. Extract of ginger alone or in combination with low temperature storage (refrigeration) extended the shelf life of beverage for a minimum of 6 weeks and contributed to the overall quality and acceptability **(Ogiehor *et al.,* 2008).**

2.10 Diabetes mellitus

Diabetes mellitus was first identified as a disease associated with "sweet urine," and excessive muscle loss in the ancient world. Diabetes is a plurimetabolic disease characterized by chronic hyperglycaemia and glycosuria with disturbances of carbohydrate, fat and protein metabolism resulting from defects in structure of insulin, or its receptor, insulin secretion, insulin action, or

both due to dysfunction of pancreatic beta cells and insulin resistance **(WHO 1999; Pawar, 1999; Giacco *et al.,* 2002 and Khan and Safdar, 2003;).** The effects of diabetes mellitus include long–term damage, dysfunction and failure of various organs especially the kidneys, eyes, nerves, heart and blood vessels. It is a complex metabolic disorder in which the control of blood glucose is of paramount importance and is characterized by glucose overproduction and underutilization **(De Fronzo *et al.,* 1992; Lilloja *et al.,* 1993; Jacqueline *et al.,* 2006 and Canadian Diabetes Association, 2008).**

2.10.1 Global scenario of diabetes mellitus

The incidence of diabetes mellitus is on an increase both in the developed and developing countries. Growing westernization, adoption of obesogenic life style, diet and genetic susceptibility may contribute to alarming increase in prevalence of diabetes mellitus. The prevalence of diabetes for all age-groups worldwide was estimated to be 2.8% in 2000 and 4.4% in 2030. The total number of people with diabetes is projected to rise from 171 million in 2000 to 366 million in 2030. By 2030, it is estimated that the number of people with diabetes >64 years of age will be >82 million in developing countries and >48 million in developed countries **(Wild *et al.,* 2004).**

Diabetes not only afflicts prosperous nations, but often reaches its highest frequency in poor and disadvantaged communities that can least afford the heavy burden of the treatment and long term complications **(Hannan *et al.,* 2007).** There is growing evidence that Asian Indians, i.e. persons originating from the Indian subcontinent, are at uniquely heightened risk of type 2 diabetes when compared to

other populations (**Abate and Chandalia, 2007**). **Cameron *et al.* (2003)** estimated that 7% of Australian women and 8% of Australian men had diabetes. The impact of diabetes is also observed in Canada, where 1.8 million adult Canadians, 5.5% of the population, had diagnosed diabetes in 2005 **(National Diabetes Fact Sheet; Canada 2007).** Researchers projected an increase of diagnosed diabetes in Canada to 2.4 million by the year 2016 **(Ohinmaa *et al.*, 2004).**

2.10.2 Indian scenario of diabetes mellitus

India leads the world with the largest number of diabetic subjects earning the dubious distinction of being termed as the "diabetes capital of the world". According to the Diabetes Atlas 2006 the number of people with diabetes in India is currently around 40.9 million and is expected to rise to 69.9 million by 2025. There was a large pool of subjects with impaired glucose tolerance and 14 per cent with risk of conversion to diabetes. This could have lasting adverse effect on nation's health and economy **(Ramchandran *et al.*, 2001 and Mohan *et al.*, 2007).**

Diabetes epidemic is more pronounced in India than anywhere else as the World Health Organization (WHO) reports show that 31.7 million Indian people had diabetes in the year 2000 and is expected to be 79.4 million by the year 2030 **(Wild *et al.*, 2004).** Diabetes is rapidly emerging as a major health care problem in India, especially in urban areas **(Kapur, 2007).** Under National Urban Diabetes Survey (NUDS), conducted in six metropolitan cities across India reported that the age standardized prevalence of type–II diabetes was 12.1 per cent. The annual report of International Diabetic Federation on 2 Nov 2009 projected 58.7 million diabetes cases in India by 2010 and 435 million people worldwide by 2030.

2.10.3 Values for diagnosis of diabetes mellitus and other categories of hyperglycaemia (WHO, 1999)

The diagnostic criteria developed by WHO and the American Diabetes Association (ADA) are currently the most frequently used standards for identifying diabetes among populations.

Diabetes Mellitus	Impaired Fasting Glucose	Impaired Glucose Tolerance
Fasting plasma glucose of ≥7.0 mmol/L (126 mg/dL) or 2 hour post 75g glucose load* of≥11.1 (200 mg/dL)	Fasting plasma glucose of 6.1-7.0 mmol/L (110 mg/ dL-126 mg/dL)	Fasting Glucose of ≤ 7.0 mmol/L (126 mg/dL)
OR	OR	AND
Whole blood glucose of ≥6.1 mmol/L (110 mg/dL) or ≥10.0 mmol/L (180 mg/dL) 2 hours after 75g glucose load	Whole blood glucose of 5.6 mmol/L (100 mg/dL)-6.1 mg/dL (110 mg/dL)	Plasma and whole blood glucose of ≥ 7.8 mmol/L (≥ 140 mg/dL) 2 hours post glucose load of 75 g but < 11.1 mmol/L (200mg/dL)

2.10.4 Therapeutic role of fruits and vegetables juice in Diabetes Mellitus

The biological mechanisms responsible for the beneficial effects of fruits and vegetables on diabetes risk are likely to be multiple. Fruit and vegetable consumption may play a protective role in the development of type 2 diabetes. Besides their contribution to low energy intake, high fiber content and low glycemic load, fruits and vegetables are also rich in antioxidant vitamins, magnesium, potassium, plant proteins, and other individual phytochemicals, which could be beneficial in reducing risk of type 2 diabetes **(Bazzano *et al.*, 2003). Bolton *et al.* (1981)** studied the effect of dietary fiber of fruit and fruit juice in satiety, glucose, and insulin. With oranges, there was a smaller insulin response to fruit than to juice and less post absorptive fall in plasma glucose.

With grapes, the insulin response to the whole fruit was more than that of juice while post absorptive glucose values were similar. The glucose in grapes appeared to be more insulinogenic than that in oranges. Conversely, grape juice evoked less insulin than expected, possibly because its high osmolarity delayed gastric emptying. However, diluting it did not increase its insulinogenicity. Thus, they showed that the plasma insulin and glucose responses to fruit appear to depend on the fiber as well as the glucose content of the fruit.

Cheng and Yang (1983) suggested that guava juice may be employed to improve and/or prevent the disease of diabetes mellitus. Study done by **Upritchard *et al.* (2000)** indicated that consumption of commercial tomato juice (500ml/day) can increase plasma lycopene levels and the effect on intrinsic resistance of LDL to oxidation was similar to high dose of vitamin E supplementation (800U/d). **Asgard *et al.* (2007)** showed positive relation of high intake of fruit and vegetables to low oxidative stress and inflammation in 54 patients with type 2 diabetes and supported the usefulness of plasma alpha-carotene and beta-carotene. **Wilson *et al.* (2008)** suggested that the consumption of a low-calorie cranberry juice is associated with glycemic response and may be beneficial for persons with impaired glucose tolerance.

2.10.4.1 Therapeutic role of *karela* (bitter gourd) and its juice

Bitter gourd, bitter melon, balsam pear or *karela* botanically known as *Momordica charantia* is a tropical and subtropical vine of the family Cucurbitaceae which is most bitter among fruits, widely grown around the world and frequently used as a food stuff and medicinal plant.

2.10.4.1.1 Anti-hyperglycemic activity

Extracts from various parts of plants possess hypoglycaemic activity and is extensively used as an alternative medicine in the treatment of diabetes mellitus**. Leatherdale *et al.* (1981)** showed that karela improves glucose tolerance in diabetes. The effect was most pronounced with raw juice, but a small improvement occurred with fried karela. **Ahmed *et al.* (1998)** suggested that oral feeding of *Karela* fruit juice may have a role in the renewal of beta cells in STZ-diabetic rats or alternately may permit the recovery of partially destroyed beta cells. Extract feeding at the level of 25mg, 50mg and 75 mg showed marked improvement in the activity if islets of Langerhans **(Singh *et al.*, 2008).**

Among thirty most popular anti-diabetic Indian herbs, K*arela* was found to be the most potent. It reduced the initial blood glucose reading of 244 mg/dl to 119 mg/dl after a single dose of 250 mg/kg dry ethanol extract for two weeks **(Kar *et al.*, 2003).** Water extracts of bitter melon fruits has higher hypoglycemic and antihyperglycemic potential and may be used as complementary medicine to treat the diabetic population by significantly reducing dose of standard drugs **(Yadav *et al.*, 2010).** Decoction of dried fruit and dried powder fruit taken orally by the human adult show the antihyperglycemic activity **(Potawale, 2008).** Similarly **Welihinda *et al.* (1986)** demonstrated that bitter gourd act like insulin or promote insulin release and showed improvement in glucose tolerance in eighteen type- 2 diabetics who were given 100 ml bitter gourd juice 30 minutes prior to a glucose load.

Dried fruit powder (5 g three times daily) given to diabetics showed an average 25 per cent drop in blood sugar while aqueous extract containing 100 g

fruit per 100 ml of water brought an average 54 per cent drop in blood sugar at the end of the three-week trial **(Srivastava *et al.,* 1993).** The oral administration of 50-60 ml of the juice has shown good results in clinical trials **(Kumar *et al.,* 2010).**

Bitter gourd/Karela extracts increase glucose utilization by the liver, decrease gluconeogenesis via inhibition of two key enzymes (glucose-6-phosphatase and fructose-1,6-bisphosphatase), and improve glucose oxidation by activating glucose-6-phosphate dehydrogenase. Extracts of bitter gourd enhance cellular uptake of glucose, increase the levels of glucose transporters, stimulate glucose uptake in skeletal muscle cells, promote insulin release, potentiate its effect and preserve the structure , function as well as promote new growth of insulin-secreting beta cells in the pancreas of diabetic animals **(Shibib *et al.,* 1993 and Bastaki, 2005)**

2.10.4.1.2 Anti-hyperlipidemic activity

Experimental studies carried out in normal as well as diabetic animals have shown hypo-cholesterolemic effect by bitter gourd **(Singh *et al.,* 1989; Anila and Vijayalakshmi, 2000; Noguchi *et al.,* 2001**). Feeding freeze-dried powdered bitter melon fruit for 14 days to rats on either a cholesterol-free, or a cholesterol-enriched diet, caused an elevation of serum HDL-cholesterol and a consistent reduction of hepatic triglycerides and total cholesterol concentrations in both control and test group **(Jayasooriya *et al.,* 2000).**

Decrease in triglycerides and LDL cholesterol and increases in HDL cholesterol due to bitter gourd consumption were noted in animal studies

(Ahmed *et al.,* 2001; Chaturvedi *et al.,* 2004; Senanayake *et al.,* 2004; Chaturvedi *et al.,* 2005 and Chen *et al.,* 2005). Bitter gourd reduces liver secretion of *apolipoprotein B (Apo B)*-the primary lipoprotein of low-density "bad" cholesterol ; reduce apolipoprotein C- III expression, the protein found in very-low density cholesterol which turns into LDL/bad cholesterol; and increases the expression of *apo lipoprotein A-1 (ApoA1)*-the major protein component of high density "good" cholesterol. It also lowers cellular triglyceride content **(Kumar *et al.,* 2010).** The triglyceride levels in the diabetic rats was reduced with the water extract of bitter melon by 69% **(Virdi *et al.,* 2003).**

2.10.4.1.3 Anti-microbial activity

Fresh fruit extracts of *Momordica charantia* have anti-bacterial activity against tuberculosis and the stomach ulcer causing bacteria *Helicobacter pylori* **(Hussain and Deeni 1991; Omoregbe *et al.,* 1996; Yesilada *et al.,* 1999). Jagessar *et al.,* (2008)** suggested use of the ethanol extracts of *Momordica Charantia (Karela)* in the control of *E.coli* and *S.aureus* induced diseases as herbal medicines. **Knoch, (2007)** reported that extracts of bitter gourd inhibit the growth of numerous gram-negative and gram-positive bacteria, including *E. coli*, *Salmonella, Shigella dysenteriae*, Staphylococcus, Pseudomonas, Streptobacillus, Streptococcus and parasitic organisms *E. histolytica* and *Plasmodium falciparum*. **Taylor *et al.*(2002)** reported antiprotozoal activity of an extract of the entire plant against *Entamoeba histolytica.* Bitter gourd fruit extracts showed higher antimicrobial activity than leaf extract against *Pseudomonas aeruginosa, Escherichia coli, Candida albicans, Staphylococcus aureus*, *Klebsiella pneumoniae* and *Salmonella typhi* **(Mwambete, 2009).**

2.10.4.2 Anti-hyperlipidemic and anti-hyperglycemic activity of *lawki* (bottle gourd) and its juice

Lagenaria siceraria , a common vegetable known as bottle gourd or *lauki or ghia* or calabash belonging to family cucurbitaceae, is one of the oldest cultivated plants and occupies an important position among summer vegetables. Bottle gourd fruit is traditionally known for its cardioprotective, cardiotonic and general tonic. *Lauki, dudhi* or bottle gourd holds pride of place in the Indian Ayurvedic medical system. Gourd juice helps manage blood pressure in patients of hypertension, because of its high potassium content. It helps in losing weight quickly because of low in calories, fat and cholesterol but provides high dietary fiber **(Deshpande *et al.*, 2008 and http://www.indiamart.com/healthconcept/healthy-juices.html#bottle-gourd-juice).**

The fruit pulp has anti-hepato toxic activity and hypolipidimic activity. The fruit juice have analgesic and anti inflammatory activity. Ethanolic extract of epicarp and fresh juice has anti oxidant activity. These properties of bottle gourd fruit have been attributed to its saponins, carbohydrates and flavonoids (**Shah and Sethi, 2010 and Kudbe *et al.,* 2010).** Cardio vascular disease is claimed to be relieved following regular intake of bottle gourd juice for about 4-6 months **(Deshpande *et al.,* 2008).** The study by **Mohale *et al.* (2008)** exhibited that elevated level of blood cholesterol, triglycerides, LDL are reduced and decreased HDL was increased by the administration of constituents of *Lagenaria siceraria* fruit juice.

Bottle gourd given as a decoction or pills at a dose of 3 g/day has been shown to reduce blood glucose levels **(Keji, 1981). Saoji *et al.* (2009)** and **Ghule**

***et al.* (2006)** showed that extract of bottle gourd fed to rats brought reduction in total cholesterol, LDL cholesterol, triglyceride, VLDL cholesterol and increment in HDL cholesterol levels. **Deshpande *et al,* (2008)** reported that administration of ethanolic extract of bottle gourd at the rate of 100 and 200 mg/kg to hyperglycemic rats showed anti-hyperglycemic and anti-hyperlipidemic effect.

2.11 Hypertension

Hypertension or high blood pressure is a condition in which the blood pressure in the arteries is chronically elevated. The World Health Organization has estimated that high blood pressure causes one in every eight deaths world wide making hypertension the third leading silent killer in the world **(Srilakshmi, 2007).**

2.11.1 Global scenario of hypertension

High blood pressure is an important modifiable risk factor for cardiovascular and renal disease in Western **(Chockalingam *et al.,* 2006; Cheung *et al.,* 2006 and Primatesta *et al.,* 2003)** and Asian populations **(Gu *et al.,* 2002 and Choi *et al.,* 2006).** Hypertension is ranked third as a cause of disability adjusted life-years **(Ezzati *et al.,* 2002).** It is a risk factor for myocardial infarction, stroke, congestive heart failure, end-stage renal disease, and peripheral vascular disease **(Ishizaka *et al.,* 2005).** In China 129 million people aged 35-74 yr has hypertension. The prevalence and absolute numbers of individuals with hypertension have increased dramatically during the past several decades **(Reynolds *et al.,* 2003 and Wu *et al.,* 1995).** Existing data suggests that the prevalence of hypertension has remained stable or has decreased in economically developed countries during the past decade, while it has increased in developing

countries **(Kearney *et al.*, 2004). Kearney *et al.* (2005)** further reported that overall, 26.4% of the adult population in 2000 had hypertension (26·6% of men and 26·1% of women), and 29·2% were projected to have this condition by 2025 (29·0% of men and 29·5% of). The estimated total number of adults with hypertension in 2000 was 972 million, 333 million in economically developed countries and 639 million in economically developing countries. This would like to increase 413 million (24%) and 1·15 billion (80%) in 2050 for both countries respectively. The number of adults with hypertension in 2025 was predicted to increase by about 60% to a total of 1·56 billion (1·54–1·58 billion).

2.11.2 Indian scenario of hypertension

India is on the verge of becoming the "heart disease capital of the world". The average prevalence of hypertension in India is 25% in Urban and 10% in rural population. Hypertension is a significant public health problem in urban and rural areas of India. It is directly responsible for 57% of all stroke deaths and 42% of coronary heart disease death in India. It is also a leading cause of blindness, renal failure and congestive heart failure **(Anonymous, 1993 and Gupta *et al.*, 2004).** In India, 60.4 millions male and 57.8 millions female were found to be hypertensive in 2000 which was estimated to increase 107.3 millions and 106.2 millions for males and females respectively by the year 2050. According to Indian Hypertension Guidelines-II the prevalence of primary hypertension and secondary hypertension is approximately 93-95% and 4-5% of all hypertensive respectively. **Kearney *et al,* (2005)** reported 20.6% and 20.9% prevalence of hypertension in Indian males and females respectively in 2000 which is expected to increase 22.9% for males and 23.6% for females respectively by 2025.

2.11.3 Classification and target values for blood pressure

The Japanese Society of Hypertension (2004) Guidelines classified hypertensive blood pressure levels into mild, moderate and severe hypertension, but they have been expressed as grade I, grade II and grade III hypertension, respectively, in the Guidelines to avoid confusion, because even a mild hypertension may be high-risk hypertension. According to **William *et al,* (2004)** the target values for blood pressure are based on British Hypertension Society and European Society of Hypertension guidelines which equates blood pressure levels with that of the **WHO/ ISH (Guidelines Subcommittee, 1999)** and is based on clinic blood pressure values. The target values for blood pressure are presented in Table 2.5.

Table 2.5: Target values for blood pressure

Category	Systolic blood Pressure (mmHg)	Diastolic blood pressure (mmHg)
Optimal blood pressure	<120	<80
Normal blood pressure	<130	<85
High-normal blood pressure	130–139	85–89
Grade 1 hypertension (mild)	140–159	90–99
Grade 2 hypertension (moderate)	160–179	100–109
Grade 3 hypertension (severe)	≥180	≥110
Isolated systolic hypertension (Grade 1)	140–159	<90
Isolated systolic hypertension (Grade 2)	≥160	<90

Elevated serum levels of LDL cholesterol and triglycerides are associated with increased risk of atherosclerotic cardiovascular disease. Normal of elevated levels of HDL cholesterol seems to protect against the development of this disorder. The National Cholesterol Education Program uses the following heart disease risk classifications. The target values for blood lipid are presented in Table 2.6.

Table 2.6: Target values for blood lipid profile

Blood lipid parameters	Category	Range
Total cholesterol	Desirable	<200 mg/d
	Borderline high	200-239 mg/dl
	High	>240 mg/dl
HDL- cholesterol	High	>60 mg/dl
	Low	<40 mg/dl
LDL- cholesterol	Optimal	<100 mg/dl
	Near Optimal	100-129 mg/dl
	Borderline high	130-159 mg/dl
	High	160-189 mg/dl
	Very high	>190 mg/dl
Triglycerides	Normal	< 150 mg/dl
	Borderline	150-197 mg/dl
	High	200-499 mg/dl
	Very High	>500 mg/dl

2.11.4 Therapeutic role of fruit, vegetables and their juices in hypertension

Hypertension is an important public health issue and contributes to the incidence of stroke and coronary heart disease. **Houston *et al.* (2005)** showed favorable effect of an encapsulated juice powder concentrate made primarily of multiple fruits, vegetables and berries, on several markers of cardiovascular disease. Systolic and diastolic blood pressure was decreased. According to **Joshipura *et al.* (1999)** a protective relationship exists between consumption of fruit and vegetables particularly cruciferous and green leafy vegetables and citrus fruit and juice and ischemic stroke risk. An increment of 1 serving per day of fruits or vegetables like Cruciferous vegetables, green leafy vegetables, citrus

fruit including juice and citrus fruit juice was associated with a 6% lower risk of ischemic stroke. **Castilla *et al.* (2006)** found that dietary supplementation with concentrated red grape juice for 14 days can improve the lipoprotein profile and may favor a reduction in cardiovascular disease risk. **Ruel *et al.* (2006)** showed that daily consumption of cranberry juice cocktail is associated with an increase in plasma HDL-cholesterol concentrations in abdominally obese men**. Das *et al.* (2005)** found that it was tomato juice and not lycopene that possesses cardioprotective ability. **Ascherio *et al.* (1996)** also supported the fact that intake of fruit and vegetables help in reducing systolic and diastolic pressures.

2.11.4.1 Dietary Approach to Stop Hypertension (DASH) diet

There are strong evidences that support the concept of multiple dietary factors affecting blood pressure. Well-established dietary modifications that lower BP are reduced salt intake, weight loss, and moderation of alcohol consumption. Over the past decade, consumption of dietary patterns based on the "DASH diet" has emerged as effective strategies that also lower BP **(Appel *et al.*, 2006).**

The DASH diet (Dietary Approaches to Stop Hypertension) is a diet promoted by the National Heart, Lung, and Blood Institute (part of the NIH, a United States government organization) to control hypertension. It generally encourages the consumption of nuts, whole grains, fish, poultry, low fat or nonfat dairy, beans, fruits and vegetables while lowering the consumption of red meats, salt and sugar. It promotes consumption of foods rich in potassium, magnesium, and calcium, as well as protein and fiber. It also suggests healthy alternatives to "junk food" and discourages the consumption of processed foods. The DASH diet

can reduce systolic blood pressure by 6 mm Hg and diastolic blood pressure by 3 mm Hg in patients with normal blood pressure. Those with hypertension dropped by 11 and 6, respectively **(http://www.nhlbi.nih.gov/health/public/heart/hbp/dash/new_dash.pdf).**

2.11.4.2 Therapeutic role of *aonla*

The *Amla* or *Aonla* (*Emblica officinalis* Gaeltn) also known as Indian gooseberry is a minor sub-tropical deciduous tree indigenous to Indian sub-continent. It is grown in all over Asia for its nutritional, pharmacological and commercial significance **(Goyal *et al.,* 2008).** It is widely used in the Indian system of medicine and believed to increase defense against diseases. It contains rich amount of vitamin C which is associated with lower BP. **Ness *et al.* (1997)** reported an inverse association between BP and plasma vitamin C and also with vitamin C intake.

2.11.4.2.1 Cardio protective Activity

The chronic oral administration of fresh fruit homogenate of *aonla* provides protection to myocardial antioxidant system and also protects heart from oxidative stress **(Rajak *et al.,* 2004).**

2.11.4.2.2 Anti-hyperlipidemia activity

In vitro and *in vivo* investigation on the role of *aonla* on LDL oxidation and cholesterol levels showed effectiveness of *aonla* for hypercholesterolemia and prevention of atherosclerosis **(Kim *et al.,* 2005).** *Aonla* contains flavonoids which reduce the levels of lipid in serum and tissues of rats induced with hyperlipidemia. Both cause the degradation and elimination of cholesterol **(Anila *et al.,* 2002).** According to **Iyer *et al.* (2009)** supplementation with *Amla* brought

significant changes in the lipid profile with 5.7 per cent decrease in the total cholesterol, 9.4 per cent decrease in the atherogenic LDL-Cholesterol, 23.4 per cent reduction in triglycerides and 5.5 per cent increment in HDL- cholesterol. **Krishnaveni *et al.* (2010)** also reported significant reduction in TC, VLDL, LDL, TG and an elevation in HDL upon feeding *aonla* fruit ethanolic extract to diabetics rats. *E. officinalis* fresh juice when administered at a dose of 5 ml/kg body weight per rabbit per day for 60 days, Serum cholesterol, TG, and LDL levels were lowered by 82%, 66%, and 90% respectively **(Mathur *et al.*, 1996).**

2.11.4.2.3 Anti microbial activity

Emblica Officinalis (*aonla*) plant has been reported to posses potent antibacterial activity against *Escherichia coli, Pseudomonas aeruginosa, S. paratyphi A, S. paratyphi B.* **(Khan, 2009). Treadway (1994)** showed antibacterial and antifungal property of *aonla*. **Saeed and Tariq (2007)** showed maximum activity of aqueous infusion of *aonla* against *B. subtilis.*

2.11.4.3 Therapeutic role of ginger

Ginger is a tuber/rhizome of the plant *Zingiber officinale* of family Zingiberaceae which is consumed whole as a delicacy, medicine, or spice. It is sometimes called root ginger to distinguish it from other things that share the name ginger.

2.11.4.3.1 Effect on blood pressure

Studies on rats have suggested that ginger exerts many direct and indirect effects on blood pressure and heart rate **(Afzal *et al.*, 2001).** The crude extract of ginger induced a dose-dependent (0.3–3 mg/kg) fall in the arterial blood pressure

of anesthetized rats. The blood pressure-lowering effect of aqueous extract of ginger is mediated through blockade of voltage dependent calcium channels **(Ghayur and Gilani, 2005).**

2.11.4.3.2 Effect on lipid and glucose concentrations in blood

Ginger promotes the circulation through the extreme vessels. It is effective against anemia, heart disease, heart palpitations, chest pain, nosebleed, Poor circulation, cold hands and feet, leg and pain on exertion due to reduced circulation **(Leonard, 2006). Bhandari *et al.* (1998)** reported antilipemic effects of ginger extracts and reduction in atherogenesis and high lipid levels in rabbits fed with high cholesterol diets. **Tanabe *et al,* (1993)** showed that ginger impairs cholesterol biosynthesis and lowered serum cholesterol concentrations. Ginger lowers cholesterol in lab animals through interruption of biosynthesis **(Fuhrman and Rosenblat, 2000)** and reduces atherosclerotic lesions, possibly through antioxidant effects **(Liu and Huo, 2003).**

Al-Amin *et al.* (2006) found that at a dose of 500 mg/kg, raw ginger was significantly effective in lowering serum glucose, cholesterol and triacylglycerol levels in the ginger-treated diabetic rats thus showing hypoglycemic, hypocholesterolemic and hypolipidemic potential**. Kadnur and Goyal (2005)** reported significant reduction in lipid levels and bodyweight upon treatment with extract of dried rhizomes of ginger.

Indian gooseberry (*amla*) & ginger (Zanjabeel) together are useful in obesity and can also be proved beneficial in lowering increased concentration of plasma lipids or treating hyperlipidaemia. The combination of drugs was found to

be significant in lowering the level of serum total cholesterol (from 288.2 to 233.2), serum tryglycerides (from 231.7 to 178.1), serum LDL-cholesterol (from 195.1 to 144.2), serum VLDL-cholesterol (from 46.5 to 35.5) and in increasing the level of serum HDL-cholesterol (from 42.6 to 53.1) in patients of primary hyperlipidaemia **(Kamal and Aleem, 2009).**

2.11.4.3.3 Anti microbial activity

Ginger extract had the broadest range of anti-fungal activity. Ginger extract (10 mg/kg) had a dose dependent anti-microbial activity against *Pseudomonas aeruginosa, Salmonella typhimurium, Escherichia coli and Candida albicans* **(Jagetia *et al.,* 2003).** Ethanol extract inhibits both gram-positive and gram-negative bacteria while the essential oil is also found to have antimicrobial. A methanol extract of dried ginger inhibited 19 strains of *Helicobacter pylori* in vitro **(Mahady *et al.,* 2006). Gur *et al.* (2006)** reported anti-bacterial activity of ginger extract against *Bacillus subtilis, E. Coli and Staphylococcus.* **Jain *et al.* (2009)** found ginger as effective against *B. Subtilis* and *E. Coli.* Ginger was found to inhibit the growth of *E. Coli, Staphylococcus, Strepto Coci and Salmonella*. Ginger also inhibits *aspergillus fungus* that produces aflatoxin. Fresh ginger juice showed inhibitory action against *A niger, S. cerevisiae* and *L. acidophilus* at ambient temperature **(ICMR Bulletin, 2003).**

2.11.4.4 Therapeutic role of honey

Honey, the oldest foods in existence, is considered as a balanced diet and equally popular with both sexes in all ages. Honey is nectar collected from many plants and processed by honey bees (Apis mellifera). Honey never spoils and

because of the high level of fructose, honey is 25% sweeter than table sugar (**Khan *et al.,* 2007).** Honey, by definition, is a sweet viscous substance elaborated by the honeybee from the nectar of plants **(White, 1978)**

2.11.4.4.1 Hypocholesterolemic effect

Honey plays important role in lowering bad cholesterol and increasing level of good cholesterol. According to **Wailli (2004)** honey consumed for 15 days decreased cholesterol (7%), LDL-C (1%), TG (2%) and increased HDL-C (2%). In patients with hypertriglyceridemia, honey decreased triglycerides and LDL-C.

2.11.4.4.2 Anti microbial activity

The anti microbial activity of honey is considered to be due to hydrogen peroxide liberated enzymatically in honey by glucose oxidase. Light sensitive, heat-stable antibacterial factors in honey inhibit the growth of *Bacillus subtilis, B. alvei, Escherichia coli, Pseudomona pyocyanes.* Non-dissociated organic acids also play a role in the antimicrobial activity of honey **(Jeffrey and Echazarreta, 1996).** Honey was found to have antibacterial activity against *Staphylococcus aureus* **(Cooper *et al.,* 1999)** and antifungal activity against *aspergillus flavus and Aspergillus niger* **(Sheikh *et al.,* 1995). Kacaniova *et al.* (2009)** reported antifungal activity against yeast of Candida species.

2.12 Constipation

The word constipation comes from the Latin word ‘constipare’, meaning to crowd together. The term constipation includes a range of symptoms and signs that either suggests that there are undue difficulty with defaecation, or that abnormal

faecal retention, 'impaction', is present **(Lewis and Rudolph, 1997).** Constipation, a most common problem in the community, is not a disease but a symptom and is one of the most prevalent gastrointestinal complaints **(Briejer *et al.*, 1999).**

Constipation is classified as chronic if it occurred for 12 weeks during the previous year, although these weeks need not be consecutive **(Eoff and Lembo, 2008).** Chronic constipation is frequently divided into 3 broad categories: slow transit constipation, normal transit constipation, and dyssynergic defecation or rectal evacuation disorders (**Lembo and Camilleri 2003).**

According to Rome II criterion, two or more of the following symptoms should persist in more then 25 per cent of bowel movements for at least twelve weeks but need not to be consecutive.

- Straining
- Lumpy or hard stools
- Sensation of incomplete evacuation
- Sensation of anorectal obstruction/blockage
- Manual maneuvers to facilitate bowel movements
- Less then three defecations per week. **(Thompson *et al.*, 1999)**

The American College of Gastroenterology (ACG) Task Force (2005) recommended an expanded definition of chronic constipation as unsatisfactory defecation characterized by infrequent stools, difficult stool passage, or both that persist for at least three months. Difficult stool passage includes straining, a sense of difficulty passing stool, incomplete evacuation, hard/lumpy stools, prolonged time to stool, or need for manual maneuvers to pass stool.

2.12.1 Global and Indian Scenario of Constipation

Constipation is very common, as approximately 63 million people in North America meet the Rome II criteria for constipation. The prevalence of constipation in this region ranged from 2.9% to 27.2% with most estimates from 12% to 27%. Prevalence estimates by gender support a female- to- male ratio of 2.2:1 **(Higgins and Johanson, 2004).** According to **Croffie (2006)** 0.3% to 28% of children worldwide suffer from constipation. Prevalence rates of constipation recorded in other developed countries are also within the same range; 14.3% in the general population in Hong-Kong **(Cheng *et al.,* 2003),** 16.5% in the general population in Korea **(Jun *et al.,* 2006),** 24.5% in women in Taiwan **(Chen *et al.,* 2003)**, 26% in a population of young women in Japan **(Murakami *et al.,* 2006),** 29.6% in young children in Hong Kong **(Ip *et al.,* 2005),** and 11.6% in an elderly Asian population **(Wong *et al.,* 1999).** In the general population of Europe and Oceania the prevalence of constipation rates reported were 17.1% and 15.3% respectively **(Peppas *et al.,* 2008).**

According to US Census Bureau, International Data Base, 2004, extrapolated prevalence rate for constipation in the Indian populations was 1.61%. (Http://Www.Wrongdiagnosis.Com/C/Constipation/Stats-Country.Html).

2.12.3 Management of constipation

2.12.3.1 Exercise and physical activity

Regular exercise has long been considered in the management of chronic constipation. This recommendation is probably based on the assumption that exercise shortens the transit time through the gastrointestinal tract. Aerobic

exercise does not necessarily decrease transit time and may actually prolong it **(Meshkinpour *et al.*, 1998).**

According to **Everhart *et al.* (1989)** low physical activity level is associated with a two fold increased risk of constipation. Patients having sedentary life style are more likely to complain of constipation **(Whitehead *et al.*, 1989).** In Nurses' Health Study, it was found that doing physical activity two to six times per week was associated with a 35 percent lower risk of constipation **(Dukas *et al.*, 2003).**

2.12.3.2 Water

The intestines have a large capacity for absorbing extra ingested water. Colon serves as a site of fluid and electrolyte absorption as well as a storage reservoir for faeces. The fluid entering is absorbed in the ascending and transverse colon, yielding a stool fluid volume of approximately 100 ml. Although rapid emptying occurs from the caecum and ascending colon, faecal matter generally is retained several hours in the transverse colon, continuing reabsorption of water results in hard and small stools that are difficult to expel. Fluid restriction and thus dehydration also increases constipation **(Valtin, 2002 and Arnaud, 2003).**

Increasing water alone generally unhelpful in relieving from constipation but fiber plus water works. In patients with chronic constipation, a high-fiber diet and 2 liters per day of water increased frequency of bowel movements and reduced use of laxatives compared with the same diet and ad libitum fluid intake. By binding water, fiber increases stool weight, softens stool, decreases colonic

transit time, and increases GI motility **(Bleser, 2006). Murakami *et al.* (2007)** found that low intake of water from foods was associated with an increasing prevalence of constipation.

2.12.3.3 Tea

The effect of tea was probably due to theophylline which causes extracellular dehydration, a secondary increase in intestinal fluid absorption and hence constipation **(Hojgaard *et al.*, 1981).**

2.12.4 Therapeutic role of carrot in preventing gastrointestinal ailment

Carrot, the most important nourishing and inexpensive vegetable root crop cultivated throughout the world for its fleshy edible roots is classified scientifically as *Daucus Carota* belonging to Umbelliferae family.

Carrots, especially carrot juice, are beneficial for stomach and gastrointestinal health. Carrot and its juice improve a variety of digestive problems, such as upset stomach, peptic ulcers, gastritis, crohn's disease, diarrhea, celiac disease, intestinal colic, colitis, appendicitis. It is also useful for preventing putrefaction in the intestine and for gastro-intestinal catarrh **(Dweck, 2001).** Chewing of carrots increases saliva and quickens digestion by supplying the necessary enzymes, minerals and vitamins.Carrots contain a great deal of roughage thus works as natural laxative and is very effective in the treatment of constipation. It supplies fluid to combat dehydration, replenishes sodium, potassium, phosphorus, calcium, sulfur and magnesium. It is a good source of pectin and coats the intestines to allay inflammation **(http://flavoursofindia.tripod.com/carrot.html).**

2.12.5 Therapeutic role of orange

Orange juice is known to increase peristaltic activity and drinking loads of freshly squeezed orange juice is an easy and tasty way of combating constipation (**http://www.colon-cleanse-information.com/natural-cures-for-constipation. html**).

The water-insoluble fiber-rich fraction (WIFF) isolated from the peel of orange showed significant improvements in serum, intestinal, caecal and faecal parameters **(Chau *et al.*, 2005).**

2.13 Aloe vera *(Aloe barbadensis)*

Aloe Vera (*Aloe barbadensis*) is one of the most important medicinal plants which have been used for its medicinal value for several thousands of years. The plant has many common names and is often referred to as elixir of youth, burn plant, first aid plant or medicine plant. Aloe vera belongs to the family Liliaceae and the tribe Aloineae. Aloe are perennial succulents and are characterized by stemless large, thick, fleshy leaves that are lance shaped and have a sharp apex and a spiny margin. Aloe leaves have a yellow latex, which is referred to as Aloe sap and has a bitter taste. The leaf pulp is the innermost portion of the leaf and is composed of the parenchyma cells that contain the gel **(Steenkamp and Stewart, 2007).**

2.13.1 Aloe vera Gel

Aloe vera gel is the clear jelly-like substance obtained from the Aloe vera leaf pulp. The mechanical extrusion of the mucilaginous gel from the fibrous fraction of the pulp gives a 70% yield with a water content of 99–99.5% (57). The

gel of field-grown Aloe vera is reported to have a pH of 4.4–4.7 and a total and soluble solids content of 0.56–0.66% however fluctuations due to water availability and seasonal is there. Amount of soluble sugars (27.8%) detected was substantially higher than that in the rind or pulp. Calcium was the main mineral detected in the rind and pulp fractions while sodium and potassium were higher in the gel. Aloe vera gel polysaccharides consist of linear chains of glucose and mannose molecules, the molecules are referred to as polymannans **(Boudreau and Beland, 2006).**

2.13.2 Value added products of aloe vera

Aloe vera can be used as a potential source to develop wide variety of food products. It can also be incorporated in other food products to enhance their nutritional value. Refreshing juice, ready–to- serve drink, health drink, sports drink, soft drink, diet drink, laxative drink and *sherrabets* can be made from aloe vera. The fleshy portion can also be converted into candies, squash, jam, jelly, and bar munch. Additionally, it can also be incorporated to dairy products like yoghurt, curd, *lassi,* and ice-cream as a dairy alternative. Use of aloe vera in meat products with health benefits has found high level of consumer acceptance. Aloe vera is also used as a nutritionally beneficial additive in the preparation of chewing gum. Healthy baby infant formula beverage and healthy baby toddler formula beverage have been prepared from cow's milk, refined sugar, goat's milk and rice milk along with aloe vera juice and water. Vinegar is also prepared from aloe vera juice using Acetobactor species. Attempts were also made to prepare wines from aloe vera **(Chauhan *et al.,* 2007).**

2.13.3 Therapeutic role of aloe vera

Aloe vera has a long history of acceptance as an herbal remedy and is perhaps the most popular herb in use today. Aloe vera plant is used as topical or oral therapeutic agents. Aloe vera latex is a laxative regulated as a drug by the FDA. Aloe vera gel is primarily a topical agent for skin wounds and irritations but is also taken internally for the treatment of gastric ulcers and diabetes; and the whole leaf extract, which combines both the gel and latex, is popular as a dietary supplement for various systemic ailments and is promoted as a potential anti-cancer, anti-AIDS, and anti-diabetic agent **(Boudreau *et al.,* 2010).** Aloe Vera also has anti asthmatic, anti burn, antifungal, antibacterial, anti hypercholesterolemic, anti hyperglycemic and anti inflammatory effects **(Grewal, 2000).**

2.13.3.1 Anti-diabetic activity

The oral administration of Aloe vera lowers fasting blood glucose levels in human as well as diabetic animals. The consumption of constituent polysaccharides of the fraction of soluble fiber modulates the intestinal absorption of glucose, besides reducing cholesterolemia. Therefore, the antidiabetic effects of Aloe maybe due to the components of soluble polysaccharides present in the gel. The role of certain minerals present in the gel play important role in biochemical alterations related to diabetes. The presence of several trace elements in the gel contribute to their hypoglycemic activity **(Rajasekaran *et al.,* 2005).** Over 3000 ‘mildly’ diabetic patients fed aloe gel incorporated bread showed a reduction in blood sugar levels in over 90% of the cases **(Agarwal, 1985).** Hypoglycemic effect of aloe vera leaf pulp was also observed in type-2 diabetic rats by **Okyar *et al.* (2001).**

Oral administration of one tablespoon of aloe vera juice twice daily for 42 days vs. placebo to 72 women showed decrease in blood glucose level **(Yongchaiyudha *et al.*, 1996).** Preparations from both the outer regions of the leaf and the inner gel caused a decrease in blood glucose level in mice. There was also a significant rise in insulin level. The leaf skin preparation lowered blood glucose and resumed normal insulin production in artificially induced diabetic animals **(Beppu *et al.*, 1993). Yagi *et al.* (2009)** found hypoglycemic and hypolipidemic effect of aloe vera high molecular weight fractions on type 2 diabetic patients. **Arora *et al,* (2009)** showed reduction in fasting blood glucose level from 196.8 to 124.2 mg/100ml after feeding aloe vera juice for three months due to presence of high molecular weight polysaccharide or bioactives in the aloe vera.

2.13.3.2 Anti-hyperlipidemia activity

Orally administered aloe gel lowered total cholesterol by 61% and increased the high density lipoprotein **(Dixit and Joshi, 1983). Rajeskaran *et al.*, (2001)** studied the effect of oral administration of aloe vera gel on diabetic rabbit at a concentration of 500mg/kg body weight and showed a significant decrease in the level of blood glucose and serum lipid profile, thus confirming the hypoglycemic and hypolipidemic effect of aloe vera. **Rajeskaran *et al.* (2006)** further studied the beneficial effect of aloe vera gel extract on lipid profile status of diabetic rats and stated reduction in plasma and tissue cholesterol, triglycerides, phospholipids and improvement in plasma insulin. **Bunyapraphatsara *et al.* (1996)** reported certain constituents of aloe vera that lowered the triglyceride levels. A study of 5000 patients

of atheromatous heart disease, using 20 gm husk of isabgol and 100 gm aloe vera for fibers, mixed with wheat flour and prepared in bread to be consumed at lunch and dinner showed a marked reduction in total serum cholesterol, serum triglycerides, fasting and post prandial blood sugar level in diabetic patients, total lipids and also increase in HDL **(Agarwal, 1985).**

Oral administration of 150 ml of aloe vera juice for 3 months to diabetic patients showed marked changes in lipid profile viz. reduction in total cholesterol (203.5 to 174.5 mg/dl), triglycerides (196.2 to 113.9 mg/dl), LDL (124.9 to 100.8 mg/dl), VLDL (37.2 to 22.8 mg/dl) and increment in HDL (38.3 to 51.1 mg/dl) **(Arora *et al.,* 2009). Kim *et al.* (2009)** demonstrated the role of aloe vera gel in the prevention of the progression of NIDDM-related symptoms its usefulness for treating NIDDM.

2.13.3.3 Effect of aloe vera in constipation

Aloe vera latex possesses laxative properties and is used to relieve constipation. Its effect is due to anthraquinone glycosides, aloin A and B which is hydrolized by the bacterial flora of large intestine to form aloe emodin- 9-anthrone, the active metabolite. It induces secretion of fluid and electrolytes into the lumen **(Ishii *et al.,* 1990).** It also alters the motility of the large intestine by a release of endogenous substances **(Capasso *et al.,* 1998).** Leaf exudates of aloe vera were found to have laxative activities higher than senna leaf **(Odeleye *et al.,* 2009).**

Bland (1985) reported decrease in stool specific gravity indicating a greater water-holding characteristic of the stool and improved gastrointestinal motility with reduced bowel transit time. This indicated the tonic effect of aloe

vera supplementation on the intestinal tract, thereby promoting a reduced transit time with decreased residence of fecal material in the colon.

Aloe vera juice supplementation appeared to alter colonic biota. Those subjects that had heavy overgrowth of fecal bacteria and some yeast infection were found to have improved fecal colonization and decreased yeast after the Aloe vera juice supplementation.

The average gastrointestinal pH after Aloe supplementation was found to increase indicating a more alkaline buffer capacity of the aloe vera juice. This would support the hypothesis that aloe vera juice supplementation may act also as a mild antacid with a reasonably good buffering capacity.

Bland (1985) also confirmed that aloe vera juice supplementation in normal individuals is well tolerated and did not produce any adverse effects on gastrointestinal physiology. Oral supplementation resulted in improved bowel motility, increased stool specific gravity, and reduced indication of protein putrefaction in the colon. Clinical improvements in intestinal function while supplementing with Aloe included reduced bloating after meals and reduced flatulence, indicating improved colonic bacterial function.

2.13.4 Composition of aloe vera

Aloe vera contains 75 potentially active constituents viz. vitamins, enzymes, minerals, sugars, lignin, saponins, salicylic acids, and essential amino acids. Enzymes like glucose oxidase, mannose amylase, alkaline phosphatase, lipases and proteases present in aloe vera aids in digestion of foods. Sugars derived from the mucilage layer of the plant under the rind which surrounds the

inner gel known as mucopolysaccharides enhance the immune system and help to detoxify. They form 25 per cent of the solid fraction and comprise both mono- and polysaccharides. Aloe vera contains good amount of pectic substances and phenolics compounds in the sap and exert purgative effect. They also function as anti-microbial against bacteria, viruses, fungi and yeasts. Saponins form about 3% of the aloe vera gel and have cleansing and antiseptic properties. **(Hirat and Suga 1983; Vogler and Eernst, 1999; Choi and Chung, 2003; Hamman, 2008 and Rodríguez *et al.,* 2010).**

2.13.4.1 Structural composition

Broadly there are three distinct portions of the aloe vera leaves: yellow sap, mainly anthraquinones; internal colourless parenchyma gel matrix or the 'fillet' containing the aloe gel and the outer green 'rind,' which consists of outer rinds, tips, bases, and thorns **(Hamman, 2008).**

2.13.4.2 Physico- chemical composition

Aloe vera gel is the water storage organ of the plant. In *aloe vera*, organic acids accumulate as the result of carbon fixation during the night which lowers the pH in gel due to more accumulation of organic acids. The acids are then used for the production of sugars. Reducing sugar in aloe Vera are reliable indicator for the quality of aloe products especially health drinks. The physico chemical composition of aloe vera leaf gel is shown in Table 2.1 (C).

2.13.4.3 Minerals

Aloe vera contains some essential minerals like calcium, sodium, potassium, manganese, copper, zinc and iron which plays important role in

improving impaired glucose tolerance and account for their indirect role in the management of diabetes mellitus, hypoglycemic, wound healing and anti-inflammatory effect (**Rajendran *et al.*, 2007: Shelton 1991 and Vogler and Eernst, 1999).** Mineral composition of aloe vera is shown in Table 2.4 (b).

2.13.5 Antimicrobial activity

The antimicrobial activity of aloe vera inner gel against both Gram-positive and Gram-negative bacteria has been demonstrated by several different methods. *Streptoccocus pyogenes and Streptococcus faecalis* are two microorganisms that have been inhibited by aloe vera gel. Aloe vera gel is bactericidal against *Pseudomonas aeruginosa* while acemannan prevented it from adhering to human lung epithelial cells. A processed aloe vera gel preparation inhibited the growth of *Candida albicans* **(Wynn , 2005). Arun Kumar and Muthuselvan (2009)** reported antibacterial activity of aloe vera against pathogenic bacteria *Staphylococus aureus, Streptococcus pyrogenes, Pseudomonas aeruginosa and E. Coli.* They also showed antifungal activity of aloe vera against *Aspergillus flavus and Aspergillus niger.* According to **Habeeb *et al.*, (2007) and Agarry *et al.*, (2005),** the aloe vera gel and leaf had antimicrobial activity against *S. aureus,* this could be responsible for the popular use of aloe vera gel and leaf to relieve many types of GIT irritations **(Foster 1999 and Grindlay and Reynolds, 1986),** since *S. aureus* form part of the normal microbial flora of intestinal tract (**Cheesbeough, 1984).** However, most of the constituents are found in the gel and not on the leaf, hence the gel is likely to be more active and effective than the leaf. **Ferro *et al.* (2003)** have shown that aloe vera gel can inhibit the growth of the *Streptococcus pyrogenes*. **Cock (2008)** reported antibacterial and antifungal activity of aloe vera juice against *E. Coli* and *Aspergillus niger* respectively.

MATERIALS AND METHODS

Chapter 3 MATERIALS AND METHODS

The present study entitled "Assessment of Therapeutic Value of Aloe Vera *(Aloe barbadensis)* Incorporated Juices" involved both laboratory and field investigations. This chapter precisely describes the methodological procedure along with tools and instruments / equipments adopted in conducting the present investigation. The whole investigation has been divided into four main categories-

I. Formulation of juice blends.

II. Analysis of composition of single strength juices and juice blends

III. Storage study of juices.

IV. Experimental study of juice blends for therapeutic purposes

3.1 Formulation of juice blends

3.1.1 Procurement of raw material

Aonla (Emblica officinalis), ginger (*Zingiber officinale*), carrot (*Daucus carota)*, orange (*Citrus reticulata)*, *lawki* / bottle gourd *(Langenaria siceraria)*, *karela* / bitter gourd (*Momordica charantia*) and honey were procured from the local market of Pantnagar. Aloe vera leaves were obtained from Central Institute of Medicinal and Aromatic Plants (C.I.M.A.P.), Pantnagar. U.S. Nagar, Uttarakhand.

3.1.2 Preparation of single strength juice

Following single strength juices were prepared.

↓ Karela

↓ Washing

↓ Slicing

↓ Sliced Karela

↓Juice extraction

↓ Karela juice

↓Lawki

↓ Washing

↓ Peeling

↓ Sliced lawki

↓Juice extraction

↓ Lawki juice

↓Lawki juice

↓Adding karela juice

↓Lawki-karela juice (LK)

↓Adding aloe vera juice

↓Lawki karela aloe juice (LKA)

Plate 1 Preparation of *karela* juice, *lawki* juice, LK and LKA juice blends

3.1.2.1 Preparation of *karela* juice

Small *karela* (bitter gourd) devoid of blemishes, any visible sign of microbiological infection, insect infestation and physical injury were thoroughly washed under running tap water so as to remove the adhered soil, dust and dirt particles. After this they were dipped in warm water for three minutes twice. Excess surface moisture was blotted using muslin cloth. *Karela* were then cut into halves and hard seeds if any present were removed using a sharp stainless steel knife. They were then cut vertically into thin pieces. The *karela* juice was obtained by passing *karela* pieces through an electrically operated juicer (Glan Company) (Plate 1).

3.1.2.2 Preparation of *lawki* juice

Mature soft *lawki* (bottle gourd) was thoroughly washed under running tap water so as to remove the adhered dust and dirt particles. *Lawkis* were peeled manually using a sharp stainless steel peeler in such a manner so as to remove very thin layer from surface. Peeled *lawki* were gently washed and vertically cut into thin pieces. The *lawki* juice was obtained by passing *lawki* pieces through an electrically operated juicer (Plate 1).

3.1.2.3 Preparation of carrot juice

Medium size carrots were thoroughly washed under fast stream of continuous flowing tap water so as to remove the adhered soil, sand and other impurities. Carrots were peeled manually using a sharp stainless steel peeler in such a manner so as to remove very thin layer from surface. The peeled carrots

↓ Carrots

↓ Washing

↓ Peeling

↓ Peeled carrots

↓ Slicing

↓ Sliced carrots

↓ Juice extraction

↓ Carrot juice

↓ Oranges

↓ Peeling

↓ Cutting into half

↓ Removing seeds

↓ Juice extraction

↓ Orange juice

↓ Carrot juice

↓ Adding orange juice

↓ Carrot orange juice (CO)

↓ Adding aloe vera juice

↓ Carrot orange aloe vera juice (COA)

Plate 2 Preparation of carrot juice, orange juice, CO and COA juice blends

were again gently washed. Thick carrots were vertically cut into thin pieces so that they can pass easily through the feeder of juicer. Carrot juice was obtained by passing carrots through an electrically operated juicer (Plate 2).

3.1.2.4 Preparation of orange juice

Mature oranges were thoroughly washed under running tap water so as to remove the adhered dust and dirt particles. Oranges were then manually peeled and cut into halves. Seeds from each segment were removed manually using a sharp pointed stainless steel knife. Orange juice was obtained by passing seedless orange pieces through an electrically operated juicer (Plate 2).

3.1.2.5 Preparation of *aonla* juice

Mature *aonla* fruit devoid of blemishes, any visible sign of microbiological infection, insect infestation and physical injury were thoroughly washed under fast stream of continuous flowing tap water so as to remove the adhered dust and dirt particles. The excess surface moisture was blotted gently using muslin cloth. The edible portion was obtained by destoning. They were cut into small pieces manually with the help of sharp stainless steel knife. These small pieces were ground into fine paste in an electrically operated mixer-grinder (Kenstar). *Aonla* juice was obtained by squeezing the finely ground paste through single layered muslin cloth (Plate 3).

3.1.2.6 Preparation of ginger juice

Soft, less fibrous ginger rhizomes were thoroughly washed under fast stream of continuous flowing tap water so as to remove the adhered soil, sand and other

↓ Ginger rhizomes

↓ Washing

↓ Peeling

↓ Sliced ginger

↓Grinding ginger

↓ Ginger pulp

↓ Squeezing juice

↓ Ginger juice

↓ Aonla

↓ Washing

↓ Slicing

↓ Sliced aonla

↓Grinding aonla

↓ Aonla pulp

↓ Squeezing pulp

↓ Aonla juice

↓ Mixing honey in water

↓ Adding aonla juice

↓ Adding ginger juice

↓ Aonla ginger juice (AG)

↓ Adding aloe vera juice

↓ Aonla ginger aloe vera juice (AGA)

Plate 3 Preparation of ginger juice, *aonla* juice, AG and AGA juice blends

impurities. Rhizomes were peeled manually using a sharp stainless steel knife and gently washed. Excess surface moisture was blotted using muslin cloth. Peeled rhizomes were then manually cut into small pieces and ground into fine paste in an electrically operated mixer- grinder (Kenstar). Ginger juice was obtained by squeezing the finely ground paste through single layered muslin cloth (Plate 3).

3.1.2.7 Preparation of aloe vera juice

Thick mature aloe vera leaves were selected and thoroughly washed under running tap water. One to two inch of lower base of leaf and two to five inch of leaf top was removed by using a sharp stainless steel knife. The leaves were cut into about five inch pieces. The short sharp spines located along the leaf margin were removed. The top rind was removed by introducing the knife into the mucilage layer below the green rind avoiding the vascular bundles. The internal fillet (transparent mass) was then scooped out and cut into pieces. Aloe vera juice was obtained by grinding these pieces in an electrically operated mixer-grinder (Plate 4).

3.1.3 Preparation of juice blends

Following combinations were used for the preparation of juice blends.

3.1.3.1 Preparation and optimization of *lawki-karela* juice blend

To optimize *lawki- karela* juice, five blends each of 150 ml were formulated using *lawki* juice and *karela* juice in the following manner (Plate 5).

Juice	**BCD**	**HIJ**	**NOP**	**EFG**	**KLM**
Lawki juice (ml)	150	135	120	105	0
Karela juice (ml)	00	15	30	45	150

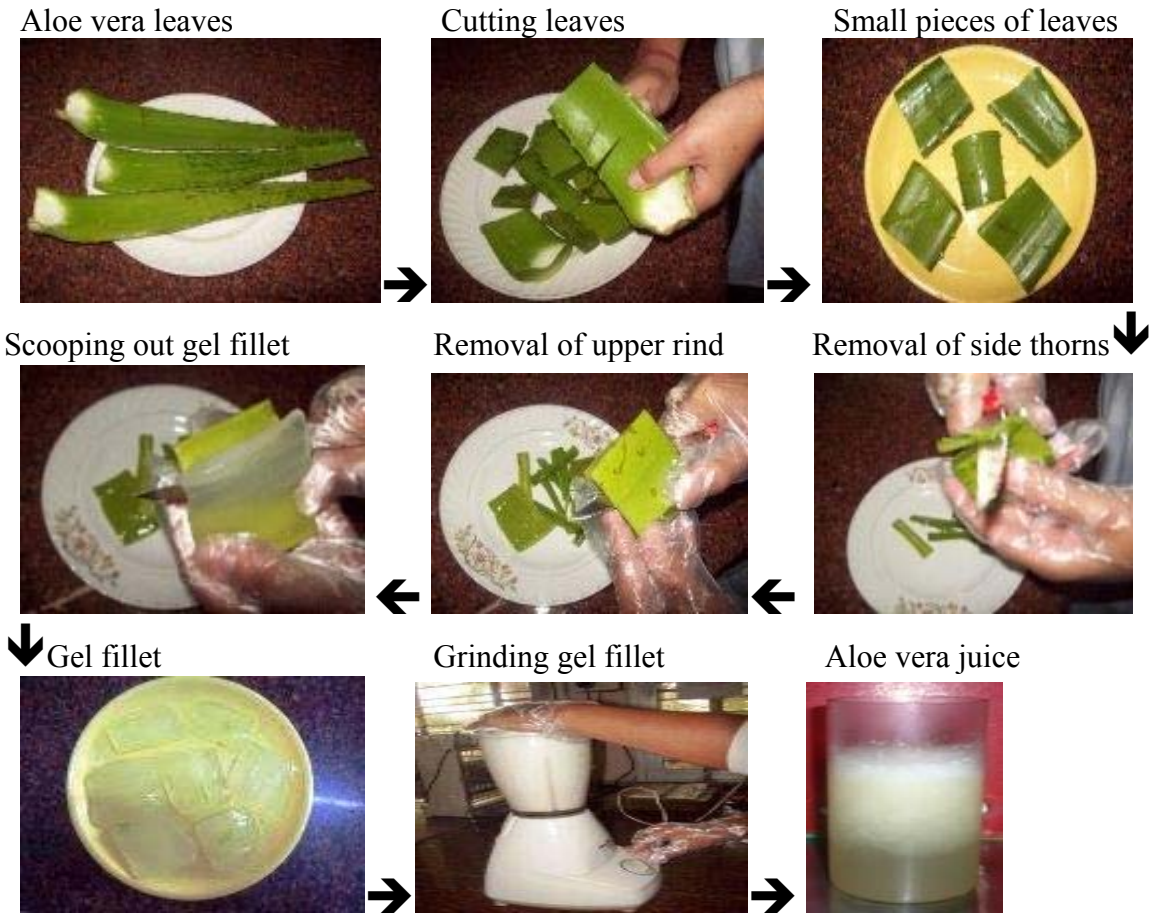


Plate 4 Preparation of aloe vera juice

3.1.3.2 Preparation and optimization of carrot-orange juice blend

To optimize carrot-orange juice, six blends each of 150 ml were formulated using carrot juice and orange juice in the following manner (Plate 6).

Juice	**FGH**	**OPQ**	**IJK**	**CDE**	**LMN**	**RST**
Carrot juice (ml)	150	125	100	75	50	25
Orange juice (ml)	00	25	50	75	100	125

3.1.3.3 Preparation and optimization of *aonla*- ginger juice blend

To optimize *aonla*-ginger juice, five blends each of 150 ml were formulated using *aonla* juice, ginger juice, honey and water in the following manner (Plate 7).

Juice	**JKL**	**GHI**	**ABC**	**MNO**	**DEF**
Aonla juice (ml)	00	20	30	40	50
Ginger juice (ml)	05	05	05	05	05
Honey (ml)	15	15	15	15	15
Water (ml)	130	110	100	90	80

3.1.3.4 Preparation of aloe vera incorporated juice blends

On the basis of organoleptic evaluation, three juice blends viz. *lawki –karela* juice (NOP=120 ml *lawki* juice+30 ml *karela* juice), carrot – orange juice (IJK=100ml carrot juice+50 mi orange juice) and *aonla* – ginger juice blends (ABC=30 ml *aonla* juice + 5 ml ginger juice+15 ml honey +100 ml water) were selected for the preparation of aloe vera incorporated juice blends. For this, 30 ml juice from each of the three optimized juice blends was replaced by 30 ml of aloe vera juice. Thus three juice blends *lawki – karela* - aloe vera juice, carrot –

Plate 5 *Lawki* and *karela* juice (LK) in different proportions

Plate 6 Carrot and orange juice (CO) in different proportions

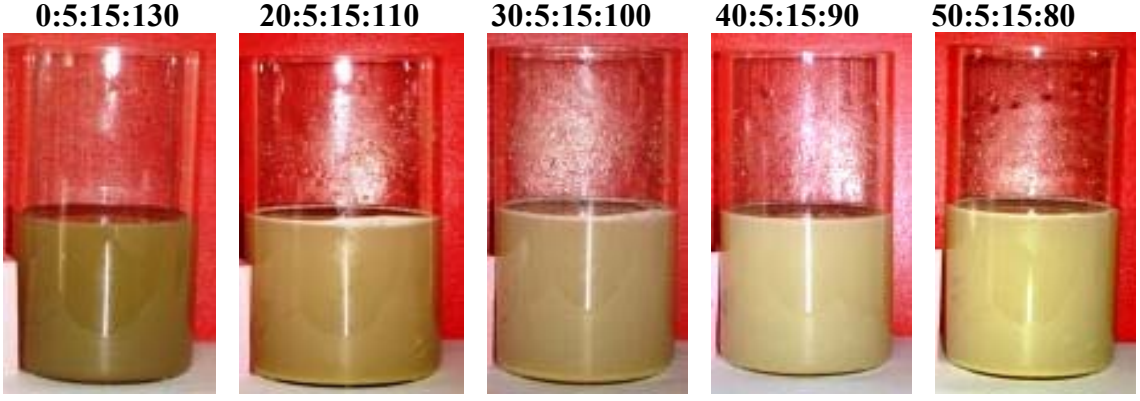


Plate 7 *Aonla* juice, ginger juice (AG juice), honey and water in different proportions

orange- aloe vera juice, and *aonla*–ginger-aloe vera juice blends were prepared. These aloes vera incorporated juice blends were then compared with their respective optimized juices using organoleptic scores (Plate 8).

3.1.4 Sensory evaluation of juice blends

The prepared juice blends viz. *lawki –karela* juice, carrot – orange juice, *aonla* – ginger juice, *lawki – karela*- aloe vera juice, carrot – orange- aloe vera juice and *aonla* – ginger-aloe vera juice were evaluated for sensory quality characteristics on a Nine Point Hedonic Scale to test the liking or disliking of the juice blends and also by Score Card method to test the various attributes which contribute to the acceptability of the juice blends **(Amerine *et al.,* 1965).** The evaluation was done by a panel comprising of 15 panelists drawn from faculty members and post graduate students of the Department of Foods and Nutrition (Plate 9). The panelists were asked to record their observations on the sensory sheet based on a Nine Point Hedonic Scale. For evaluation by Score Card method, the panelists were asked to score the juice combinations for their color, appearance, taste, flavour, consistency and overall acceptability (Appendix I). On the basis of mean sensory scores the best acceptable level of juice blends from each group was selected. A brief research design for the formulation of juice blends has been shown in Figure 3.1.

3.2 Analysis of physical attributes of *lawki*, *karela*, carrot, orange, *aonla*, ginger and aloe vera leaves

Approximately 100 g each of *lawki*, *karela*, carrots, oranges, *aonla*, ginger and aloe vera leaves were washed properly. Peel, stone/seeds and edible portion

Lawki karela juice blend

Lawki karela-aloe vera juice blend

Aonla ginger juice blend

Aonla ginger-aloe vera juice blend

Carrot orange juice blend

Carrot orange–aloe vera juice blend

Plate 8 Juice blends with and without aloe vera juice

Plate 9 Organoleptic evaluation of different juice blends by panelists

were separated and weighed individually. Edible portion of *aonla* and ginger were cut into small pieces and ground into fine paste. It was then filtered through muslin cloth to squeeze out juice while edible portion of carrots, oranges, *lawki* and *karela* was passed through juicer to extract juice. Edible portion of aloe vera leaves was ground in mixer- grinder. All the juices were then measured separately.

3.2.1 Edible weight and per cent weight index

Edible weight and per cent weight index was calculated in the following manner-

$$\text{Edible weight} = \text{Original weight - weight of peel and / or seeds}$$

$$\text{Per cent weight Index} = \frac{\text{Weight of edible portion}}{\text{Weight of Fruit or Vegetable}} \times 100$$

3.2.2 Proportion of pulp, peel and seed

The data on peel, pulp and seed was recorded by weighing each of them separately for each raw material. Peel: pulp ratio was calculated for *lawki*, *karela*, carrot and aloe vera. Seed: pulp ratio was calculated for *aonla* while seed + peels: pulp ratio was calculated for oranges

3.2.3 Percent juice extraction

Percent juice extraction was calculated by following formula :

$$\%\ \text{Juice index} = \frac{\text{Volume of juice extracted}}{\text{Fruit/Vegetable weight}} \times 100$$

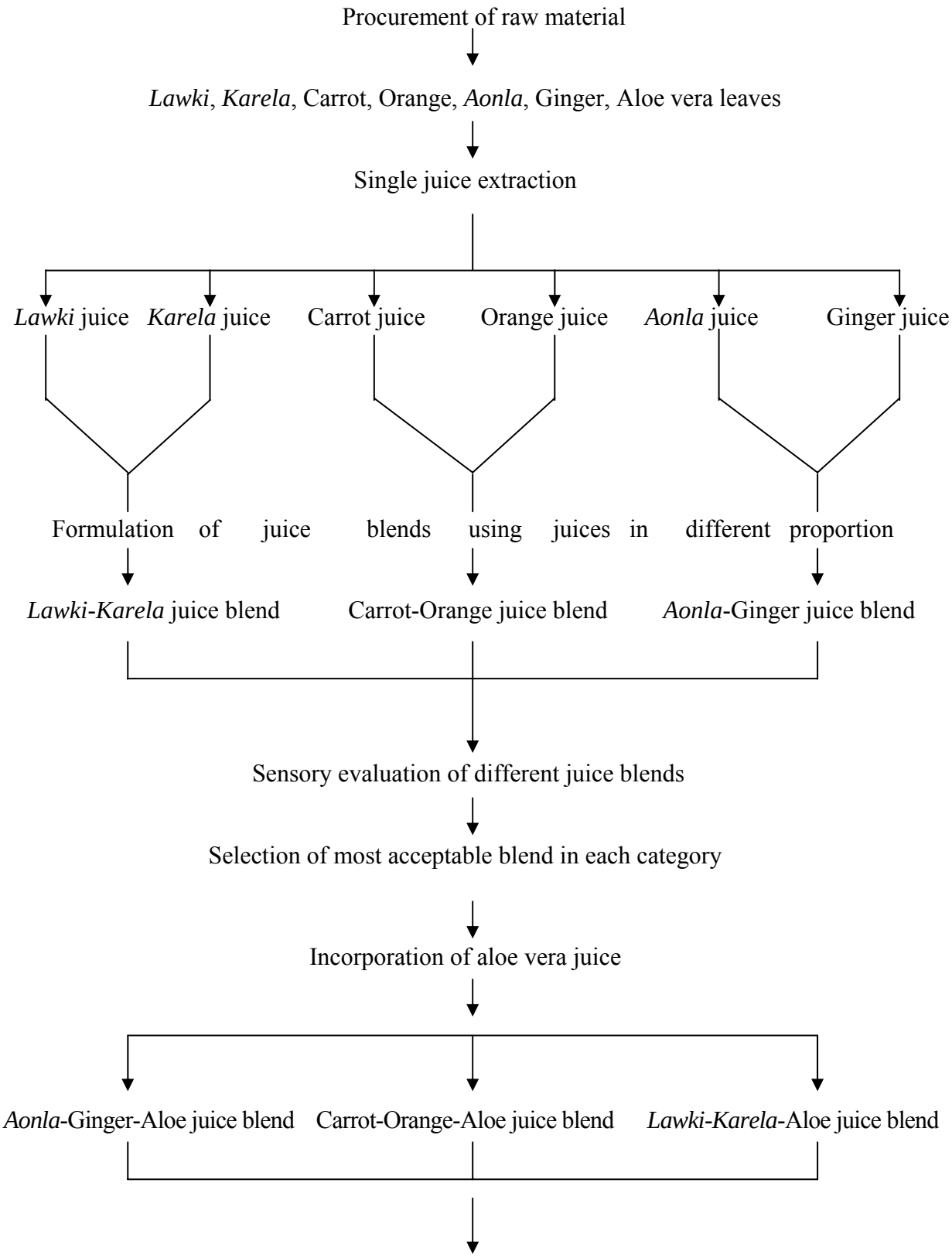


Figure 3.1: Flow chart of research design of formulation of juice combinations

3.2.4 Percent waste index

Percent waste index of carrots, ginger and *lawki* was calculated by the following

Formula :

$$\% \text{ Waste Index} = \frac{\text{Peel Weight}}{\text{Fruit/Vegetable weight}} \times 100$$

Percent waste index of *karela* and *aonla* was calculated by following formula :

$$\% \text{ Waste Index} = \frac{\text{Seed Weight}}{\text{Fruit/Vegetable weight}} \times 100$$

Percent waste index of orange was calculated by following formula :

$$\% \text{ Waste Index} = \frac{\text{Peel Weight} + \text{Seed Weight}}{\text{Fruit/Vegetable weight}} \times 100$$

3.3 Analysis of physico -chemical composition of single strength juices and juice blends

3.3.1 Total solids

The total solids in juices were determined according to the procedure described by Ranganna (2009) after slight modification. Predried petri dish was weighed and 10 ml of juice was poured. The petri dish with juice was weighed and then kept in hot air oven at 55° C for 8 hours. After cooling in desiccator, the dish with dry matter was weighed and the result was expressed in terms of percentage.

- Weight of empty dish (A) in g
- Weight of dish + 10 ml juice weight (B) in g
- Weight of dish+ dry matter weight (C) in g

- Weight of solid matter in g = C - A

$$\% \text{ Total solids} = \frac{\text{Weight of solid matter (g)}}{\text{Weight of juice (g)}} \times 100$$

3.3.2 Total Soluble Solids (TSS)

The total soluble solid of juices was determined by using hand refractometer (ERMA, Japan) at room temperature. Refractometer was set at Zero with distilled water before recording TSS values of the juices. The values so obtained were expressed in ^{0}brix (Ranganna, 2009).

3.3.3 Titrable acidity

Titrable acidity of juices was determined by the method as described by Ranganna (2009). Titrable acidity of light colored juices was measured by diluting 5 ml juice with distilled water to 100 ml while those of dark colored juices by diluting 5 ml juice to 250 ml with distilled water. Few drops of 1% phenolphthalein solution were added as indicator to 5 ml of diluted juice solution. It was then titrated with 0.1N NaOH solution. The titer value was recorded and acidity was calculated as percent acid in terms of citric acid using following formula –

$$\% \text{ Titrable acidity} = \frac{\text{Titre value} \times \text{Normality of alkali} \times \text{Volume made up} \times \text{Equivalent weight of acid}}{\text{Volume of sample for estimation} \times \text{Volume of sample} \times 1000} \times 100$$

3.3.4 pH

pH of juices was determined by a digital pH meter (LI 120/LI 610, Elico Ltd) at room temperature.

3.3.5 Sugars

The contents of reducing sugar, non reducing sugar and total sugar in single strength juices and juice blends were determined by Lane and Eynon method as described by Ranganna (2009).

Reagents

- Fehling's solution A
- Fehling's solution B
- Methylene blue indicator
- 45% Neutral lead acetate solution
- 22% Potassium oxalate solution
- Standard invert sugar solution – 9.5 g of sucrose was weighed accurately into one liter volumetric flask. To it 100 ml water and 5 ml concentrated HCl were added. It was then allowed to stand for three days at 20°- 25°C for conversion to take place. The volume was made up with distilled water. Twenty five ml standard invert solution was pipetted into 100 ml volumetric flask and 50 ml water was added. Few drops of phenolphthalein indicator was added and neutralized with 20% NaOH until the solution turned pink. It was then acidified with 1N HCl by adding dropwise until one drop causes the pink color to disappear. Made up to mark with water (1 ml = 2.5 mg of invert sugar).

Factor for Fehling's solution

Fifty ml of Fehling's solution (B) and 50 ml of Fehling's solution (A) was mixed. Ten ml of this mixed solution was pipetted into 250 ml conical flask and 25 ml water was added. Standard invert sugar solution was filled in burette. Cold

mixture of Fehling's solution was then allowed to boil. When the liquid began to boil, it was kept in moderate flame for two minutes. Then without removing from flame three drops of methylene blue indicator solution was added and titration was completed in next one minute. The end point was indicated by the decolorization of the indicator. The volume of the sugar solution required for complete reduction of 10 ml Fehling's solution was noted.

$$\text{Factor for Fehling's solution (g of invert sugar)} = \frac{\text{Titre value} \times 2.5}{1000}$$

Preparation of sample

To prepare sample 10 ml of juice was transferred to 250 ml volumetric flask. To it 100 ml of water was added and then neutralized with 1 N NaOH using phenolphthalein indicator solution. Two ml of lead acetate solution was added, stirred and allowed to stand for 10 min. After this necessary amount of Potassium oxalate solution was added to remove the excess of lead. Volume was made up to mark with distilled water. Thereafter it was filtered through Whatman Filter paper No. 4.

3.3.5.1 Reducing sugar

Burette was filled with the clarified sample solution to be titrated up to the mark. Ten ml of mixed Fehling's solution (A+B) was taken in a 250 ml conical flask. To it fifty ml water was added. This was then titrated and boiled simultaneously until a faintest blue color remained. Thereafter, 3 drops of the methylene blue solution was added and titration was completed by adding sugar solution drop wise until the indicator was completely decolorized. The volume

of the solution required was noted. Percentage of reducing sugars was calculated as follows –

$$\%\ \text{Reducing Sugar} = \frac{\text{Fehling's Factor} \times \text{Dilution} \times 100}{\text{Titre value} \times \text{volume of sample taken}}$$

3.3.5.2 Total sugar

Twenty ml of the prepared sample solution was taken in a 100 ml volumetric flask and 5 ml of HCl (1 HCl:1 Water) was added. Lid was placed on it and then kept for 24 hours at the ambient temperature for the hydrolysis of non - reducing sugars to the reducing sugars. Thereafter the content was neutralized with 1N NaOH and made up to 100 ml with distilled water. It was titrated against freshly prepared and pre standardized Fehling's solution as described above. Percentage of reducing sugars was calculated as follows –

$$\%\ \text{Total Sugar} = \frac{\text{Fehling's Factor} \times \text{Dilution} \times 100}{\text{Titre value} \times \text{volume of sample taken}}$$

3.3.5.3 Non - reducing sugar

The content of Non - reducing sugar was calculated as follows –

$$\%\ \text{Non – reducing sugar} = (\%\ \text{Total sugar} - \%\ \text{Reducing sugar}) \times 0.95$$

3.3.6 Free acidity, lactonic acid and total acidity

Free acidity, lactonic acid and total acidity of honey was determined by AOAC method (1995)

Reagents

- 0.05 N NaOH
- 0.05 N HCl

Procedure

Ten g of sample was dissolved in 75 ml distilled water in a 250 ml beaker. Its pH was recorded with the help of pH meter. Titrated with 0.05 N NaOH at the rate of 5 ml per minute. Addition of NaOH was stopped at pH 8.5. Immediately 10 ml of 0.05 N NaOH was added and without any delay it was back titrated with 0.05 N HCl to pH 8.30. Acidity was calculated as milliequivalent per kg.

$$\text{Free acidity (meq/kg)} = (\text{ml of 0.05 N NaOH - ml of blank}) \times \frac{50}{\text{weight of sample (g)}}$$

$$\text{Lactonic acidity (meq/kg)} = (10 - \text{ml of 0.05 N HCl}) \times \frac{50}{\text{weight of sample (g)}}$$

$$\text{Total acidity (meq/kg)} = \text{Free acidity} + \text{Lactonic acidity}$$

3.3.7 Chlorophyll

Chlorophyll content of single strength juices and their combinations was estimated using procedure of Arnon (1949).

Reagents

- Solvent – 80% acetone (80 ml acetone + 20 ml distilled water).

Procedure

Five ml of juice was transferred into an aluminum wrapped volumetric flask containing 25 ml of 80% acetone and shaken vigorously. The suspension was filtered through Whatman Filter Paper No.1. Absorbance of chlorophyll extract was measured at 645 nm and 663 nm. The chlorophyll content of the juice was calculated as follows-

$$\text{Chlorophyll - a (mg/100g)} = (12.7 \times A_{663} - 2.69 \times A_{645}) \times \frac{V}{1000 \times W} \times 100$$

$$\text{Chlorophyll - b (mg/100g)} = (22.9 \times A_{645} - 2.69 \times A_{663}) \times \frac{V}{1000 \times W} \times 100$$

$$\text{Total Chlorophyll (mg/100g)} = (20.2 \times A_{645} + 8.02 \times A_{663}) \times \frac{V}{1000 \times W} \times 100$$

Where

A_{645} = Optical density at 645 nm

A_{663} = Optical density at 663 nm

V = Final volume (ml) of chlorophyll extract in 80% acetone

W = Volume (ml) of fresh juice used for chlorophyll extraction

3.3.8 Analysis of nutritional composition of single strength juices and juice blends

3.3.8.1 Ascorbic acid

The ascorbic acid content of juices was determined by the usual titration method as described by Ranganna (2009), with modification described by Hawk (1965).

Reagents

- **3% metaphosphoric acid-** acetic acid extracting solution – Fifteen g of metaphosphoric acid sticks were dissolved in 200 ml water containing 40 ml acetic acid and then volume was made up to 500 ml.
- **Ascorbic acid standard –** For the preparation of standard stock solution, exactly 100 mg of L- ascorbic acid was dissolved in 100 ml of 3% metaphosphoric acid- acetic acid extracting solution. Working standard solution was prepared by diluting 10 ml of this solution to 100 ml with 3% metaphosphoric acid- acetic acid. (1 ml=0.1 mg of ascorbic acid).

- **Dye solution –** 2,6-dichlorophenol indophenol dye was dissolved in 50 ml distilled water containing 42 mg of sodium carbonate in 200 ml volumetric flask. Volume was made up and filtered.
- **Acid washed activated charcoal** – Acid washing of activated charcoal was done by suspending 100 gm of activated charcoal in 500 ml of 10% hydrochloric acid. After boiling, it was filtered through muslin cloth. The cake was stirred up in 500 ml distilled water and filtered again. The washing was repeated three times. It was then dried overnight at 110°-120° C in a hot air oven.

Procedure

- **Standardization of dye** – To 5 ml of working standard solution, 5 ml of metaphosphoric acid- acetic acid solution was added in a conical flask. The burette was filled with dye. The solution was then titrated with dye to a faint pink color which persisted for 5 seconds. The dye factor (mg of ascorbic acid per ml of dye) was determined as follows –

$$\text{Dye Factor} = \frac{\text{ml of standard ascorbic acid} \times \text{concentration of standard ascorbic acid}}{\text{Titre value}}$$

- **Preparation of sample**

- In case of light colored juice, 10 ml of juice was diluted to 100 ml with 3% metaphosphoric acid- acetic acid solution.
- In case of dark colored juice, 5 ml of juice was diluted to 25 ml with metaphosphoric acid- acetic acid solution. Thereafter, 1.25 g acid washed activated charcoal was added and shaked vigorously. It was then filtered through whatman filter paper no. 1 to get colorless extract.

Assay of extract

Five ml of metaphosphoric acid- acetic acid extract of the sample was taken and titrated with standard dye to a faint pink color end point that persisted for 5 second.

Calculation

Ascorbic acid content of the juices were calculated as follows –

$$\text{mg of ascorbic acid per 100 ml} = \frac{\text{Titre value} \times \text{Dye factor} \times \text{Volume made up}}{\text{Aliquot of extract} \times \text{volume of sample}}$$

3.3.8.2 Beta carotene

The carotene content of juice combinations containing appreciable amount of carotene was estimated by the method of AOAC (1975) with modification in column packing as described by Goodwin (1955).

Reagents

- Solvent – acetone and hexane in the ratio of 1:9
- Adsorbent – mixture of alumina and sodium sulphate in the ratio of 1:1

Extraction of carotenoids

Five ml of a juice sample was taken in a volumetric flask. Twenty five ml of solvent was added and kept for overnight. Next day it was filtered through glass wool and the volume of aliquot was measured.

Separation of carotenoids by column chromatography

The chromatography column was compactly filled 3/4 with adsorbent. The adsorbent was then moistened with 25 to 50 ml solvent for making compact column. Five ml of aliquot was loaded on the top of the column and was allowed to run down the column. Twenty ml of the solvent was allowed to run and 5-7 ml

of elute containing the carotene was collected in a conical flask when the leading edge of the descending carotene zone was near the bottom of the column. The total volume of elute was noted each time.

Colorimetric estimation of beta carotene

Preparation of standard curve

Twenty five mg of standard beta carotene was dissolved in 250 ml of solvent. Ten ml of this solution was diluted to 100 ml with solvent to get the concentration of 10 µg/ml. Different volume (5-50 ml) were pipetted in 100 ml volumetric flask separately and diluted to the mark with solvent. The final concentrations were 0.5 µg/ml, 1.0 µg/ml, 1.5 µg/ml, 2.0 µg/ml, 2.5 µg/ml, 3.0 µg/ml, 3.5 µg/ml, 4.0 µg/ml, 4.5 µg/ml and 5.0 µg/ml. The intensity of the color was measured in spectrophotometer at 436 nm after setting the instrument at zero per cent absorbance with solvent. The standard curve was plotted with optical density (O.D) versus concentration. The color of elute of carotene of each sample was read in the spectrophotometer at the same wavelength and from the O.D the concentration of carotene was directly read from the standard curve. The total beta carotene content was computed using following formula-

$$\%\,\beta\,\text{Carotene} = \frac{\text{Concentration of carotene as read from curve } (\mu g/ml) \times \text{Dilution} \times \text{Volume of elute} \times \text{volume of aliquot}}{\text{Volume of aliquot loaded in column (ml)}} \times \frac{100}{\text{Volume of sample taken}}$$

3.3.9 Analysis of mineral composition of single strength juice and juice blends

Mineral content of juices was determined by double beam Atomic Absorption Spectrophotometer using wet digestion procedure as described by Ranganna (2009).

Reagents

- Concentrated nitric acid (HNO_3)
- Concentrated sulphuric acid (H_2SO_4)

Preparation of sample solution

Volume of sample sufficient to contain 5-10 g solid was taken in digestion flask in the following manner-

Juices	**Volume (ml)**
Aloe vera juice	500
Carrot juice	50
Orange juice	60
Carrot – orange juice	50
Carrot – orange- aloe vera juice	50
Aonla juice	50
Ginger juice	50
Aonla – ginger juice	50
Aonla – ginger aloe vera juice	50
Lawki juice	100
Karela juice	50
Lawki – karela juice	130
Lawki – karela aloe vera juice	150

Twenty ml of concentrated HNO_3 was added then cooled and boiled. The solution was allowed to cool and 20 ml of concentrated HNO_3 and 20 ml of H_2SO_4 was added. It was then heated very gently until the liquid darkens in color. Then 1-2 ml of HNO_3 was added and heated continuously until darkening again occurred. Acid was added continuously and heated to fuming until the solution failed to darken. When all the organic matter was oxidized the solution was

allowed to cool. Then 25 ml of distilled water was added and boiled gently to fuming. The solution was cooled again and further 10 ml of water was added and boiled gently to fuming. Finally, it was cooled and volume was made up to a known volume.

Atomic absorption spectrophotometer (AAS) determination

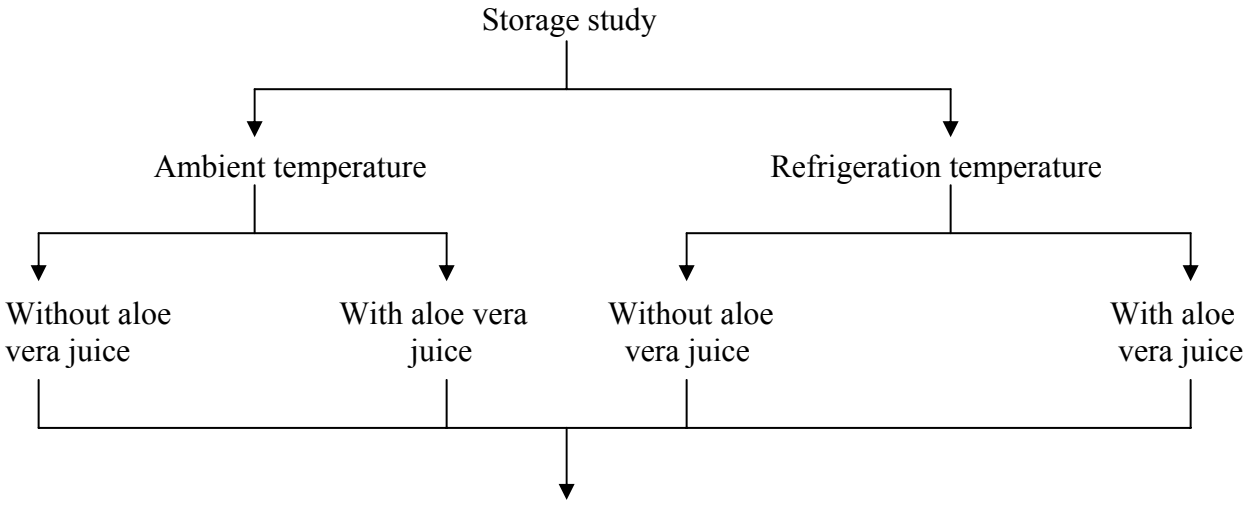
Atomic absorption spectrophotometer was used for the determination of copper, iron, manganese, zinc and calcium while flame photometer was used for the determination of sodium and potassium present in the juices by method quoted by Raghuramulu et al. (2003). Representative sample in suitable liquid form was sprayed into the flame of an atomic absorption spectrophotometer (AAS 4141, Electronics Company of India Ltd.) and the absorption or emission of the mineral to be analyzed was measured at a specific wavelength.

Calculation:

$$\text{ppm mineral} = (\mu\text{g mineral/ml}) \times \frac{\text{Dilution factor}}{\text{ml of aliquots} \times \text{g of sample}}$$

3.4 Storage study of juice blends

The storage behavior of juice blends was studied by carrying out microbial, nutritional and organoleptic analysis. Microbiological analysis was done to check how safe juices were and for how many days. On the basis of microbiological test, nutritional and organoleptic analyses of juice combinations were done. A brief research design for the storage study of juice blends has been shown in Figure 2.



- Microbial analysis- Total Plate Count, Total Coliform Count, Yeast and Mould Count
- Nutritional analysis – Ascorbic acid, Beta carotene
- Chemical composition analysis – Total sugar, Total chlorophyll
- Organoleptic analysis- Nine point hedonic scale, Score card

Figure 3.2 Flow chart of research design of storage study of juice combinations

3.4.1 Microbial analysis of juice blends

Juice blends were analyzed on 0 (fresh) day, 1st, 2nd, 3rd and 7th day for microbial load. To carry out the analytical procedure for microbial analysis following preparations were made -

3.4.1.1 Sterilization of glass ware

All glasswares used in microbiological work were of Borosil make. Prior to start of experiment, glasswares were sterilized in hot air oven at 180 ° C for 2 hours (Busta *et al*., 1976).

3.4.1.2 Preparation of peptone water

For the analysis, peptone water was used for preparing dilutions. Peptone water was prepared by dissolving 0.1 g of dehydrated peptone water in 100 ml distilled water (pH 7.2). After preparing solution, it was sterilized by autoclaving at 121° C (15 lbs pressure) for 15 minutes and then cooled to 45 ^{0}C before use.

3.4.1.3 Determination of Total Plate Count

Total Plate Count (TPC) reflects the condition in which the food was produced, stored or abused. TPC of juices was determined using standard plate count method as given by Busta *et al.*, (1976). The plate count method is generally accepted as a satisfactory method of estimating the total number of viable bacteria in foods.

3.4.1.3.1 Preparation of media

Nutrient agar was used as a medium to determine the total plate count. Thirty five g of nutrient agar was suspended in 1000ml distilled water and then boiled to dissolve the medium. The medium was then sterilized by autoclaving it at 121^{0} C (15 lbs pressure) for 15 minutes and then cooled to 45 ^{0}C before use.

3.4.1.3.2 Preparation of sample dilutions

Ten ml of juice was mixed properly with sterilized 0.1 per cent peptone water and volume was made up to 100 ml with the same solution. This constituted first dilution (1:10). The suspension was then shaken thoroughly by hand shaking for 2 minutes and subsequent dilutions were made using sterilized 0.1 percent peptone water. One ml of this suspension was aseptically transferred

to 9.0 ml of sterilized 0.1 percent peptone water tube, thus making 10^{-2} dilution (1:100). In the same fashion, dilutions of 10^{-3}, 10^{-4}, 10^{-5}, and 10^{-6} were prepared.

3.4.1.3.3 Preparation of plates

Plates were prepared by pour plate method. One ml from each dilution was transferred aseptically to sterilized petri plates in triplicates. Then 10-15 ml of sterilized nutrient agar medium was poured in each of the petri plates. The contents were mixed thoroughly by rotating the plates clockwise and anticlockwise. After solidification, the plates were then incubated at 37^0 C for 48 hours.

3.4.1.3.4 Quantification of colonies

There after, petri plates were taken out of the incubator and the colonies were counted using colony counter. The dilution plates showing the number of colonies in the statistical range of 30-300 were selected and average of the counts was determined. The total plate count per ml of the sample was calculated using formula given below:

$$\text{cfu / ml of sample} = \frac{\text{no. of colonies x dilution factor}}{\text{amount of sample taken}}$$

3.4.1.2 Determination of Total Coliform Count

Coliform counts are generally used as an indicator of possible faecal contamination, and reflect the hygiene standards adopted during preparation of food. Total Coliform Count (TCC) of the juices was determined using standard plate count method as given by APHA (1984).

3.4.1.2.1 Preparation of Violet Red Bile Agar media

Violet Red Bile Agar (VRBA) was used to determine the Total Coliform Count. Exactly 38.53 g of VRBA was suspended in 1000 ml distilled water and then boiled to dissolve the medium completely. The medium was then sterilized by autoclaving it at 121^0 C (15 lbs pressure) for 15 minutes and then cooled to 45 ^{0} C before use as plating medium.

Further steps viz. preparation of sample dilution, preparation of plates and quantification of colonies were followed in the same manner as described in determination of Total Plate Count.

3.4.1.3 Determination of Yeast and Mould Count

Yeast does not cause food poisoning but some types are capable of causing food spoilage. Moulds can produce mycotoxins, which can affect man adversely. Mould spores can be carried by the wind hence can have easy entry to a food. Yeast and Mould Count (YMC) of the juices was determined using standard plate count method as given by APHA (1984).

3.4.1.3.1 Preparation of Potato Dextrose Agar media

Potato Dextrose Agar (PDA) was used to determine the Yeast and Mould Count. Exactly 42.5 g of PDA was suspended in 1000 ml distilled water and then boiled to dissolve the medium completely. The medium was then sterilized by autoclaving it at 121^0 C (15 lbs pressure) for 15 minutes and then cooled to 45 ^{0} C before use as plating medium.

Further steps viz. preparation of sample dilution, preparation of plates and quantification of colonies were followed in the same manner as described in determination of Total Plate Count.

3.4.2 Nutritional and compositional analysis of juice blends during storage

Ascorbic acid, beta- carotene, total sugar and total chlorophyll content of juice blends during storage period were analyzed as per the methods described earlier.

3.4.3 Sensory evaluation of juice blends during storage

Sensory evaluation of the best-selected juice blends and aloe vera incorporated juice blends were done using Nine point Hedonic Scale and Score card during storage period.

3.5 Experimental study of juice blends for therapeutic purposes

3.5.1 Selection of location

The experimental study was conducted among the population residing in the campus of G.B.P.U.A.T., Pantnagar, U.K.

3.5.2 Selection of target group

Purposively 50 subjects in the age group of 35- 60 years having one or more problem of constipation, hypertension and diabetes were selected. They were mainly from the College of Agriculture, College of veterinary sciences, College of Home Science and from colonies of university campus. For hypertension and diabetes, name and address of some diabetics and hypertensive patients were taken from the university hospital as well as few were searched personally while constipated patients were mainly searched through personal contact. Consent of the subject to participate in the study and to draw blood sample was taken through consent form.

3.5.3 Period and duration of study

The study was conducted when plenty of raw materials were available in the peak season.

Patients were given juice combinations according to disease conditions for a period of 30 days.

3.5.4 Selection of juice blends

The experimental juice blend was allocated according to disease condition. *Lawki – Karela* (LK) juice and *Lawki – Karela*- Aloe (LKA) juice was selected for diabetics, Carrot–Orange (CO) juice and Carrot–Orange-Aloe (COA) juice was for constipated patients while *Aonla*-Ginger (AG) juice and *Aonla*-Ginger- Aloe (AGA) juice was selected for hypertensive patients. Each patient was given 150 ml of juice daily for a period of 30 days.

3.5.5 Development of tool for data collection

A consent form was developed (Appendix- II) and distributed among those who were ready to participate in study to have their consent. A presurvey questionnaire (Appendix-III, IV, V and VI) was prepared for gathering information regarding general information, anthropometric assessment, work pattern and habit, physical fitness, medical history, medication use, biochemical and dietary assessment of patient.

3.5.5.1 General information

Information regarding age, sex, occupation, education, marital status and religion was collected using questionnaire.

3.5.5.2 Information on anthropometry

Following anthropometric measurements were taken -

- **Height –** Height of the subjects was measured using measuring rod having least count of 0.1 cm. subjects were asked to remove footwear and head wear (if any) and stand erect with feet parallel while heels, buttock, shoulders and back of head touching the measuring rod. The arms were kept hanging at the sides in natural manner and chin was kept parallel to flat surface while taking the reading.
- **Weight –** weight of subjects was measured using personal weighing balance. Machine was placed on a leveled surface and was set at zero point. Subjects were asked to stand straight and erect on weighing balance with minimal clothing and without any footwear.
- **Body mass index (BMI) -** BMI or Quetlet Index was used for determining overweight and obesity in subjects using the formula –

$$\text{BMI} = \frac{\text{Weight (kg)}}{\text{Height (m}^2\text{)}}$$

3.5.5.3 Work pattern and habit

Information related to life style, active working hours and habits of subjects were collected.

3.5.5.4 Physical fitness

Information about the type, frequency and duration of exercise done by the subjects and hours of sleep taken by the subject was also collected.

3.5.5.5 Medical history and medication used

Information regarding type of disease, duration and family history of disease, treatment, and associated problem, type of medicine and frequency of disease, any supplements and herbal medication used by subjects was collected. Information on biochemical parameters like blood sugar, lipid profile was also collected.

3.5.5.6 Dietary assessment

Information pertaining to food habits, meal pattern, and frequency of taking different types of food products was collected. Subjects were also asked to record their seven days dietary intake in proforma provided. Dietary intake was determined by 24 hour dietary recall method and food frequency questionnaire.

3.5.6 Experimental study

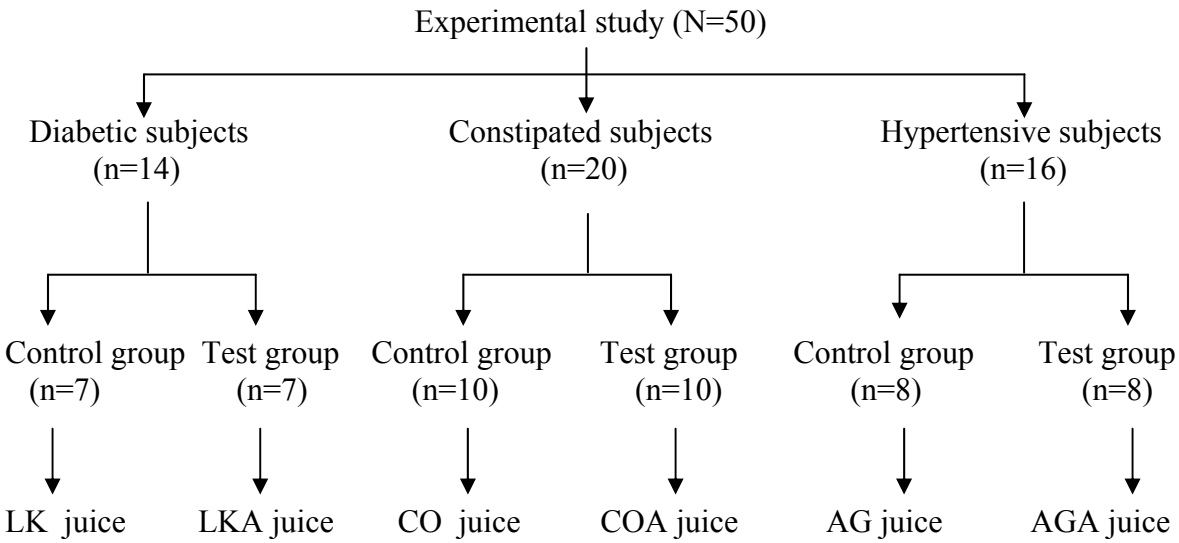
Examination of biochemical parameters like blood sugar, lipid profile and blood pressure was done on zero day. For this, blood samples were drawn from antecubital vein of overnight fasted subjects by trained pathologist and were analyzed in renowned pathology lab Thyrocare. Exactly one fifty ml of each juice combination was given to subjects for 30 days. A brief research design for the intervention has been shown in Figure 3.

3.5.6.1 Collection of specimen and handling

Blood sample was collected as per recommendation by National Cholesterol Education Programme Expert Panel – Adult Treatment Panel (NCEP-ATP III). Patient was allowed to sit comfortably for at least 5 min before sample collection (Plate 10-a and 10-b).

Plate 10 (a) **Pre and post intervention blood sample collection of diabetic subjects**

Plate 10 (b) **Pre and post intervention blood sample collection of hypertensive subjects**



- Reduction in signs and symptoms of problems were analyzed by post survey proforma (Appendix IV, V and VI) and biochemical constituents and clinical signs were assessed (wherever necessary) after 7, 15 and 30 days.

Figure 3.3 Flow chart of research design of intervention study of juice blends

3.5.6.2 Analysis of biochemical constituents of blood

Blood sugar was analyzed in diabetic patients using Excel Diagnostic kits while lipid profile was analyzed in diabetics and hypertensive patients by using Span's Liquid Gold Diagnostic kits.

3.6 Statistical analysis

Statistical analysis of data obtained in the present investigation was done using techniques of analysis of variance (ANOVA) as described by Snedecor and Cochran (1968). Mean and SD was calculated for physico- chemical characteristics. CRD one way ANOVA was used for sensory analysis. CRD three factor was used to study the effect of storage temperature, juice type and storage days on the sensory and chemical attributes during storage. Paired- t test was done to analyze the differences in biochemical constituents of control and experimental subjects before and after the experiment.

RESULTS AND DISCUSSION

Chapter 4 RESULTS AND DISCUSSION

The present study was undertaken with a view to explore the possibility of utilization of precious fruits and vegetables known to have therapeutic value viz. *Lawki* (Bottle gourd), *Karela* (Bitter gourd), carrot, orange, *aonla*, ginger and honey in the formulation of juice blends with the incorporation of aloe vera juice. The juice blends were analyzed for their sensory quality and nutritional quality. The shelf life of optimized juice blends with and without aloe vera juice at ambient and refrigeration temperature for a period of 7 days were assessed. The therapeutic benefits of juice blends (with and without aloe vera juice) in constipated, diabetics and hypertensive patients through intervention studies was seen. The specific findings of the investigation are being discussed below:

4.1 Physical characteristics of fruits and vegetables and Aloe vera used in the study

Data pertaining to physical characteristics of carrot, orange, *aonla*, ginger, *Lawki*, *karela* and aloe- vera are presented in Table 4.1.

4.1.1 Carrot *(Daucus Carota)*

The per cent juice extracted from carrot was measured as 45.04 per cent. Sahota *et al.* (2009) reported 47.8 per cent (478 ml/kg) and 48.4 per cent (484 ml/kg) juice in two varieties of carrot. These values are comparable with the values obtained in present study. The peel weight of carrot was 7.15 g/100g showing 6.87 per cent waste index. The peel : pulp ratio was estimated as 1.01:13.75 while per cent weight index of carrot was 92.33 per cent in the present study (Table 4.1).

Table 4.1 Physical characteristics of Carrot, Orange, *Aonla,* Ginger, *Lawki, Karela* and Aloe vera *

Physical characteristics	**Carrot**	**Orange**	***Aonla***	**Ginger**	***Lawki***	***Karela***	**Aloe vera**
Weight (g)	104.33±1.52	102.66±1.52	102.66±1.52	104.00±2.64	102.66±1.52	104.33±1.52	104.66±1.52
Peel weight (g)	7.15±0.04	31.85±0.48	-	13.61±0.34	10.58±0.15	-	39.57±0.58
Edible weight (g)	96.33±1.40	66.57±0.98	94.89±1.41	89.93±1.99	91.86±1.36	102.86±1.28	62.62±0.68
% Edible weight index	92.33±1.22	64.84±0.05	92.42±0.64	86.47±0.48	89.47±0.25	98.59±0.22	61.74±0.22
Seed weight (g)	-	1.55±0.02	6.98±0.10	-	-	1.3±0.28	-
Peel:Pulp ratio or Seed:Pulp ratio	1.01:13.75 (0.073)	1.05:2.21 (0.475)	1.03:14.29 (0.072)	1:6.6 (0.151)	1.05:9.18 (0.114)	0.1:8.02 (0.012)	1.01:1.64 (0.615)
Juice (ml)	47.36±0.77	43.33±0.57	74.66±1.52	53.33±1.52	58±1.35	48.33±1.04	61.8±1.12
% Waste index	6.87±0.13	33.37±0.71	6.79±0.75	13.08±0.65	10.30±0.45	1.24±0.17	37.80±0.55
% Juice index	45.04±0.33	42.52±0.20	72.71±0.40	51.27±0.25	56.49±0.21	46.31±0.31	59.03±0.35

* Mean of triplicate observation expressed as mean±SD

** Dash indicate Not present

4.1.2 Orange *(Citrus reticulata)*

The peel weight and juice per cent of orange was estimated to be 31.85 per cent and 42.52 per cent respectively. The peel weight is found to be in accordance with values (31.9 per cent) reported by Beerh and Rane (1983) while juice per cent (45.6 per cent) was found to be comparable with values obtained in present study. The seed weight was observed higher as 1.55/100 g oranges than those reported by Beerh and Rane (1983) i.e. 0.35g/100g oranges. The peel – pulp ratio, weight index and waste index in the present study was recorded as 1.05 : 2.21, 64.84 and 33.37 percent respectively (Table 4.1).

4.1.3 *Aonla (Emblica officinalis)*

The edible weight, seed weight, and seed-pulp ratio of *aonla* was found to be 94.89 g, 6.98 g and 1.03:14.29 respectively. These results are in conformity with values reported by Mehta *et al.* (2002) as 92.77-95.44 percent edible weight, 4.56-7.23 g seed weight and 1:13-1:21 seed/pulp ratio in different varieties of *aonla*. The per cent juice index in present study was found to be 72.71 per cent. This value was higher than the values reported by Mishra *et al.* (2009) as 41.9 per cent and 48.3 per cent in two different varieties of *aonla*. These higher values of juice in the present study may be attributed to variation in variety, climate and other geographical conditions. The waste index of *aonla* was found to be 6.79 per cent (Table 4.1).

4.1.4 Ginger *(Zingiber officinale)*

Data furnished in Table 4.1 indicates 86.47 per cent edible index, 13.08 per cent waste and 51.27 per cent juice index of fresh ginger rhizomes. Singh *et al.* (2005) reported similar trend in edible portion (87.17 per cent) and peel waste

(12.83 per cent) but slightly higher value of juice index (56.03 per cent) than the value obtained in present study. The peel pulp ratio in the present study was found to be 1:6.6.

4.1.5 *Lawki* (*Lagenaria siceraria*)

The percent edible index and waste index of bottle gourd was estimated to be 89.47 per cent and 10.30 per cent respectively. Sawate *et al.* (2009) reported higher edible index of 94.17 per cent and lower waste index of 5.82 per cent as compared to values obtained in present study. The peel: pulp ratio was found to be 1.05:9.18. The juice recovery was found to be 56.49 per cent which is lower than the values (66.67 per cent) reported by Deore *et al.* (2008). The reason for lower values obtained in present study may be attributed to variations in variety, geographical conditions and to some extent the type of processing method employed (Table 4.1).

4.1.6 *Karela* (*Momordica charantia*)

Analysis of physical characteristics of fresh *karela* juice is given in Table 4.1. The per cent edible index and waste index of *karela* was found to be 98.59 per cent and 1.24 per cent respectively. Similar value (97.5 per cent) of edible index of *karela* was reported by Aggarwal and Kaur (1997). A range of percent edible index 94.3-96.8 per cent and waste index 3.2-5.7 per cent was reported in different varieties of bitter gourd by Kalra *et al.* (1983). Kulkarni *et al.* (2005) reported higher average value (4.8 per cent) of *karela* fruit waste than those obtained in present study. Per cent juice index was obtained as 46.31 per cent (Table 4.1).

4.1.7 Aloe vera *(Aloe barbadensis)*

The per cent edible index of aloe vera obtained in present study was 61.74 per cent while peel:pulp ratio was 1.01:1.64. These values were found to be in conformity with values reported by Ganesh and Alagukannan (2009). They reported 61.42 per cent gel yield and 1:1.6 peel:gel ratio. In aloe vera, per cent waste index and juice index was observed as 37.80 per cent and 59.03 per cent respectively (Table 4.1).

4.2 Organoleptic evaluation of juice blends

Juice blends were prepared by using different single strength juice in various proportions. The juice blends were evaluated for sensory characteristics viz. color, appearance, taste, flavour, consistency and overall acceptability by a team of panelists comprising of 15 semi trained members and trend using score cord. The preference or rating of the different juice blends were evaluated using Nine Point Hedonic scale.

4.2.1 Organoleptic evaluation *Lawki – Karela* (LK) juice blend

Four types of *Lawki – Karela* (LK) juice blends were prepared by blending *Lawki* and *karela* juice in the ratio of 135:15, 120:30, 105:45 and 90:60 using *Lawki* juice as control 150:0. Results of the sensory evaluation of *Lawki – karela* juice are presented in Table 4.2 (a).

4.2.1.1 Result of Nine Point Hedonic scale

Data pertaining to evaluation of *Lawki* kerela juice blend for sensory characteristics by Hedonic Scale with varying levels of *Lawki* and *karela* juice are depicted in Table 4.2 (a) showed that 41.33 per cent panelist rated the control as

liked moderately. However, as the level of *karela* was increased in the preparation of juice blends, the preference for the blends decreased. About 38.66 per cent panelists and 35.86 per cent panelists rated the blends having *Lawki* and *karela* juice in the ratio of 135:15 and 120:30 respectively as liked slightly. Since further increment in the level of *karela* juice resulted in rating of juice blends as disliked slightly, the *Lawki karela* juice blend 120:30 was selected for further incorporation of aloe vera juice.

4.2.1.2 Result of Score Card method.

Lawki - Karela juice blends having varying proportion of *Karela* juice and *Lawki* juice were analyzed for various sensory characteristics viz. color, appearance, flavour, taste, consistency and overall acceptability and data are presented in Table 4.2 (a).

4.2.1.2.1 Color

The highest mean sensory score (7.60) for color was obtained by the juice blend having *lawki* and *karela* juice in the ratio of 120:30 while control (150:0) received lowest scores (5.93). As the ratio of *karela* juice increased beyond 120:30, the mean sensory scores for color decreased. Incorporation of k*arela* juice showed significant difference in color of all blends when compared to control having only *lawki* juice. However, no significant difference in color was observed among the various juice blends (Table 4.2a).

4.2.1.2.2 Appearance

The highest mean sensory score for appearance was observed for the juice blend having *Lawki* and *karela* juice in the ratio of 120:30 followed by 105:45,

Table 4.2 (a) Sensory characteristics of Lawki – Karela (LK) juice blend

Lawki juice : karela juice	Color	Appearance	Flavour	Taste	Consistency	Overall acceptability	Preference
150:0	5.93±1.22	5.93±1.22	7.40±1.76	7.54±1.76	6.93±1.27	7.26±1.57	41.33 % LM
135:15	7.20±0.77	7.20±0.86	6.22±1.68	6.11±1.68	7.06±1.57	6.16±1.42	38.66 % LS
120:30	7.60±0.73	7.46±0.74	6.13±1.40	5.46±1.80	7.13±1.06	5.75±1.38	35.86 % LS
105: 45	7.40±0.98	7.33±0.16	5.53±1.59	5.38±2.03	6.73±1.38	5.49±1.54	32.00 % DS
90: 60	7.26±1.16	7.26±0.88	5.13±1.40	4.93±1.62	6.60±1.68	5.03±1.12	28.00 % DS
S. Em	0.25	0.22	0.40	0.46	0.36	0.36	-
CD at 5%	0.72	0.64	1.14	1.30	1.03	1.03	-

LM = Liked moderately, LS = Liked slightly, DS = Disliked slightly
*Mean of score given by 15 panelists±SD, **Maximum score = 10

Table 4.2 (b) Sensory characteristics of Carrot -Orange juice (CO) juice blend

Carrot juice: Orange juice	Color	Appearance	Flavor	Taste	Consistency	Overall acceptability	Preference
150:0	8.16±1.09	8.13±1.16	7.12±0.88	7.16±0.83	7.86±0.83	7.18±0.89	48.86 % LM
125:25	8.52±0.77	8.13±0.91	7.39±0.86	7.81±0.88	7.66±0.92	8.01±0.94	49.73 % LM
100:50	8.84±0.50	8.79±0.48	8.59±0.50	8.73±0.48	8.32±0.59	8.86±0.51	54.66 % LVM
75: 75	7.83±0.79	8.06±0.79	8.13±0.74	7.89±0.83	7.74±0.89	8.81±0.73	48.40 % LM
50: 100	7.05±0.97	7.14±0.83	7.83±1.08	6.48±1.08	7.36±1.03	7.41±1.08	44.00 % LS
25:125	6.33±1.16	6.76±0.96	6.47±1.09	6.33±1.23	7.24±1.18	6.46±1.12	36.40 % NLND
S.Em	0.23	0.22	0.22	0.24	0.23	0.23	-
CD at 5%	0.66	0.64	0.64	0.67	0.67	0.65	-

LM = Liked moderately, LVM= Liked very much, LS = Liked slightly,
NLND = Neither like nor dislike, *Mean of score given by 15 panelists±SD, **Maximum score = 10

90:60 and 135:15 *Lawki karela* juice blends. The control having no incorporation of *karela* juice showed least mean score 5.93 for appearance. No significant difference was found among the various blends. However, on comparing with control, all blends showed significant difference.

4.2.1.2.3 Flavour

The mean sensory score for the flavour was found to be highest for control (7.40) juice as compared to juice blends having *Lawki* and *karela* juice in varying proportions. Among the *Lawki* - *karela* juice blends, the highest mean sensory score (6.22) for flavour was observed for juice blend 135:15 while lowest (5.13) for 90:60 juice blend. Significant difference was observed between the control and different juice blends of *Lawki* and *karela*. However, no significant difference was observed among the juice blends having varying proportions of *karela* juice incorporated into *Lawki* juice (Table 4.2a).

4.2.1.2.4 Taste

The mean sensory score for taste was found to be highest for the control (7.54) having no *karela* juice incorporated into it. Among the blends, the mean sensory score was found to be maximum in case of juice blend having *Lawki* and *karela* juice in the proportion of 135:15. Further, it was observed that bitterness in juice blend increased as the level of *karela* juice was increased. While no significant difference in the taste of juice blends containing *Lawki* and *karela* juice in varying proportions was observed, a significant difference was observed between the control and different blends of *Lawki karela* juice.

4.2.1.2.5 Consistency

It is inferred from the results that mean sensory scores for consistency of juice blends with different levels of *karela* juice ranged from 6.60 to 7.13. Juice blend having *Lawki* and *karela* juice in the proportion of 90:60 obtained minimum score (6.60) while juice blend 120:30 scored highest (7.13) among juice blends for consistency. No significant difference was observed among the *Lawki* - *karela* juice blends and also between the control and juice blends (Table 4.2a).

4.2.1.2.6 Overall acceptability

The highest mean sensory score for overall acceptability was observed for control i.e. 7.26. The mean sensory score of *Lawki* - *Karela* juice blends having varying proportions of *karela* juice was found in the range of 6.16 to 5.03. A decreasing trend was observed among the juice blends while significant difference was observed between the control and various juice blends having different levels of *karela* juice but not among juice blends (Table 4.2a).

4.2.2 Organoleptic evaluation of Carrot – Orange (CO) juice blend

Five types of Carrot – Orange (CO) juice blends were prepared by blending carrot and orange juice in the ratio of 125:25, 100:50, 75:75, 50:100 and 25:125 using carrot juice as control (150:0). The results are presented in Table 4.2 (b).

4.2.2.1 Result of Nine Point Hedonic scale.

Data on organoleptic evaluation of carrot - orange juice blend for sensory quality by Hedonic Scale with varying levels of carrot and orange juice as shown in Table 4.2 (b) revealed that among six juice blends of carrot orange juice 54.66 per cent panelists preferred blend having carrot and orange juice in the ratio of

100:50 and rated like very much. Blends having carrot and orange juice in the ratio of 150:0, 125:25 and 75:75 were rated liked moderately by 48.86 per cent, 48.93 per cent and 48.40 per cent panelists respectively. Further, it was found that as the level of orange juice was increased, the preference for juice decreased. The juice blend with carrot and orange juice in the ratio of 50:100 was liked slightly by 44.00 percent panelists. The blend having highest level of orange juice (25:125) was rated neither like nor dislike by 36.40 percent panelists. The blend 100:50 had highest preference was further used for the preparation and evaluation of aloe vera incorporated juice (carrot-orange–aloe vera juice blend).

4.2.2.2 Result of Score Card Method

Carrot - orange juice blends having varying levels of carrot and orange juice were analyzed for various sensory characteristic like color, appearance, flavour, taste, consistency and overall acceptability. Data pertaining to sensory characteristics are presented in Table 4.2 (b).

4.2.2.2.1 Color

The mean sensory score for color of carrot - orange juice blend was found to be highest (8.84) for the blend having carrot and orange juice in the ratio of 100:50. Initial incorporation of orange juice showed no significant difference in color of juice blends i.e. 100:50 and 125:25 carrot- orange juice blend. But as the level of orange juice was increased, a significant difference in the acceptability of color of juice blends was observed. A decreasing trend was seen in the acceptability of color of juice blends from 100:50 to 25:125 carrots – orange juice blends (Table 4.2b).

4.2.2.2.2 Appearance

The highest mean sensory score for appearance (Table 4.2b) was observed as 8.79 for blend having carrot orange juice in the ratio of 100:50. Blend having carrot – orange juice in the ratio of 125:25 showed no significant difference in appearance as compared to control having carrot and orange juice in the ratio of 150:0. It was further noted that as the level of orange juice increased beyond the ratio 100:50, significant difference was observed in appearance of juice blends. The acceptability for appearance of juice blends decreased from 100:50 to 25:125 (8.84 to 6.33).

4.2.2.2.3 Flavour

The mean sensory score for the flavor of carrot - orange juice blends was found to be ranged from 6.47 to 8.59. The mean sensory score for control was found to be 7.12 and showed significant difference with all the blends of carrot and orange juice except with 125:25 carrot orange- juice blends. The highest mean sensory score was found to be 8.59 for carrot orange juice blend 100:50. Among the blends, no significant difference in the flavour was observed between blend having carrot and orange juice in the ratio of 100:50 - 75:75 and 75:75-50:100. However, carrot orange juice blends 100:50 and 50:100 showed significant difference. The mean sensory score for flavour decreased as the level of orange juice was increased. Thus showing decreasing trend in acceptability of flavour of juice with increased level of orange juice beyond 100:50 ratio of carrot and orange juice (Table 4.2b).

4.2.2.2.4 Taste

The highest mean sensory score (8.73) for taste was observed for blend having carrot and orange juice in the ratio of 100:50 while lowest (6.33) for blend

having carrot and orange juice in the ratio of 25:125. Mean sensory score of the juice blends showed a decreasing trend in acceptability for taste with increase in the level of orange juice after 100:50 ratios of carrot and orange juice. Significant difference was seen between the control and blends having varying proportions of carrot and orange juice. Among blends, no significant difference for taste was observed between 50:100 – 25:125 and 125:25 – 75:75 (Table 4.2b).

4.2.2.2.5 Consistency

The data regarding the consistency (Table 4.2b). of various juice blends of carrot and orange juice revealed that the blend with carrot orange juice in the ratio 100:50 had highest mean sensory score of 8.32 while CO juice blend in the ratio of 25:125 had lowest mean sensory score of 7.24. No significant difference in the consistency of control and juice blends was seen. However, a decreasing trend in the mean sensory score of juice blends having carrot and orange juice in varying proportions was observed. Among blends, significant difference was observed in the consistency of CO juice blend 100:50 – 50:100 and 100:50 – 25:125.

4.2.2.2.6 Overall acceptability

The highest mean sensory score for the overall acceptability of carrot and orange juice blends was found to be 8.86 for CO blend 100:50 while CO blend 25:125 scored lowest mean sensory score (6.48). The result showed that mean sensory score decreased with increase in level of orange juice. Significant difference between the control and carrot orange juice blend was seen except for CO juice blend 50:100. Among blends, no significant difference was observed between blend having carrot orange juice in the ratio of 125:25 and 75:75 respectively (Table 4.2b).

ShivKumar *et al.* (2009) reported that addition of orange juice in tomato juice at 10 per cent, 20 per cent and 30 per cent brought about increase in mean sensory score for appearance, color, flavour, taste and overall acceptability to a limit and then the scores declined, this trend was found to be in accordance with present study.

4.2.3 Organoleptic evaluation of *Aonla* Ginger (AG) juice blend

Four types of juice blends were prepared by mixing *aonla*, ginger, honey and water in ratio of 20:5:15:125, 30:5:15:115, 40:5:15:105, 50:5:15:95 with 0:5:15:145 as control. Data regarding to sensory characteristics are presented in Table 4.2(c).

4.2.3.1 Result of Nine Point Hedonic scale.

Data on the sensory evaluation of *aonla* – ginger (AG) juice blend with varying level of *aonla* juice as shown in Table 4.2(c) revealed that juice blend without *aonla* juice was least preferred by panelists (36 per cent) having only ginger juice and was rated neither liked nor disliked on Nine Point Hedonic scale.

Blends 40:5:15:80 and 50:5:15:95 both were rated like slightly by 42.2 and 40.4 percent panelists. However, 47.06 per cent panelists rated AG juice blend having *aonla* juice, ginger juice and water in the ratio of 20:5:15:110 as like moderately. Highest percentage of preference (52.2per cent) was observed in blend having *aonla* juice, ginger juice and water in the ratio of 30:5:15:100. Further it was observed that as the level of *aonla* juice increased, the preference increased from blend 0:5:15:130 to 30:5:15:100 then decreased to blend 50:5:15:95. The blend 30:5:15:100 was found to have high per cent of preference so it was further analyzed and used for the preparation of aloe vera incorporated juice blend (*Aonla*- Ginger- aloe vera juice blend).

Table 4.2 (c) Sensory characteristics of Aonla – Ginger (AG) juice blend

Aonla : Ginger : Honey : Water	Color	Appearance	Flavor	Taste	Consistency	Overall acceptability	Preference
00 : 5 : 15 : 130	6.40±0.80	7.11±0.80	6.31±1.10	6.20±1.04	6.73±1.39	6.13±1.08	36 % NLND
20 : 5 : 15 :110	7.29±0.33	8.43±0.44	7.14±0.69	7.23±0.71	7.60±0.95	7.53±0.80	47.06 % LM
30 : 5 : 15 : 100	8.16±0.44	8.21±0.44	8.82±0.67	8.73±0.67	8.26±.44	8.13±0.71	52.2 %LVM
40 : 5 : 15 : 90	7.73±0.65	7.88±0.67	7.78±0.73	7.98±0.71	7.74±.06	6.93±0.77	42.2 % LS
50 : 5 : 15 : 80	7.62±0.51	7.56±0.44	7.02±0.77	6.93±0.77	7.26±.12	6.80±0.74	40.40 % LS
S.Em	0.15	0.15	0.21	0.21	0.27	0.22	-
CD at 5%	0.43	0.43	0.61	0.60	0..77	0.63	-

LM = Liked moderately
LVM= Liked very much
LS = Liked slightly
NLND = Neither like nor dislike
*Mean of score given by 15 panelists±SD
**Maximum score = 10

4.2.3.2 Result of Score Card method.

4.2.3.2.1 Color

The highest mean sensory score for color was observed as 8.16 for blend having *aonla* and ginger in the ratio of 30:5 while the control having only ginger juice received the lowest score (6.40). Significant difference in the color of control and other juice blends was observed. Among blends no significant difference was observed between blends having *aonla* ginger juice in ratio 30:5-40:5 and 40:5-50:5. It was further observed that increase in the level of *aonla* juice increase the acceptability to a certain limit (30:5 blend) and then it decreased (Table 4.2c).

4.2.3.2.2 Appearance

The highest mean sensory score 8.43 for appearance was observed in juice blend having *aonla* and ginger juice in the ratio of 20:5 whereas blend with no *aonla* juice (control) showed least mean sensory score 7.11. Significant difference was observed between the appearance of control and various blends having *aonla* and ginger juice at varying levels. Among juice blends a decreasing trend in the mean sensory score of various blends was observed with increase in level of *aonla* juice beyond 20:5 ratio of *aonla* and ginger juice. Significant difference in appearance of blends having *aonla* and ginger juice in the ratio 20:5-40:5 and 30:5-50:5 was observed (Table 4.2c).

4.2.3.2.3 Flavour

Juice blend having *aonla* – ginger juice in the ratio 30:5 showed highest mean sensory score (8.82) for flavour followed by blend 40:5, 20:5, 50:5 and 0:5 (control) which scored least. Significant difference between the flavour of control

and juice blends was observed and the difference was also evident among juice blends. Further, decrease in mean sensory score was observed with increase in level of *aonla* juice in different juice blends. This might be due to acrid taste of *aonla* juice (Table 4.2c).

4.2.3.2.4 Taste

The highest and lowest mean sensory score for taste (Table 4.2c) of different juice blends was observed as 8.73 and 6.20 for blend having *aonla* – ginger juice in the ratio of 30:5 and control respectively. With increase in the level of *aonla* juice, it was found that mean sensory score decreased in juice blends. Significant difference was observed between control and juice blends and it was also noted among the juice blends having varying proportions of *aonla* juice.

4.2.3.2.5 Consistency

The highest mean sensory score was observed as 8.26 for blend having *aonla* and ginger juice in the ratio of 30:5. Mean sensory score for the consistency of juice blend was found to decrease with increase in the ratio of *aonla* juice. Significant difference was observed between the consistency of control and juice blends having varying proportions of *aonla* juice. No significant difference between the consistencies of 30:5-40:5, 40:5-50:5 and 20:5-40:5 juice blends was observed (Table 4.2c).

4.2.3.2.6 Overall acceptability

The mean sensory score for the overall acceptability (Table 4.2c) of blend having *aonla* and ginger juice in the ratio of 30:5 was found to be highest 8.13 while control received least mean sensory score (6.13). The overall acceptability

of juice blends was found to decrease with increase in level of *aonla* juice. Significant difference in the overall acceptability was observed between, control and juice blends. No significant difference was found in the overall acceptability of juice blend having *aonla* and ginger juice in the ratio of 20:5 and 30:5 respectively. Similar trend was seen in blends having *aonla* and ginger juice in the ratio 40:5 and 50:5.

4.2.4 Organoleptic evaluation of *Lawki Karela* (LK) juice and *Lawki-Karela*-Aloe vera LKA) juice blend

Data on sensory evaluation of *Lawki-Karela* (LK) juice and *Lawki-Karela*-Aloe vera (LKA) juice blend presented in Appendix VII and Fig. 4.1(a) showed that both the juice blends were rated as liked slightly. Thirty-seven per cent panelists preferred LK juice blend while 36.86 per cent panelists preferred LKA juice blend. The mean sensory scores for the color, appearance, flavour, taste, consistency and overall acceptability of LK juice blend was found to be 7.93, 7.86, 5.86, 5.80, 7.13 and 6.20 respectively. The mean sensory scores of LK juice blend showed no significant difference with LKA juice blend scores having 7.93, 7.86, 6.40, 6.66, 7.33, 6.46 scores for color, appearance, flavour, taste, consistency and overall acceptability respectively. Deka *et al.* (2002) reported that the effect of blending of apple with the pulp of mango, papaya and banana in the ratio of 75:25, 50:50 and 25:75 had no significant effect on the sensory quality of resultant nectars**.**

4.2.5 Organoleptic evaluation carrot -orange juice (CO) and carrot-orange- aloe vera (COA) juice blend

Data on mean sensory scores of CO and COA juice blends as given in Appendix VII and Fig. 4.1(b) showed that 52.86 per cent panelists rated CO juice

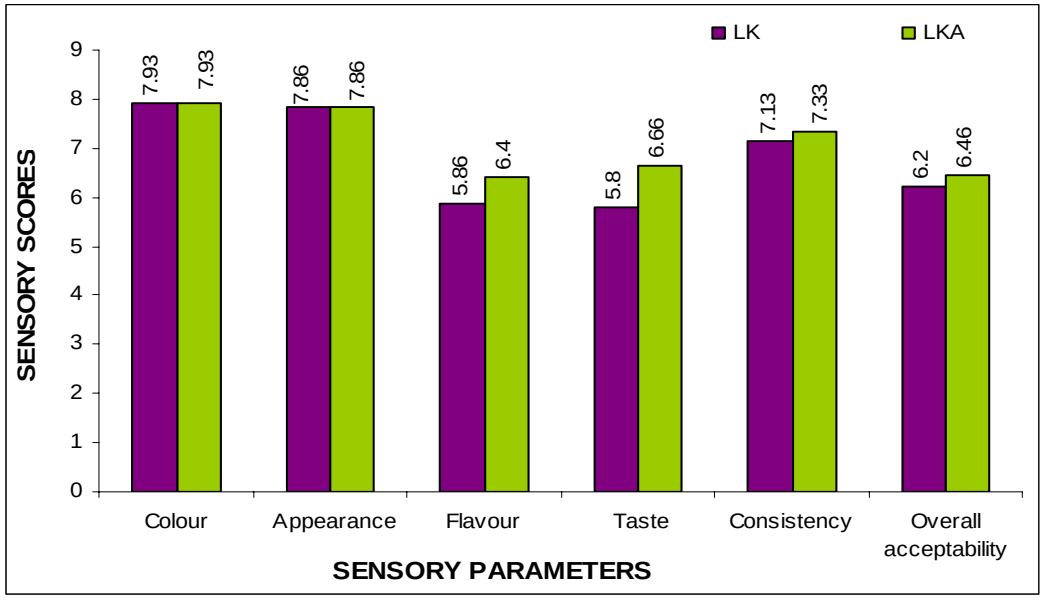


Fig. 4.1 (a) Organoleptic evaluation of LK and LKA juice blend

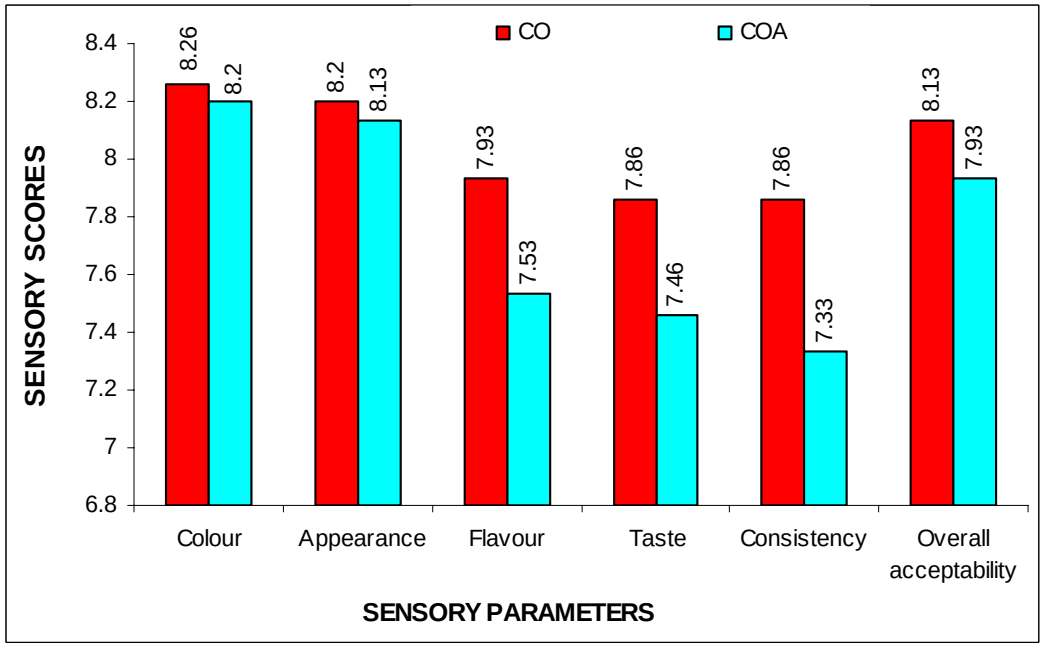


Fig. 4.1 (b) Organoleptic evaluation of CO and COA juice blend

blend as liked very much while 51.06 per cent panelists rated COA juice blend as liked moderately on Nine Point Hedonic scales. Data further revealed that addition of 30 ml aloe vera juices in 120 ml of carrot orange juice blend (CO) brought no significant difference in the sensory attributes of carrot -orange juice (CO) and carrot orange - aloe vera (COA) juice blend. The mean sensory score for color and appearance of CO juice was found to be 8.26 and 8.20 respectively while for COA juice it was 8.20 & 8.13 respectively which showed no significant difference. The mean sensory scores for flavour, taste, consistency and overall acceptability of CO juice blend were found to be 7.93, 7.86, 7.86, and 8.13 respectively and of COA juice blend the scores were 7.53, 7.46, 7.33, and 7.93 respectively showed no significance difference.

4.2.6 Organoleptic evaluation of *aonla*-ginger juice (AG) and *aonla*-ginger-aloe vera (AGA) juice blend

Data pertaining to the comparison of *aonla* - ginger juice blend (AG) and *aonla*-ginger-aloe vera juice blend (AGA) showed that 48.4 per cent panelists preferred AG juice blend while 47.53 per cent panelists preferred AGA juice blend. Both the juice blends were rated as liked moderately by the panelists. Data also revealed that there was no significant difference in the sensory parameters of AG juice and AGA juice blends. The mean sensory scores for color, appearance, flavour, taste, consistency and overall acceptability of AG juice blend was found to be 8.06, 7.93, 7.80, 7.80, 7.66, and 7.86 respectively. AGA juice blend scored 8.06, 7.93, 7.60, 7.60, 7.33, and 7.60 for various sensory attributes viz. color, appearance, flavour, taste, consistency and overall acceptability (Appendix VII and Fig. 4.1c).

4.3 Physico-chemical and nutritional composition of single strength juices

The data related to physico-chemical and nutritional composition single strength juice obtained from carrot, orange, amla, ginger, *Lawki*, *karela*, aloe vera and honey are depicted in Table 4.3.

4.3.1Carrot juice

4.3.1.1Moisture

The moisture content of carrot juice was found to be 91.42 per cent. Kalra *et al.* (1987) reported 88.82 per cent to 92.43 per cent moisture in carrot roots which is in close association with the values obtained in present study. Gothwal *et al.* (1998) and Lingappa and Naik (1999) estimated 87.5 per cent and 87 per cent moisture in carrot respectively A range of seasonal variation was reported in carrot by Tsukakoshi *et al.* (2009) i.e. 88.55 to 90.09 per cent on fresh weight basis. Madan and Dhawan (2005) measured 91.25 per cent moisture in fresh carrot. This value of moisture content is in conformity with the value obtained in the present study (Table 4.3).

4.3.1.2 Total solids

The total solids content of fresh carrot juice in the present study was observed as 8.56 per cent. Grewal and Jain (1982) reported 6.40 per cent of total solids in carrot juice. Kaur *et al.* (1976) reported that total solids in different varieties of carrot ranged from 7.57 to 10.05 per cent. Vandresen *et al.* (2009) reported 8.94 per cent total solids in carrot which are found to be in accordance with the value obtained in the present study (Table 4.3).

Table 4.3 Chemical characteristics of single strength juice of Carrot, Orange, *Aonla*, Ginger, *Lawki*, *Karela*, Aloe Vera and Honey

Parameters	Carrot	Orange	*Aonla*	Ginger	*Lawki*	*Karela*	Aloe vera	Honey
Moisture (%)	91.42±0.12	88.88±0.16	88.65±0.56	87.14±1.55	95.63±0.17	94.43±0.20	99.34±0.23	19.68±0.28
Total solids (%)	8.56±0.13	11.11±0.16	11.33±0.56	12.85±1.55	4.36±0.17	5.56±0.20	0.65±0.23	80.31±0.28
TSS (^{0}Brix)	7.53±0.25	11.36±0.25	11.4±0.2	4.63±0.30	5.2±0.2	4.43±0.30	0.5±0.3	80.53±0.25
pH	6.29±0.06	3.52±0.09	2.55±0.03	6.61±0.07	6.8±0.03	7.32±0.03	4.44±0.03	3.86±0.04
Titrable acidity (%)	0.13±0.01	0.53±0.18	2.34±0.36	0.14±0.03	0.128±0	0.085±0.03	0.11±0.03	0.15±0.02
Brix acid ratio	58.87±10.44	23.53±9.65	4.93±0.77	36.91±13.32	43.33±1.67	58.59±23.05	4.44±1.50	562.29±100.62
Reducing sugar (%)	2.48±0.02	5.29±0.02	7.8±0.10	0.209±0.00	1.74±0.03	3.40±0.01	0.170±0.03	67±2.11
Non reducing sugar (%)	3.04±0.05	4.25±0.08	3.05±0.35	0.091±0.01	1.04±0.02	0.96±0.53	0.14±0.01	2.45±1.35
Total sugar (%)	5.53±0.03	9.55±0.05	10.86±.23	0.3±0.002	2.78±0.01	4.08±0.01	0.31±0.01	69.45±0.96
Free acidity (meq/kg)	-	-	-	-	-	-	-	29.0±1.80
Lactonic acid (meq/kg)	-	-	-	-	-	-	-	15.5±1.00
Total acidity (meq/kg)	-	-	-	-	-	-	-	44.33±1.6
Ascorbic acid (mg/100ml)	8.74±0.94	23.50±1.89	624.56±2.36	5.46±1.183	12.24±0.62	87.48±1.08	0.8±1.35	20.22±1.24
Beta carotene (mg/100ml)	7.2±1.11	4.31±0.21	-	-	-	-	-	-
Chlorophyll -a (mg/100ml)	-	-	0.48±0.12	0.74±0.18	3.131±0.06	168.60±0.04	-	-
Chlorophyll- b (mg/100ml)	-	-	0.24±0.07	1.47±0.34	2.72±0.24	73.54±0.20	-	-
Total chlorophyll (mg/100ml)	-	-	0.73±0.18	2.22±0.53	5.85±0.18	242.15±0.22	-	-

* Mean of triplicate observations±SD

4.3.1.3 Total soluble solids (TSS)

TSS of carrot juice was investigated as 7.53 brix. Vandresen *et al.* (2009) and Khan *et al.* (1988) reported value of TSS in carrot juice as 7.57 and 7.00^0 brix respectively which is in agreement with the result of present study. Pandey *et al.* (2003) and Grewal and Jain (1982) showed slightly lower value of (6.00^0 brix) TSS in carrot juice. Sahota *et al.* (2009); AnandKumar *et al.* (2008) and Madan and Dhawan (2005) reported similar value of 7^0 brix, 7.30^0 brix and 7.48^0 brix in fresh carrot respectively. A higher value than value in present study was reported by Koca and Kardeniz (2008) as 9.64^0 brix in carrot. Little variation in TSS value may be attributed to variety, environmental conditions and methods of preparation (Table 4.3).

4.3.1.4 pH

The pH of carrot juice was found to be 6.29 which is in conformity with those reported by Sharma *et al.* (2009) as 6.22. The value reported by Pandey *et al.* (2003) and Grewal and Jain (1982) as 5.32 and 5.20 respectively is slightly lower than the pH value obtained in the present study. Pandey *et al.* (2003) and Sahota *et al.* (2009) reported higher pH value i.e. 7.1 and 7.3 respectively in carrot juice. Zhou *et al.* (2009) reported 6.55-6.74 pH range in carrot (Table 4.3).

4.3.1.5 Titrable acidity

The titrable acidity in carrot juice was measured as 0.13 per cent. Pandey *et al.* (2003) showed a comparable value of 0.125 per cent acidity in carrot juice. Vandresen *et al.* (2009) and Sharma *et al.* (2009) reported slightly higher titrable acidity i.e. 0.14 per cent and 0.148 per cent respectively than the value in `present study. A very low value was also estimated by Grewal and Jain (1982) i.e. 0.099

in carrot juice however Sahota *et al.* (2009) calculated higher percentage of acidity in different varieties of carrot as 0.22 to 0.25 per cent (Table 4.3).

4.3.1.6 Brix acid ratio

The brix acid ratio (Table 4.3) of carrot juice was obtained as 58.87. Grewal and Jain (1982) also reported somewhat similar value of 60.60 of brix acidity in carrot juice. Sahota *et al.* (2009) reported low value of brix acid ratio in different varieties of carrot (19.44 and 34.00).

4.3.1.7 Reducing sugar

The reducing sugar (Table 4.3) content of fresh carrot juice was estimated as 2.48 per cent. Sharma *et al.* (2009) and Pandey *et al.* (2003) reported 3.39 per cent and 3.40 per cent reducing sugar respectively in carrot juice which is found to be higher than the value obtained in the present study. A wide range of reducing sugar was reported in different varieties of carrot by Kaur *et al.* (1976) i.e. 1.67 to 3.35 per cent. The value obtained in the present study was found to lie in this range. However, a slightly lower value of reducing sugar was reported as 2.20 per cent in fresh carrots by Madan and Dhawan (2005).

4.3.1.8 Non-reducing sugar

The non-reducing sugar content of carrot juice in present study was found as 3.04 per cent. Non-reducing sugar content of 5 different varieties of carrot was 1.02 to 1.18 per cent as reported by Kaur *et al.* (1976). This reported value is slightly lower than the result of present study. Madan and Dhawan (2005) showed higher value of reducing sugar i.e. 3.52 than the present finding (Table 4.3).

4.3.1.9 Total sugar

The total sugar content of fresh carrot juice was obtained as 5.53 per cent. Gothwal *et al.* 1998 and Anandkumar *et al.* (2008) found slightly higher total sugar content (6.96 and 7.50 per cent respectively) in carrot whereas Khan *et al.*1988 reported slightly lower value of total sugar (4.09 per cent) in carrot juice. Previous investigator Madan and Dhawan (2005) and Vandresen *et al.* (2009) estimated 5.72 and 5.47 per cent total sugar respectively in fresh carrots which is found to be comparable with the value obtained in present study. Similarly Pandey *et al.* (2003) and Tsukakoshi *et al.* 2009 reported a comparable value 5.13 and 5.41 to 6.26 per cent of total sugar in carrot juice (Table 4.3).

4.3.1.10 Ascorbic acid

The ascorbic acid (Table 4.3) in carrot juice was found to be 8.74 mg/100ml. Pandey *et al.* (2003) and Grewal and Jain (1982) reported very lower value of ascorbic acid in carrot juice i.e. 1.83 mg/100ml and 1.81mg/100 ml respectively. Khan *et al.* (1988) estimated slightly lower ascorbic acid (4.68 mg/100ml) in carrot juice. However, higher ascorbic acid content (mg/100g) was measured as 9.50 and 8.9 in fresh carrot by Gothwal *et al.* (1998) and Gebczynski (2006) respectively. These reported values are in agreement with the result of present study.

4.3.1.11 Beta- Carotene

The carrot juice was found to have 7.20 mg/100 ml β carotene. Sharma *et al.* (2009) and Grewal and Jain *et al.* (1982) reported a comparable value of β carotene in carrot juice i.e. 3.408 mg/100g and 4.27 mg/100ml respectively. However, Sethi and Anand (1983) and Lingappa and Naik (1997) reported β carotene content (mg/100g)

as 11.88 and 13.60 in carrot respectively. This reported value of β carotene is higher than value obtained in the present study (Table 4.3).

4.3.2 Orange juice

4.3.2.1 Moisture

The moisture content of orange juice was found to be 88.88 per cent. Tanushree *et al.* (2009) reported 90.49 per cent moisture in the juice of Malta (Citrus seninsis). Gopalan *et al.* (2004) reported higher moisture content i.e. 97.7 per cent in orange juice but also reported a comparable value of 87.6 per cent moisture in orange fruit (Table 4.3).

4.3.2.2 Total solids

The total solids content of orange juice was estimated as 11.11 per cent. Kaveri and Gupta (2001) reported 10.5 per cent total solids in single strength orange juice. The value reported by them is found to be comparable to the value obtained for orange juice in the present investigation (Table 4.3).

4.3.2.3 Total soluble solids

The TSS of orange juice was found to be 11.36 ^{0} brix. Ying *et al.* (2008) reported a wide range of TSS (8.7-10.8 ^{0} brix) in orange. Similar range of TSS was also given by Beerh and Rane (1983) as 8.40-10.20 ^{0} brix in different varieties of oranges. Whereas Kaveri and Gupta (2001) and ShivKumar *et al.* (2006) reported lower value i.e. 10.0 and 10.8 ^{0} brix TSS in orange juice respectively. A comparable value of TSS of orange juice in present study was reported by Jain *et al.* (1984) as 11.00 ^{0} brix. Supraditareporn and Pinthong (2007) also reported similar TSS values (11.93 and 11.46^{0} brix) in different varieties of orange which

was found to be in accordance with the findings of present study. Tiwari *et al.* (2009) found 9.60 ^{0} brix TSS in orange juice (Table 4.3).

4.3.2.4 pH

The pH of orange juice was measured as 3.52. Jain *et al.* (1984); Kaveri and Gupta (2001); ShivKumar *et al.* (2006) and Tiwari *et al.* (2009) reported, 3.50, 3.55, 3.53 and 3.41 pH in orange juice. The value reported by them was found to be in agreement with the present investigation value. Ying *et al.* (2008) reported slightly higher pH range for oranges (3.8-4.31). Higher pH value than the value of present study was also measured by Beerh and Rane (1983) and Ladaniya *et al.* (2004) as 4.0-4.2 and 4.03 respectively in oranges (Table 4.3).

4.3.2.5 Titrable acidity

The titrable acidity (Table 4.3) of orange juice was estimated as 0.53 per cent in terms of citric acid. Jain *et al.* (1984), Kaveri and Gupta (2001) and Tewari *et al.* (2009) gave higher values of titrable acidity as 0.68 per cent, 0.65 and 0.78 per cent in orange juice respectively. Further a higher value was reported by Goyle and Ojha (1998) as 1.80 per cent. A value higher than the value of present study was reported by Beerh and Rane (1983) as 0.8 per cent. The investigator further reported 0.5 per cent titrable acidity in another variety of orange which is found to be in agreement with present study result. Similar value of 0.52 per cent titrable acidity was also given by Supraditareporn and Pinthong (2007).

4.3.2.6 Brix acid ratio

The brix acid ratio of orange juice was found to be 23.53. A low value of brix acid ratio in orange juice (16.9, 12.8 and 14.11) was reported by Jain *et al.* (1984),

Kaveri and Gupta (2001) and Tiwari *et al.* (2009) respectively. Whereas Ladaniya *et al.* (2004) and Shivkumar *et al.* (2006) reported higher ratio than the ratio obtained in the present study i.e. 51.81 and 31.76 respectively. However, a comparable value of brix acid ratio of 20.40 and 22.03 was measured by Beerh and Rane (1983) and Supraditareporn and Pinthong (2007) in oranges respectively (Table 4.3).

4.3.2.7 Reducing sugar

The orange juice was found to contain 5.29 per cent reducing sugar. Jain *et al.* (1984) and Shivkumar *et al.* (2006) reported slightly lesser value of reducing sugar in orange juice i.e. 4.98 and 3.76 per cent respectively. Kaveri and Gupta (2001) reported 5.30 per cent reducing sugar in orange juice. This value showed conformity with the value obtained in present study. A slightly higher value of reducing sugar in orange was noticed in the values reported by Beerh and Rane (1983) in orange as 5.40 per cent (Table 4.3).

4.3.2.8 Non reducing sugar

The non - reducing sugar in orange juice was measured as 4.25 per cent. A higher value of non - reducing sugar can be seen in orange juice estimated by Shivkumar *et al.* (2006) i.e. 5.20 per cent. Whereas Kaveri and Gupta (2001) and Jain *et al.* (1984) found 4.30 and 4.11 per cent non- reducing sugar in orange juice respectively. The values of non - reducing sugar in orange juice reported by them are found to be in agreement with the values of non - reducing sugar estimated in present study (Table 4.3).

4.3.2.9 Total sugar

The orange juice was found to contain 9.55 per cent total sugar. Jain *et al* (1984) and ShivKumar *et al.* (2006) reported 9.09 and 8.96 per cent total sugar in

orange juice respectively. These values of total sugar are slightly lesser than the values obtained in the present investigation. However, Kaveri and Gupta (2001) reported a comparable value of total sugar in orange juice i.e. 9.60 per cent which confirms the present value of total sugar in orange juice (Table 4.3).

4.3.2.10 Ascorbic acid

The ascorbic acid content of orange juice was found to be 23.50 mg/100ml. Tiwari *et al.* (2009) reported higher value of ascorbic acid in orange juice than the value in present study i.e. 46.62 mg/100g. Jain *et al.* (1984) and Shivkumar *et al.* (2006) showed slightly higher value of ascorbic acid (mg/100g) 26.04 and 27.56 in orange juice respectively. A near about comparable value of ascorbic acid as 25.50 and 25.33 mg/100g was recorded by Beerh and Rane (1983) and Supraditareporn and Pinthong (2007) in oranges respectively (Table 4.3).

4.3.2.11 Beta - carotene

The β-carotene in present study was estimated as 4.31 mg/100ml. Supraditareporn and Pinthong (2007) reported a low value of .0427 and .0198 mg/100g β-carotene in oranges. Similarly low values are also reported by USDA, as 0.033 mg/100ml. However, Mehta and Bajaj (1983) estimated 2.13 mg/100g carotenoids in fresh kinnow juice which is found to be comparable with the β carotene content of orange juice in the present study (Table 4.3).

4.3.3 *Aonla* juice

4.3.3.1 Moisture

The moisture (Table 4.3) content of *aonla* juice was found to be 88.65 per cent. Daisy and Gehlot (2006) and Chaudhary *et al.* (2003) reported 86.50 to 86.80

per cent and 86.93 per cent moisture in *aonla* which is lower than the present study. Mehta *et al.* (2002) reported a range of moisture content i.e. 85.20 to 88.10 per cent in different varieties of *aonla*. The range is found to be in agreement with the moisture content of present study. Premi *et al.* (2002) reported comparatively a low value of moisture (80.98 per cent) in *aonla*. However, they simultaneously reported a some what near value i.e. 87.17 per cent of moisture in different variety of *aonla*.

4.3.3.2 Total solids

The total solids (Table 4.3) content of *aonla* juice was estimated as 11.33 per cent. From the investigations of Mehta *et al.* (2002), Premi *et al.* (2002), Chaudhary *et al.* (2003) and Daisy and Gehlot (2006) it is observed that total solids content of *aonla* ranges from 11.90 to 19.02 per cent. This reported range is in agreement with the finding of the present study.

4.3.3.3 Total soluble solids (TSS)

Total soluble solids (TSS) of *aonla* juice was found to be 11.40 ^{0} brix. Teotia *et al.* (1968) reported 9.0 to 15.2 ^{0} brix TSS in different varieties of *aonla*. Garg *et al.* (2008) showed both low (10.20 ^{0} birx) and high (12.40 ^{0} brix) TSS for *aonla*. Thorat *et al.* (2007) estimated a high value of 15.70 and 15.20 ^{0} brix TSS in *aonla* juice extracted by cold and hot method respectively. A very low value (8.76 ^{0} brix) was measured by Premi *et al.* (2002). Similar both high (12.80 ^{0} brix) value and low value (10.10 ^{0} brix) was also reported by Daisy and Gehlot (2006). TSS content of five different varieties of *aonla* was 10.33 to 13.06^{0} brix as reported by Mehta *et al.* (2002). This reported value is in agreement with the result of the present study (Table 4.3).

4.3.3.4 pH

pH of anola juice was measured as 2.55. Thorat *et al.* (2007) reported a lower pH value i.e. 2.05 and 2.08 of *aonla* juice extracted by two different methods. A relatively high pH value 2.9 and 2.82 was observed by Chaudhary *et al.* (2003) and Premi *et al.* (2002) respectively. However, Premi *et al.* (2002) also reported pH of *aonla* as 2.50 which is found to be in conformity with the value obtained in present investigation (Table 4.3).

4.3.3.5 Titrable acidity

The titrable acidity (Table 4.3) of *aonla* juice was found to be 2.34 per cent in terms of citric acid. Garg *et al.* (2008) and Premi *et al.* (2002) reported 2.8 per cent and 3.35 per cent titrable acidity of *aonla* respectively which was higher than the value of present study. According to earlier investigations, the titrable acidity of *aonla* ranged from 1.36 to 2.58 per cent (Teotia *et al,*. 1968 and Mehta *et al.*, 2002). The results reported by them are comparable to the value obtained for *aonla* juice in the present study.

4.3.3.6 Brix acid ratio

The brix acid ratio (Table 4.3) of *aonla* juice was found to be 4.93. Mehta *et al.* (2002) reported a range of brix acid ratio 4.52 to 9.60 in different varieties of *aonla*. The reported value is in agreement with the result of present study.

4.3.3.7 Reducing sugar

The reducing sugar (Table 4.3) content of *aonla* juice was observed as 7.8 per cent. This value of reducing sugar was lower than the values of previous workers who reported a wide range of reducing sugar from 1.03 to 4.8 per cent

(Teotia *et al.,* 1968; Kalra *et al.,* 1988; Chaudhary *et al.,* 2003) in different varieties of *aonla*. Mehta *et al., 2002* found that the reducing sugar content of *aonla* in different varieties ranged from 5.18 to 8.48 per cent. Daisy and Gehlot (2006) reported 7.85 per cent reducing sugar in *aonla*. The value is in agreement with the result of present study.

4.3.3.8 Non-reducing sugar

The non reducing sugar (Table 4.3) content of *aonla* juice was found to be 3.05 per cent. Mehta *et al.* (2002) reported slightly lesser range of non-reducing sugar in *aonla* i.e. 2.02 to 2.96 per cent. Chaudhary *et al.* (2003) reported very low value for the non-reducing sugar content of *aonla* i.e. 0.74 per cent. The value of non-reducing sugar obtained from the investigation of Daisy and Gehlot (2006) was found to be in accordance with the value of present study (3.39 per cent).

4.3.3.9 Total sugar

The total sugar content of *aonla* juice was found to be 10.86 per cent. According to earlier investigations, the total sugar content of *aonla* ranged from 3.10 to 9.6 per cent (Teotia *et al.,* 1968; Kalra *et al.,* 1988; Chaudhary *et al.,* 2003; Thorat *et al.,* 2007 and Garg *et al.,* 2008). The result reported by them are comparable to the values obtained for *aonla* juice in the present study. However, Daisy and Gehlot (2006) and Mehta *et al.* (2002) reported 10.59 and 10.87 per cent total sugar in *aonla* which is found to be in agreement with the total sugar content of *aonla* juice in the present study (Table 4.3).

4.3.3.10 Ascorbic acid

Ascorbic acid acts as an antioxidant. Ascorbic acid content of *aonla* juice was obtained as 624.50 mg/100ml. Mehta *et al.* (2002) reported 408.53 to 583.32

mg/100g ascorbic acid in different varieties of *aonla*. These values are found to be lesser than the result of present study. A range higher than the value of present study was reported as 645-680 mg/100g by Teotia *et al.* (1968), Mehta *et al.* (2002), Premi *et al.* (2002) and Throat *et al.* (2007). However, Daisy and Gehlot (2006) reported 629 mg/100g ascorbic acid in *aonla* which is found to be in conformity with the value obtained in present investigation (Table 4.3).

4.3.3.11 Chlorophyll

The chlorophyll-a, chlorophyll-b and total chlorophyll content of *aonla* juice (Table 4.3) was found to be 0.48, 0.24 and 0.73 mg/100ml. Selvi *et al.* (2007) reported 0.5 mg/100mg of total chlorophyll (mg/g) in *aonla* leaves.

4.3.4 Ginger juice

4.3.4.1 Moisture

The moisture content of ginger juice was found to be 87.14 per cent. Tripathi and Nath (2004), Krishnapillai (2005) and Odebunmi *et al.* (2010) reported 68.60 per cent, 78.71 per cent and 76.86 per cent moisture in ginger rhizomes respectively. The value obtained in the present study is higher than the reported values. Gopalan *et al.* (2004) showed slightly lower value i.e. 80.90 per cent of moisture in ginger. Phoungchandang and Sertwasana (2010) found 82.64 to 93.37 per cent moisture in fresh ginger harvested during different months of year which was in agreement with the range of moisture content in the present study (Table 4.3).

4.3.4.2 Total solids

The total solids content of ginger juice was found to be 12.85 per cent. Odebunmi *et al.* (2010) reported 23.14 per cent total solids in ginger on dry matter

basis which is higher than the present value. From the investigation of Gopalan *et al.* (2004) it can be seen that the total solids of ginger was 19.10 per cent which is higher than the total solids content of ginger juice in present study (Table 4.3).

4.3.4.3 Total soluble solids (TSS)

The total soluble solids content of ginger juice was observed as 4.63 ^{0} brix. Singh *et al.* (2005) reported 2.67 and 3.17 ^{0} brix of total soluble solids in two different types of ginger. These values are lower than the total soluble solids content of ginger juice in the present study. Krishnapillai (2005) reported higher value (5.05 ^{0} brix) of TSS in ginger rhizomes (Table 4.3).

4.3.4.4 pH , Titrable acidity and Brix acid ratio

pH of ginger juice was measured as 2.55. The titrable acidity of ginger juice was found to be 0.14 per cent in terms of citric acid. Singh *et al.* (2005) reported 0.09 per cent and 0.14 per cent titrable acidity in Pahari and Desi variety of ginger respectively. The values are in agreement with the result of present study. The brix acid ratio of ginger juice was found to be 36.91 (Table 4.3).

4.3.4.5 Reducing sugar

The reducing sugar content of ginger juice was found to be 0.209 per cent. Policegoudra and Aradhya (2007) reported 0.42 per cent reducing sugar in Mango ginger which is slightly higher than the value in present investigation (Table 4.3).

4.3.4.6 Non-reducing sugar

The non-reducing sugar content of ginger juice was estimated as 0.091 per cent. A higher value of non-reducing sugar (0.53 per cent) was observed by Policegoudra and Aradhya (2007) in Mango ginger (Table 4.3).

4.3.4.7 Total sugar

The total sugar (Table 4.3) content of ginger juice was found to be 0.3 per cent. A value higher than present investigation was reported by Policegoudra and Aradhya (2007) in mango ginger (0.95 per cent).

4.3.4.8 Ascorbic acid

The ascorbic acid (mg/100ml) of ginger juice was found to be 5.46. Gopalan *et al.* (2004) reported slightly higher value of ascorbic acid (6.0). Tripathi and Nath (2004) and Singh *et al.* (2005) reported lower value i.e. 3.10 and 2.83 mg/100g of ascorbic acid in ginger. However, Singh *et al.* (2005) also showed a value of 5.11 mg/100g of ascorbic acid which is found to be in agreement with the value of present study (Table 4.3).

4.3.4.9 Chlorophyll

The ginger juice was found to contain 0.74 per cent, 1.47 per cent and 2.22 per cent chlorophyll-a, chlorophyll-b and total chlorophyll respectively (Table 4.3).

4.3.5 *Lawki* / bottle gourd juice

4.3.5.1 Moisture

The moisture content of bottle gourd was found to be 95.63 per cent. Previous investigations by Gopalan *et al.* (2004), Babar *et al.* (1998), Deore *et al.* (2008), Sawate *et al.* (2009), Kubde *et al.* (2010) showed that moisture content of bottle gourd ranged from 96.1 to 96.5 per cent. This range is found to be comparable with the value of moisture in present study (Table 4.3).

4.3.5.2 Total solids

The total solids content of bottle gourd juice was observed as 4.36 per cent. From the investigations of Babar *et al.* (1998), Deore *et al.* (2008) and Kubde *et*

al. (2010), it can be concluded that total solids content of bottle gourd ranged from 3.50 to 3.90 per cent which is found to be comparable with the value in present study (Table 4.3).

4.3.5.3 Total soluble solids (TSS)

The total soluble solids of bottle gourd juice was found to be 5.2 ^{0} brix. Babar *et al.* (1998) and Sawate *et al.* (2009) reported 3.5 ^{0} and 3.0 ^{0} brix TSS in bottle gourd which is lesser than the result of present study. Deore *et al.* (2008) observed TSS of bottle gourd to be 5.24 ^{0} brix which is in agreement with the result of the present study (Table 4.3).

4.3.5.4 pH

The pH of bottle gourd juice in the present study was measured as 6.80. Siddique *et al.* (1990) reported pH of fresh wax gourd as 5.30 is slightly lower than the pH obtained in the present study (Table 4.3).

4.3.5.5 Titrable acidity

The titrable acidity of bottle gourd juice was found to be 0.128 per cent in terms of citric acid. Sawate (2009) and Deore *et al.* (2008) both reported 0.12 per cent titrable acidity of bottle gourd which is in conformity with the value obtained in the present study (Table 4.3).

4.3.5.6 Brix acid ratio

The brix acid ratio of bottle gourd juice was found to be 43.33. The investigation done by Sawate *et al.* (2009) showed brix acid ratio of bottle gourd to be 25.00 which is lower than the value reported in present study. However, from the study of Babar *et al.* (1998) it may be concluded that bottle gourd has a

brix acid ratio of 43.66 which is in agreement with the value of present study (Table 4.3).

4.3.5.7 Reducing sugar

The reducing sugar content of bottle gourd juice was observed as 1.74 per cent. Babar *et al.* (1998) reported reducing sugar content of bottle gourd as 1.20 per cent which is lesser than the value of present study. Sawate *et al.* (2009) showed 1.80 per cent reducing sugar in bottle gourd. This value is found to be comparable with the reducing sugar content of bottle gourd juice in the present study (Table 4.3).

4.3.5.8 Non-reducing sugar

The non-reducing sugar content of bottle gourd juice was estimated as 1.04 per cent. Siddique *et al.* (1990) reported 0.2 per cent of non-reducing sugar in wax gourd which is found to be lesser than the value of present study. From the investigation of Babar *et al.* (1998) it can be concluded that bottle gourd contains 1.80 per cent of non-reducing sugar. Whereas Sawate *et al.* (2009) reported that bottle gourd contains 1.0 per cent non-reducing sugar. This value is in agreement with the value of present study (Table 4.3).

4.3.5.9 Total sugar

The total sugar content of bottle gourd juice was calculated as 2.78 per cent. Babar *et al.* (1998) and Deore *et al.* (2008) reported 3.00 and 3.50 per cent total sugar in bottle gourd. The value obtained in present study is slightly lower than the reported values. Sawate *et al.* (2009) found 2.80 per cent total sugar in bottle gourd. The result reported by them are in agreement with the value obtained in present study (Table 4.3).

4.3.5.10 Ascorbic acid

The ascorbic acid content of bottle gourd juice was found to be 12.24 mg/100 ml. Babar *et al.* (1998) reported 14.00 mg/100g ascorbic acid in bottle gourd. The value obtained in present study is less than this reported value. Rehman *et al.* (2008) reported a low value of 6.0 mg/100g whereas Okiei *et al.* (2009) reported 8.70 and 12.4 mg/100g ascorbic acid estimated by 2 different methods in bottle gourd. Investigation done by Sawate *et al.* (2009) showed that bottle gourd contained 12.5 mg/100g ascorbic acid which is in accordance with the value of present study (Table 4.3).

4.3.5.11 Chlorophyll

The chlorophyll-a, chlorophyll-b and total chlorophyll (Table 4.3) content of bottle gourd juice was found to be 3.13, 2.72 and 5.85 mg/100 ml respectively. Deore *et al.* reported 5.6 mg/100g total chlorophyll in bottle gourd which is in agreement with the value of present investigation. Bohn *et al.* (2004) reported 3.6 mg/100g chlorophyll a in cucumber which is higher than the value in present study while value of chlorophyll b value is found to be comparable with present study (2.5 mg/100g).

4.3.6 *Karela* / bitter gourd juice

4.3.6.1 Moisture

The moisture content of bitter gourd juice was found to be 94.43 per cent. Gopalan *et al.* (2004) reported lesser value of moisture in bitter gourd (83.20 per cent). Kalra *et al.* (1983) reported 79.50 to 82.80 per cent of moisture in different varieties of bitter gourd. The value obtained in present investigation is higher than

the reported value. Further according to earlier reports, the moisture content of bitter gourd ranged from 88.42 to 89.58 per cent. (Kulkarni *et al.,* 2005 and Hussain *et al.,* 2009). Horax *et al.* (2010) reported 91.20 per cent to 92.4 per cent moisture in bitter gourd harvested at different stage of maturity. Dhillon *et al.* (2005) reported 82.77 to 85.24 per cent and 85.92 to 94.60 per cent moisture in wild and cultivated genotypes of bitter gourd respectively. The values reported by them are found to be comparable with the moisture content of bitter gourd in present study (Table 4.3).

4.3.6.2 Total solids

The total solids content of bitter gourd juice found to be 5.56 per cent. From the studies of various investigators it may be concluded that total solids content of bitter gourd ranged from 7.6 to 20.5 per cent (Kalra *et al.,* 1983; Gopalan *et al.,* 2004; Kulkarni *et al.,* 2005; Hussain *et al.,* 2009 and Horax *et al.,* 2010)). The values obtained from these studies are found to be higher than the value of present study. While from the investigation of Dhillon *et al.* (2005), it can be seen that total solids content of bitter gourd ranged from 5.4 to 14.08 per cent. The result of present study was found to be in conformity with the value of their investigations (Table 4.3).

4.3.6.3 Total soluble solids (TSS) and pH

The total soluble solids (Table 4.3) of bitter gourd juice was found to be 4.43 ^{0} brix. Barwal *et al.* (2006) observed 3.00 ^{0} brix TSS in bitter gourd. The value reported by them are slightly lesser than present study. Aggrawal and Kaur (1997) found 3.50 ^{0} brix bitter gourd which is found comparable with present study. The pH of bitter gourd juice in the present investigation was found to be 7.32.

4.3.6.4 Titrable acidity

The titrable acidity of bitter gourd juice was found to be 0.085 per cent in terms of citric acid. Aggrawal and Kaur (1997) and Khattak *et al.* (2005) gave higher value of titrable acidity i.e. 0.21 and 0.25 per cent of bitter gourd than the value obtained in the present study. Barwal *et al.* (2006) reported 0.056 per cent titrable acidity of bitter gourd. The value obtained by Kulkarni *et al.* (2005) was found to be in agreement with the value of titrable acidity of present study. They reported 0.083 per cent of titrable acidity in bitter gourd (Table 4.3).

4.3.6.5 Brix acid ratio

The brix acid ratio of bitter gourd juice was found to be 58.59. From the investigation of Aggrawal and Kaur (1997), it may be concluded that the brix acid ratio of bitter gourd was 16.66 which was found to be lower than the value of present study. The value of brix acid as concluded from the study of Barwal *et al.* (2006), showed that brix acid ratio of 53.57 in bitter gourd was found to be comparable with the ratio obtained in the present study (Table 4.3).

4.3.6.6 Reducing sugar

The reducing sugar (Table 4.3) content in bitter gourd juice was found to be 3.40 mg/100g. Dhillon *et al.* (2005) reported a wide range of reducing sugar (mg/100g) from 2.81-2.96 and 2.12-2.89 in wild and cultivated genotypes of bitter gourd. Barwal *et al.* (2006) also reported 2.5 per cent reducing sugar in bitter gourd. These values of reducing sugar are found to be slightly lesser than the value of present study. The value of reducing sugar is found to be in agreement with the values of previous workers who reported a similar range of reducing sugar content from 3.00-3.80 mg/100g (Kalra *et al.* 1983 and Kulkarni *et al.* 2005).

4.3.6.7 Non-reducing sugar

The non-reducing sugar of bitter gourd juice was calculated as 0.96 mg/100g. According to earlier investigators, the non-reducing sugar content of bitter gourd ranged from 0.30 to 0.60 mg/100g (Kulkarni *et al.* 2005 and Kalra *et al.* 1983). The result reported by them is lower than the values obtained in present study. Dhillon *et al.* (2005) reported non-reducing sugar in the range of 1.59 to 1.87 in wild genotype of bitter gourd. They further reported a wide range of non-reducing sugar (0.88 – 1.46 per cent) in cultivated genotypes of bitter gourd which is in agreement with the result of present study (Table 4.3).

4.3.6.8 Total sugar

The total sugar (Table 4.3) content of bitter gourd juice was observed as 4.08 mg/100g. Barwal *et al.* (2006) and Kulkarni *et al.* (2005) reported 2.80 and 3.75 mg/100g total sugar in bitter gourd. These values were found to be slightly lower than the value obtained in present study. The values reported by earlier investigators were found to be in agreement with the result of present study who reported a wide range of total sugar from 2.75 to 5.03 mg/100g in different varieties of bitter gourd. (Kalra *et al.,* 1983 and Dhillon *et al.,* 2005).

4.3.6.9 Ascorbic acid

The ascorbic acid content of bitter gourd juice was obtained as 87.48 mg/100 ml. Khattak *et al.* (2005) reported 15.19 mg/100g ascorbic acid in bitter gourd which was found to be lower than the result of present study. Kalra *et al.* (1983) reported a wide range of Vitamin C in different varieties of bitter gourd and the range of Vitamin C (mg/100g) quoted by them was 92.00 to 175.00. Dhillon *et al.* (2005) also reported a great variation in the vitamin C content of different

genotypes of bitter gourd (97.6 to 196.62 mg/100g). Mathur *et al.* (1955); Chaudhary *et al.* (1976) and Barwal *et al.* (2006) reported a slightly lesser value in vitamin C that ranged from 88-88.40 mg/100g. The estimated value of ascorbic acid in the present study is comparable with these reported values (Table 4.3).

4.3.6.10 Chlorophyll

The total chlorophyll content, chlorophyll-a and chlorophyll-b content of bitter gourd juice was found to be 242.15, 168.60 and 73.54 mg/100 ml respectively. Aggarwal and Kaur (1997) reported 243.35 mg/100g total chlorophyll in bitter gourd which was found to be in conformity with values in present study. They also reported chlorophyll-a and chlorophyll-b content (mg/100g) of bitter gourd as 168.75 and 74.60 respectively. These values observed by them were also found to be in conformity with the present study (Table 4.3).

4.3.7 Aloe vera juice

4.3.7.1 Moisture

The moisture content of aloe vera fillet juice was found to be 99.34 per cent. Gautam and Awasthi (2007) showed 97.2 per cent moisture in fresh whole aloe vera leaf. Pachanon (2005) determined 99.5 per cent moisture in raw aloe vera leaf mucilage. The moisture content of 21 different ecotypes of aloe vera was reported as 99.2 to 99.38 per cent by Ganesh and Alagukanna (2009). This reported value is in consonance with the value in present investigation (Table 4.3).

4.3.7.2 Total solids

The total solids content of aloe vera juice was observed as 0.65 per cent. Pachanon (2005) reported 0.50 per cent total solids in raw un-pasteurized gel of aloe vera. The value found was slightly lower than the total solids of aloe vera in

the present study. Wang and Strong (1995) reported slightly higher value (0.69 per cent) than the value in the present study. A wide range of total solids in aloe vera juice was measured by Ganesh and Alagukanna (2009). They reported 0.62 to 0.81 per cent total solids which was found to be in agreement with the value in the present investigation (Table 4.3).

4.3.7.3 Total soluble solids (TSS)

The total soluble solids content of aloe vera juice was observed as 0.5^0 brix. Wang and Strong (1995) reported average value of total soluble solids in aloe vera as 0.58 per cent and showed that it ranged from farm to farm as 0.55-0.62 per cent. A wide range of total soluble solids was also reported by Ganesh and Alagukanna (2009) in 21 ecotypes of aloe vera as 0.52 to 0.71 per cent. These values are found comparable to the result obtained in the aloe vera juice of present study (Table 4.3).

4.3.7.4 pH

The pH of aloe vera juice was found to be 4.44. Ganesh and Alagukanna (2009) reported range of pH of 21 different ecotypes of aloe vera as 3.93 to 4.49. Similarly Wang and Strong (1995) showed pH of aloe vera collected from different farm for two years as 4.4 to 4.7. They further clarified that high acidity was due to harvesting in early maturing. The values of pH reported by these investigators were found to be in conformity with the result of present study (Table 4.3).

4.3.7.5 Titrable acidity and Brix acid ratio

The titrable acidity of aloe vera juice was observed as 0.11 per cent in terms of mallic acid. Miranda *et al.* (2009) recorded 0.065 per cent of titrable acidity in fresh aloe gel. The value was found to be slightly lesser than the value obtained in present

study. The titrable acidity reported by Hernandez *et al.* (2006) as 0.08 per cent in terms of mallic acid was considered to be comparable to the result of present study. The brix acid ratio of aloe vera juice was calculated as 4.44 (Table 4.3).

4.3.7.6 Reducing sugar

The reducing sugar (Table 4.3) content of aloe vera juice was investigated as 0.17 per cent. The value was found to be lower than the result of Gautam and Awasthi (2007) who reported 0.76 per cent and 0.24 per cent reducing sugar in aloe vera leaf powder and fresh whole aloe vera leaf respectively. Ganesh and Alagukanna (2009) reported 0.099 per cent to 0.15 per cent of reducing sugar in 21 ecotypes of aloe vera. The values obtained in the present study was higher than the reported values. According to Wang and Strong (1995) reducing sugar content of aloe vera collected from different farms and studied for two years was as 0.15 per cent to 0.24 per cent. The value of reducing sugar in the present study was found to be in consonance with the range reported by them.

4.3.7.7 Non-reducing sugar

The non-reducing sugar content of aloe vera juice was observed as 0.14 per cent. Gautam and Awasthi (2007) reported 0.24 per cent and 0.76 per cent non-reducing sugar in fresh whole leaf and aloe vera whole leaf power. The value reported by them are higher than present study (Table 4.3).

4.3.7.8 Total sugar

The total sugar content of aloe vera juice was found as 0.31 per cent. The result reported by Gautam and Awasthi (2007) for total sugar content of aloe vera leaf power i.e. 1.52 per cent found to be higher than the value in present study while the value given by them for fresh whole leaf of aloe vera was 48 per cent (Table 4.3).

4.3.7.9 Ascorbic acid

The ascorbic acid content of aloe vera juice was found to be 0.80 mg/100ml. Ross reported 0.63 mg/100g ascorbic acid in aloe vera which lesser is than the value in present study. According to Gautam and Awasthi (2007), Aloe vera leaf powder and fresh aloe vera contained 27.0 and 0.87 mg/100g ascorbic acid respectively. The result obtained for fresh aloe vera juice was found to be in accordance with the ascorbic acid content in present study (Table 4.3).

4.3.8 Honey

4.3.8.1 Moisture

Moisture content of honey depends on climatic conditions, season of the year and degree of maturity of any given honey sample (White, 1978). High moisture content renders honey liable to fermentation, granulation, spoilage and flavour loss, resulting in a significant decrease in quality (Costa *et al.* 1999).

The moisture content of honey was found to be 19.68 per cent. Kamal *et al.* (2002); Juszczak *et al.* (2009) and Gomes *et al.* (2010) reported a lower range of moisture in different types of honey i.e. 15.8 to 18.1 per cent. The moisture content in different types of honey reported by earlier investigators varied from 13.33 to 21.9 per cent (Terrab *et al.,* 2004; Nalda *et al.,* 2005; Meda *et al.,* 2005; Nanda *et al.,* 2009 and Chefrour *et al.,* 2009). Moisture content of honey from different flora was found to range from 17.0-19.7 per cent (Kucuk *et al.,* 2007). A two year study of different types of honey revealed that moisture content range from 15.60 to 20.60 per cent (Downey *et al.*, 2005). These reported values are in agreement with the result of present study (Table 4.3).

4.3.8.2 Total solids

The total solids content of honey was found to be 80.31 per cent. Ahmed *et al.* (2007) studied 7 samples of honey belonging to different floral and reported a wide range of total solids (76-88 per cent). The value is in agreement with the value of total solids obtained in present study (Table 4.3).

4.3.8.3 Total soluble solids (TSS)

The total soluble solids content of honey was observed as 80.53 ^{0} brix. Terrab *et al.* (2004) reported a wide range of total soluble solids i.e. 78.80 to 84.00 ^{0} brix in 25 samples of thyme honey. The value of present study is found to be in conformity with the reported value (Table 4.3).

4.3.8.4 pH

The acidity of honey developed due to presence of organic acids. The pH of honey was measured as 3.86. In a two year study on honey, Downey *et al.* (2005) reported pH of honey as 3.75-4.61. According to Meda *et al.* (2005), the honey from three different regions and of different flora exhibit pH of 3.5 to 4.6. Kamal *et al.* (2002) reported 3.3 to 6.3 pH of honey belonging to different floral. A wide range of pH of honey was also reported by Juszczak *et al.* (2009) and Chefrour *et al.* (2009) as 3.50 to 4.61. The result of present study was found to be in consonance with the values reported by previous investigators (Table 4.3).

4.3.8.5 Free acidity

The free acidity of honey was found to be 29.0 Meq/kg. Nanda *et al.* (2009) reported a higher range in honey of different floral origin i.e. 14.67 to 32.65 Meq/kg. Terrab *et al.* (2004); Chefrour *et al.* (2009) and Gomes *et al.* (2010) also gave higher value of free acidity (11.50 to 39.98 Meq/kg) in different types of

honey. The free acidity in honey of different floral origin reported by earlier investigators varied from 15.5 to 59.0 Meq/kg (Downey *et al.,* 2005; Meda *et al.,* 2005 and Juszczak *et al.,* 2009). A range of free acidity in dark and light variety of honey reported by Nanda *et al.* (2005) was 19.0 to 42.0 and 12.65 to 32.50 respectively. The result of present study was found to be in agreement with the values reported earlier (Table 4.3).

4.3.8.6 Lactonic acid

The lactonic acid content of honey was observed as 15.5 Meq/kg. According to earlier investigators, the lactonic acid content of honey belonging to different floral ranged from 02 to 14.9 Meq/kg (Kamal *et al.,* 2002; Terrab *et al.,* 2004 and Downey *et al.,* 2005). A very wide range of lactonic acid was reported by Chefrour *et al.* (2009) in 17 samples of honey collected from different region as 3.75 to 39.98 Meq/kg. Nanda *et al.* (2003) reported 14.47 to 18.61 Meq/kg lactonic acids in different types of honey. The value of lactonic acid in honey as reported in present study was found to be in agreement with value found in various investigations (Table 4.3).

4.3.8.7 Total acidity

The total acidity of honey was found to be 44.33 Meq/kg. Kamal *et al.* (2002) and Kucuk *et al.* (2007) reported 6.73 to 36.7 Meq/kg of total acidity in different types of honey. The values were lesser than the value of present study. A wide range of total acidity (16.75 to 87.46) was reported by Downey *et al.* (2005) and Chefrour *et al.* (2009) in different types of honey. Nanda *et al.* (2009) reported 31.39 to 47.37 Meq/kg of total acidity in different types of honey which is in agreement with the result of present study (Table 4.3).

4.3.8.8 Reducing sugar

The reducing sugar content of honey was investigated as 67.0 per cent. The value of reducing sugar was slightly lower than the value reported by Meda *et al.* (2005) i.e. 70.90 to 84.70 per cent. Kamal *et al.* (2002), Nanda *et al.* (2009) and Gomes *et al.* (2010) reported 60.60 to 79.20 per cent reducing sugar in honey. The value of reducing sugar content of honey as reported by Nalda *et al.* (2005) in dark and light variety of honey was 60.46 to 75.72 per cent and 66.47 to 74.07 peer cent respectively. The reported value of reducing sugar was found to be in conformity with the result obtained in present study (Table 4.3).

4.3.8.9 Non-reducing sugar

The non-reducing sugar content of honey was found to be 2.45 per cent. From the investigation of Kamal *et al.* (2002), it may be concluded that non-reducing sugar content of honey of different floral origin ranged from 2.43 to 3.46 per cent. This reported range of non-reducing sugar was found to be in consonance with the result of present study (Table 4.3).

4.3.8.10 Total sugar

The total sugar content of honey was estimated as 69.45 per cent. Kamal *et al.* (2002) reported 69.46 to 81.63 per cent total sugar in different types of honey. The reported values of total sugar are comparable to the values obtained in present study (Table 4.3).

4.3.8.11 Ascorbic acid

The ascorbic acid (mg/100ml) content of honey was found to be 20.22. Castro *et al.* (2001) reported a very low value of ascorbic acid as 3.91 mg/100g in honey. Griebel *et al.* (1938) reported 1.60-2.80 mg/100g ascorbic acid in mint

honey. Kask (1938) reported average value of 4.88 mg/100g ascorbic acid in honey. Werder and Antener (1938) reported a wide range of ascorbic wide in 19 samples of honey as 1.1 to 14.6 mg/100g. Becker and Kardos (1938) found 31 to 89 mg/100g ascorbic acid in honey. Griebel and Hess (1939) reported 311.2 and 102.6 mg/100g of ascorbic acid in thyme and mint honey respectively while buck wheat honey contained 7.36 to 18.6 mg/100g ascorbic acid. The value of ascorbic acid as reported by previous investigators was found to be in agreement with the value of present study (Table 4.3).

4.4 Mineral composition of single strength juice

4.4.1Carrot juice

4.4.1.1 Sodium

The sodium (Table 4.4) content of carrot juice was found to be 64.50 mg/100ml. Gopalan *et al.* (2004) and Hanif *et al.* (2006) reported lower value 35.6 and 32.0 of sodium (mg/100g) in carrot respectively. According to USDA data base (NDB No. – 11124) raw carrot contain 69.09 mg/100g sodium which is slightly higher than the value obtained in present study.

4.4.1.2 Potassium

The potassium (mg/100ml) content of carrot juice was found as 239.00. Earlier investigators Gopalan *et al.* (2004) and Hanif *et al.* (2006) reported lower value of potassium (mg/100g) in fresh carrot i.e. 108 and 102 respectively. According to USDA data base (NDB No. - 11124), raw carrot contains 320 mg/100g of potassium. The reported value was found to be higher than the value of present investigation (Table 4.4).

Table 4.4 Mineral composition of single strength juice of carrot, orange, aonla, ginger, *lawki, karela*, aloe vera and honey

Juice	Sodium (mg/100ml/100ml)	Potassium (mg/100ml)	Copper (mg/100ml)	Iron (mg/100ml)	Manganese (mg/100ml)	Zinc (mg/100ml)	Calcium (mg/100ml)
Carrot	64.50	239.00	0.043	1.288	0.213	0.215	73.45
Orange	2.057	161.02	0.034	0.673	0.183	0.129	18.63
Aonla	2.00	105.50	0.086	0.251	0.209	0.203	26.34
Ginger	1.00	384.00	0.433	0.677	0.777	0.406	19.62
Karela	3.00	325.00	0.072	0.472	0.077	0.327	22.38
Lawki	0.95	137.00	0.025	0.347	0.058	0.193	21.46
Aloe vera	6.10	23.40	0.0104	0.197	0.250	0.039	38.65
Honey	12.80	74.90	0.164	0.812	0.584	0.848	4.17

4.4.1.3 Copper

The copper content of fresh carrot juice was found to be 0.043 mg/100ml. Kaur *et al.* (1976) reported range of Cu (mg/100g) 0.09- 0.11 in different varieties of carrot. Gopalan *et al.* (2004) also reported such higher value i.e. 0.10 mg/100g as against the value of present study. The raw carrots as reported by USDA data base (NDB No.- 11124) contain 0.047 mg/100g of copper. The value is slightly lower than the value reported in present study (Table 4.4).

4.4.1.4 Iron

The fresh juice of carrot was found to contain 1.29 mg/100ml of iron. Kaur *et al.* (1976) reported a higher range 2.39- 3.11 mg/100g of iron in 5 different varieties of carrot. Gopalan *et al.* (2004) reported iron content (mg/100g) of carrot as 1.03 which is slightly lower than present value. Hanif *et al.* (2006) reported a slightly higher value of iron in carrot i.e. 1.40 mg/100g (Table 4.4).

4.4.1.5 Manganese

The manganese content of fresh carrot juice was observed as 0.212 mg/100ml. Gopalan *et al.* (2004) and USDA data base (NDB no-11124) reported 0.16 and 0.15 mg/100g Mn in fresh carrot respectively. The values are lesser than the present value. A range of Mn i.e. 0.26-0.35 mg/100g in different varieties of carrot was reported by Kaur *et al.* (1976). The value of present study is slightly lower than the reported value (Table 4.4).

4.4.1.6 Zinc

The fresh carrot juice was found to contain 0.215 mg/100ml of Zn. The value is lower than the values reported by earlier investigators as 0.26 to 0.28

mg/100g USDA, (NBD No-11124) and Kaur *et al.* (1976) respectively. Gopalan *et al.* (2004) reported higher value of Zn i.e. 0.36 mg/100g in carrots (Table 4.4).

4.4.1.7 Calcium

The calcium content of fresh carrot juice was found to be 73.48 mg/100 ml. A higher value of Ca (80 mg/100g) in carrot was reported by Gopalan *et al.* (2004). According to Hanif *et al.* (2006) and USDA data base (NDB No- 11124), carrot contains 32.72 and 39.0 mg/100g of Mn respectively which is lower than the value of present study. A comparable range of Mn (55.94-72.86 mg/100g) in fresh carrot was reported by Kaur *et al.* (1976) in five different varieties (Table 4.4).

4.4.2 Orange juice

4.4.2.1 Sodium

The sodium content of fresh orange juice was found to be 2.057 mg/100 ml. A slightly higher value of Na (mg/100g) in orange was reported by Gopalan *et al.* (2004) i.e. 4.5. Ying *et al.* (2008) reported a range of Na content as 0. 24 - 1.28 mg/100g in different varieties of oranges. A higher range was also reported by Simpkins (2000) i.e. 0.058 - 7.1 mg/100g in different types of oranges. The result of present study is in accordance with the range of Na (Table 4.4).

4.4.2.2 Potassium

The fresh orange juice was found to contain 161.02 mg/100 ml potassium. Gopalan *et al.* (2004) reported 9.00 mg/100g K in orange. A lower range 123.37-156.58 of K (mg/100g) was reported by Ying *et al.* (2008) in seven different cultivars of oranges. However, Simpkins *et al.* (2000) found 77.7-234.5 mg/100g K in different types of orange juices. The present study showed value in accordance with these range reported (Table 4.4).

4.4.2.3 Copper

The copper content of fresh orange juice was found to be .034 mg/100 ml. Gopalan *et al.* (2004) reported a higher value of 0.58 mg/100g of Cu in orange. Earlier investigators had reported a range of copper (mg/100g) in different types and cultivars of oranges as 0.019-.084 (Ying *et al.,* 2008 and Simpkins *et al.,* 2000). The result of present study was found to be within the range reported (Table 4.4).

4.4.2.4 Iron

The fresh orange juice was found to contain 0.673 mg/100 ml of iron. A lower value of iron i.e. 0.009 to 0.180 was reported by earlier investigators (Ying *et al.,* 2008 and Simpkins *et al.,* 2000). The USDA data sheet (NDB No. -09206) also reported a lower value of 0.19 mg/100 g (Table 4.4).

4.4.2.5 Manganese

The manganese content of fresh orange juice was observed as 0.184 mg/100 ml. A range of Mn in orange was reported as 0.01 to 0.047 (Ying *et al.,* 2008; Simpkins *et al.,* 2000 and USDA data base, NDB No.-09206). The reported values are lower than the value obtained in present study (Table 4.4).

4.4.2.6 Zinc

The zinc content of fresh orange juice was found as 0.129 mg/100 ml. Ying *et al.* (2008) and Simpkin *et al.* (2000) reported 0.05 to 0.08 mg/100g zinc in different varities of oranges. The reported values are lower than present value. USDA datasheet NDB-09206 also showed a lower value of 0.046 mg/100g of Zn in orange (Table 4.4).

4.4.2.7 Calcium

The calcium content of fresh orange juice was found to be 18.63 mg/100 ml. Previous investigators reported a range of calcium (mg/100g) 2.06-16.90 in different varieties of oranges (Ying *et al.*, 2008 and Simpkins *et al.*, 2000). However Gopalan *et al.* (2004) reported a slight higher value (26.0 mg/100g) of calcium in orange. USDA data base (NDB No.-09206) also reported a lower value 10.46 mg/100g for calcium (Table 4.4).

4.4.3 *Aonla* juice

4.4.3.1 Sodium

The sodium content of fresh *aonla* juice was found to be 2.00 mg/100 ml. Premi *et al.* (2002) reported 19.05 and 25.68 mg/100g sodium in two different varieties of *aonla* which is higher than the value of present study. Gopalan *et al.* (2004) reported 5.00 mg/100g of sodium in *aonla* juice (Table 4.4).

4.4.3.2 Potassium

The potassium content of fresh *aonla* juice was observed as 105.50 mg/100 ml. Gopalan *et al.* (2004) reported potassium content of *aonla* as 225.00 mg/100g which was found to be higher than the value in present study. Such higher value of potassium was also reported by Premi *et al.* (2002) in two different varieties of *aonla* as 179.76 and 242.84 mg/100g (Table 4.4).

4.4.3.3 Copper and Iron

The copper and iron content (Table 4.4) of fresh *aonla* juice was found as 0.087 mg/100 ml and 0.252 mg/100 ml respectively. The fresh juice of *aonla* was found to contain. Mishra *et al.* (2009) reported 49.26-88.03 mg/100g iron in *aonla* powder prepared by different methods. Previous investigators Shukla and Kumar

(2009), Khan (2009) and Gopalan *et al.* (2004) all reported 1.20 mg/100g iron in *aonla*. The value is slight higher than value of present study. Chaudhary *et al.* (2003) reported very low amount of iron in *aonla* (0.0069 per cent).

4.4.3.4 Manganese, Zinc and Calcium

The fresh juice of *aonla* was found to contain 0.209 mg/100 ml manganese whereas the zinc content was found to be 0.203 mg/100 ml. The calcium content of fresh *aonla* juice was observed as 26.34 mg/100 ml. Shukla and Kumar (2009) and Chaudhary *et al.* (2003) reported 12.0 - 50.0 mg/100g calcium in *aonla* which was found to be in conformity with the present study. Premi *et al.* (2002) reported 14.24 and 16.76 mg/100g calcium in two different varieties of fresh *aonla*. The values are lesser than that obtained in present study. Gopalan *et al.* (2004) further reported 50 mg/100g calcium which is higher than the value obtained in present study (Table 4.4).

4.4.4 Ginger juice

4.4.4.1 Sodium

The fresh ginger juice was found to contain 1.00 mg/100 ml of sodium (Table 4.4). Previous investigators reported 0.93- 17.0 mg/100g of sodium in ginger on dry weight basis (Bhowmik *et al.,* 2008 and Hussain *et al.,* 2009). Vasala *et al.* (2003) reported 30 mg/100g (dry weight basis) sodium in ginger which was found to be higher than present values. According to USDA data base (NDB No- 11216), raw ginger rhizome contains 13.00 mg/100g sodium which is higher than present value.

4.4.4.2 Potassium

The potassium content of fresh ginger juice was found to be 384.00 mg/100 ml. Previous investigators (Vasala *et al.,* 2003 ; Bhowmik *et al.,* 2008 and Kara *et al.,*

2009) reported a higher range 563-1400 mg/100g potassium in dry ginger. However according to USDA (NDB No.-11216), raw ginger root contains 415 mg/100g potassium which was found to be higher than the present study (Table 4.4).

4.4.4.3 Copper

The copper content of fresh ginger juice was found to be 0.433 mg/100 ml (Table 4.4). Hussain *et al.* (2009) and Obiajunwa *et al.* (2002) reported 3.68 and 9.49 mg/100g copper in ginger on dry weight basis respectively. The value of present study was found to be higher than the values reported by USDA (NDB No-11216) as 0.23 mg/100g in raw ginger rhizome.

4.4.4.4 Iron

The fresh ginger juice was found to contain 0.677 mg/100 ml iron. Previous investigators reported a wide range of iron in ginger on dry basis as 5.18- 121.92 mg/100g (Obiajunwa *et al.,* 2002; Vasala *et al.,* 2003; Kara *et al.,* 2009 and Hussain *et al.,* 2009). However Gopalan *et al.* (2004) reported a slightly higher value of iron in fresh ginger as 3.5 mg/100g as compared to present study. According to USDA data base (NDB No-12116) raw ginger rhizomes contains 0.60 mg/100g iron which was found to be comparable with the results of present study (Table 4.4).

4.4.4.5 Manganese

The fresh ginger juice was found to contain 0.777 mg/100 ml manganese. Gopalan *et al.* (2004) reported 5.56 mg/100g manganese in fresh ginger. The values was higher than the present study value. Various investigators reported manganese in ginger on dry weight basis as 12.7 to 78.03 mg/100g (Kara, 2009; Bhowmik *et al.,* 2008 and obiajunwa *et.al.,* 2002). The value of manganese in

present study was found to be higher than the value reported by USDA data base (NDB No-11216) as 0.229 mg/100g in raw ginger root (Table 4.4).

4.4.4.6 Zinc

The zinc (mg/100 ml) content of fresh ginger juice was observed as 0.407. A higher range of zinc than present study was reported by various investigators as 1.32-5.62 mg/100g (obiajunwa et al., 2002; Bhowmik *et al.,* . 2008; Kara, 2009 and Hussain *et al.,* 2009). The amount of zinc (0.34 mg/100g.) in raw ginger root as reported by USDA data base (NDB No-11216) was found to be comparable with the present study (Table 4.4).

4.4.4.7 Calcium

The calcium content of raw ginger juice was observed as 19.62 mg/100ml. Kara *et al.* (2009) reported a higher value (94.4 mg/100g) of calcium in ginger on dry weight basis. Gopalan *et al.* (2004) and USDA data base (NDB No-11216) reported 20.00 and 16.00 mg/100g calcium in fresh ginger rhizome respectively. These values are found to be comparable with the value of present investigation (Table 4.4).

4.4.5 *Lawki* juice

4.4.5.1 Sodium

The sodium content of bottle gourd (*Lawki*) juice was obtained as 0.95 mg/100 ml. Both Rahman *et al.* (2008) and Gopalan *et al.* (2004) reported a higher value of 1.8 mg/100g than the value in present study. Kubde *et al.* (2010) also reported slightly higher value of Na (1.1 mg/100g) than the present study value. Jansen *et al.* (1990) reported sodium content of bottle gourd as 1.0 mg/100g. The value shows conformity with the sodium content in the present study (Table 4.4).

4.4.5.2 Potassium

The fresh bottle gourd juice was found to contain 137.00 mg/100 ml of potassium (Table 4.4). The value is higher than the values reported by previous investigators (Jansen *et al.,* 1990; Gopalan *et al.,* 2004; Rahman *et al.,* 2008; Sawate *et al.,* 2009 and Kudbe *et al.*, 2010) who showed a range of potassium content (mg/100g) in bottle gourd as 63-87 mg/100g. The variation in potassium content may be attributed to varieties, geographical and environmental conditions

4.4.5.3 Copper

The fresh juice of bottle gourd was found to contain 0.026 mg/100 ml copper (Table 4.4). The value is slightly lower than the value (.030 mg/100g) reported by all investigators Rahman *et al.* (2008); Gopalan *et al.* (2004) and Jansen *et al.* (1990).

4.4.5.4 Iron

The iron content of fresh bottle gourd juice was found to be 0.347 mg/100 ml. Rahman *et al.* (2008); Sawate *et al.* (2009) and Kubde *et al.* (2010) reported 0.7 to 0.8 mg/100g of iron in bottle gourd which is higher than the value in present study. Gopalan *et al.* (2004) reported higher iron content (0.46 mg/100g) in bottle gourd, whereas Kou *et al.* (2002) reported slightly lower value i.e. 0.30 mg/100g which was found to be comparable with the value in present investigation (Table 4.4).

4.4.5.5 Manganese

The fresh juice of bottle gourd showed 0.058 mg/100 ml manganese (Table 4.4). Jansen *et al.* (1990) reported a slightly higher value of 0.10 mg/100g in bottle gourd. Gopalan *et al.* (2004) showed 0.06 mg/100g manganese in bottle gourd which is found to be in accordance with the Mn content in present study.

4.4.5.6 Zinc

The zinc (mg/100 ml) content of fresh bottle gourd was found to be 0.193 which is slightly lower (0.22 mg/100g) than the value reported by Gopalan *et al.* (2004). Jansen *et al.* (1990) reported 0.20 mg/100g zinc in bottle gourd. The value was found to be in conformity with the value of present investigation (Table 4.4).

4.4.5.7 Calcium

The calcium content of fresh bottle gourd juice was observed as 21.46 mg/100 ml. Rahman *et al.* (2008) reported higher value of 120 mg/100g in bottle gourd. Kou (2002) showed 7.00 mg/100g calcium in bottle gourd which is lower than the present value. However, Jansen *et al.* (1990) and Gopalan *et al.* (2004) reported calcium content of bottle gourd as 20.00 and 16.00 mg/100g respectively. The finding of present study is slightly higher than the earlier reported values (Table 4.4).

4.4.6 *Karela* juice

4.4.6.1 Sodium

The sodium content of bitter gourd juice was observed as 3.0 mg/100 ml. Hussain *et al.* (2009) reported slightly higher value of 4.54 mg/100g of sodium in bitter gourd. A range of sodium content of bitter gourd i.e. 2.4- 26.4 mg/100g was stated by Gopalan *et al.* (2004) and Horax *et al.* (2010). The value of bitter gourd in present study is found to be in accordance with the range reported (Table 4.4).

4.4.6.2 Potassium

The potassium content of bitter gourd juice was found as 325.00 mg/100 ml. Horax *et al.* (2010) reported 3240 - 5750 mg/100g potassium in different parts of bitter gourd during different stages of maturity which was found to be higher

than present study. Whereas Sethi *et al.* 2003 reported lower value (161.5 mg/100 g) of potassium in bitter gourd (Table 4.4).

4.4.6.3 Copper

The copper content (mg/100 ml) of bitter gourd juice was found as 0.072 (Table 4.4). Earlier investigators reported a higher range of copper (mg/100g) in bitter gourd i.e 0.95- 2.3. (Sethi *et al.,* 2003; Hussain *et al.,* 2009 and Horax *et al.,* 2010). However a slightly higher range was reported by Gopalan *et al.* (2004) in different types of bitter gourd as 0.09- 0.10 mg/100g.

4.4.6.4 Iron

The iron content of bitter gourd juice was observed as 0.472 mg/100 ml (Table 4.4). Chaudhary *et al.* (1979) and Hussain *et al.* (2009) reported 9.40 and 13.9 mg/100g iron in bitter gourd which was quite higher than the value in present study. Mathur *et al.* (1955) and Sethi *et al.* (2003) reported 1.80 and 1.30 mg/100g iron in bitter gourd. Gopalan *et al.* (2004) reported slightly higher value of iron 0.61- 2.00 mg/100g iron in different types of bitter gourd which are found to be comparable to the value obtained in present study.

4.4.6.5 Manganese

The manganese content (mg/100 ml) of bitter gourd juice was observed as 0.077 (Table 4.4). Kosanovic *et al.* (2009) reported 0.25 mg/100g manganese in bitter gourd which is higher than the value reported in present study. Sethi *et al.* (2003) and Gopalan *et al.* (2004) both reported manganese content of bitter gourd as 0.08 mg/100g which was found to be comparable with the present study finding.

4.4.6.6 Zinc

The zinc content of fresh bitter gourd juice was found as 0.327 mg/100 ml. Sethi *et al.* (2003) and Kosanovic *et al.* (2009) reported 0.43 and 0.50 mg/100g zinc in bitter gourd respectively which was slightly higher than value of present finding. Gopalan *et al.* (2004) reported a slightly lesser range of zinc (mg/100g) in different types of bitter gourd as 0.39- 0.46 (Table 4.4).

4.4.6.7 Calcium

The calcium content of bitter gourd juice was observed as 22.38 mg/100 ml. Earlier investigators reported a very high range of calcium (mg/100g) in bitter gourd as 50.0 to 270.0 (Chaudhary, 1979 and Horax *et al.,* 2010) and also a low range i.e. 1.60 to 3.90 (Hussain *et al.,* 2009 and Kosanovic *et al.,* 2009). Gopalan *et al.* (2004), Mathur (1955) and sethi *et al.* (2003) reported 20-23 mg/100 g of calcium in bitter gourd. The value of present study was found to be in conformity with the reported values of bitter gourd (Table 4.4).

4.4.7 Aloe vera juice

4.4.7.1 Sodium

The sodium content of aloe vera juice was found to be 6.10 mg/100 ml. Jahan *et al.* (2008) reported 66.53- 160.50 and 154- 277.80 mg/100g sodium in fillets and skins of *aloe indica* leaves, a species of aloe vera. Bouchey and Gjerstad (1969) reported 1.45 per cent sodium in aloe vera juice which is lower than the present value. National Aloe Science Council (1982) observed 30 mg/100ml sodium in aloe vera leaves. Wang and Strong (1995) showed average value of 18.7 mg/100ml sodium in inner fillet. The value reported is higher than the present study. Henry (1979) showed 5.1 mg/100 ml sodium content in aloe

vera which is slightly lower than the value obtained in present study. Slight higher value than the present study was also reported by Rajasekaran *et al.* (2005) i.e. 8.1 mg/100g in aloe vera leaves (Table 4.4).

4.4.7.2 Potassium

The fresh aloe vera fillet juice was found to contain 23.4 mg/100 ml potassium (Table 4.4). Earlier investigators (Bouchey and Gjerstad 1969; NASC 1982 and Henry 1979) reported lower range 1.34- 8.5 mg/100g potassium in aloe vera. Wang and Strong (1995) reported average value of potassium 37.8 mg/100g in inner fillet of aloe vera gel which is higher than value of present study. Slightly lower value was reported by Rajasekaran *et al.* (2005) i.e 19.85 mg/100g.

4.4.7.3 Copper

The copper content of fresh aloe vera juice was found as 0.0104 mg/100 ml. Smita and Awasthi (2007) reported a higher value of 0.81 of copper (mg/100g) in aloe vera leaf powder. They further reported a slightly higher value of copper in fresh aloe vera leaf i.e. 0.025 mg/100g (Table 4.4).

4.4.7.4 Iron

The iron content of aloe vera juice was observed as 0.197 mg/100ml. Smita and Awasthi (2007) reported 2.1 mg/100g iron in fresh whole aloe vera leaf which is higher than present study. Henry (1979) also showed higher value i.e 0.39 mg/100ml, while NASC (1982) and Rajendran *et al.* (2007) reported lower value of 0.015 and 0.018 – 0.012 mg/100ml in aloe vera gel respectively (Table 4.4).

4.4.7.5 Manganese

The fresh aloe vera fillet was found to contain 0.250 mg/100 ml manganese. Bouchey and Gjerstad (1969); Henry (1979) and Rajendran *et al.*

(2007) reported lower value of manganese in aloe vera i.e. 0.0122 mg/100 ml and 0.059 mg/100ml respectively. Rajasekaran *et al.* (2005) reported higher value of manganese 31.55 mg/100g in dry aloe vera. Such higher values are also reported by Pachanon (2005) in freeze and spray dried aloe vera i.e. 165.5 per cent and 163.8 per cent (Table 4.4).

4.4.7.6 Zinc

The zinc content of fresh aloe vera juice was observed as 0.040 mg/100ml. A higher value of 31 mg/100ml was reported by NASC (1982) while Henry (1979) reported 0.10 mg/100 ml of zinc in aloe vera juice. Smita and Awasthi (2007) reported 0.07 mg/100g of zinc in fresh whole aloe vera leaf which is slightly higher than present value (Table 4.4).

4.4.7.7 Calcium

The calcium content of fresh aloe vera juice was found to be 38.65 mg/100 ml. According to NASC (1982), aloe vera leaves contain 30 mg/100ml of calcium which is lesser than the value obtained in present study. Henry *et al.* (1979) reported a higher value of calcium in aloe vera i.e. 46 mg/100ml. A wide range of calcium (mg/100g) in aloe vera fillet and aloe vera skin was reported by Jahan *et al.* (2008) as 26.60- 42.20 and 69.4- 74.4 respectively. The result of present study is concomitance with the range reported earlier (Table 4.4).

4.4.8 Honey

4.4.8.1 Sodium

The sodium content of honey was found to be 12.8 mg/100 ml (Table 4.4). Previous investigators reported a range of sodium in honey i.e. 0.038-8.96 mg/100g which was found to be lower than the value in present study (Madejezyk

et al., 2008; Chudzinska *et al.,* 2010 and Juszczak *et al.,* 2009). Terrab *et al.* (2004) reported 30.7-50.1 mg/ 100g Na in honey. The values are higher than the value in present study. Kucuk *et al.* (2007), Hernandez *et al.* 2005 and Nanda *et al.* (2009) reported range of sodium content as 7.3-30.13 mg/100g. The value of the present study is in conformity with the reported range.

4.4.8.2 Potassium

The potassium content of honey was observed as 74.9 mg/100 ml. various investigators reported a wide range of potassium (mg/100g) in honey as 0.77-381.8 (Hernandez *et al.,* 2005; Kucuk *et al.,* 2007; Madejezyk *et al.,* 2008; Nanda *et al.,* 2009; Juszczak *et al.,* 2009 and Chudzinska *et al.,* 2010). The value of present study was found to be concomitance with the range reported earlier (Table 4.4).

4.4.8.3 Copper

The copper content of honey was observed as 0.164 mg/100 ml. Previous investigators reported a lower range of copper (mg/100g) in honey as 0.009-0.073. **(**Kucuk *et al.,* 2007 and Juszczak *et al.,* 2009). Nanda *et al.* (2009) reported copper content of honey as 0.129- 0.276 mg/100g. Chudzinska *et al.,* 2010 found 0.166 mg/100g copper in honey. The value was found to be in conformity with the present study (Table 4.4).

4.4.8.4 Iron

The iron content of honey was observed as 0.812 mg/100 ml (Table 4.4). Gopalan *et al.* (2004) reported 0.696 mg/100g iron in honey. Kucuk *et al.* (2007) reported a range of iron content (mg/100g) in honey as 0.17- 0.246 which was found to be lesser than the finding of present study. Previous investigators reported a wide range (mg/100g) of iron in honey as 0.040-5.221 (Diez *et al.,* 2004; Hernandez *et al.,*

2005; Madejezyk *et al.,* 2008 and Nanda *et al.,* 2009)**.** The finding of present study is in accordance with the range reported by earlier investigators.

4.4.8.5 Manganese

The manganese content of honey was found as 0.584 mg/100 ml. Chudzinska *et al.* (2010) reported 0.487 mg/100g of Mn in honey which was found to be lesser than the value of present study. Previous investigators reported a wide range of Mn (mg/100g) in honey as 0.053 to 0.969 **(**Kucuk *et al.,* 2007 and Juszczak *et al.,* 2009). The result of present study is in conformity with the range reported by earlier investigators.

4.4.8.6 Zinc

The zinc content of honey was observed as 0.848 mg/100 ml (Table 4.4). Previous investigators reported a wide range of zinc (mg/100g) in honey as 0.018-1.998. (Hernandez *et al.,* 2005; Kucuk *et al.,* 2007; Madejczyk *et al.,* 2008; Nanda *et al.,* 2009; Juszczak *et al.,* 2009 and Chudzinska *et al.,* 2010). This wide variation may be attributed to geographic and environmental conditions along with the types of flower from which bees collected the nectar. The values are in accordance to the value obtained in present.

4.4.8.7 Calcium

The calcium content of honey was observed as 4.1 mg/100 ml. Earlier investigator reported a wide range of calcium (mg/100g) in honey as 4.53-90.0 which was found to be higher than the value of present study. Terrab *et al.* (2004; Kucuk *et al.* (2007); Madejczyk *et al.* (2008) and Juszczak *et al.* (2009) and Nanda *et al.* (2009) reported 0.33-8.25 mg/100g of calcium in honey. The values are found to be in conformity with the results of present investigation (Table 4.4).

4.5 Physico-chemical and nutritional composition of Aloe vera juice incorporated juice blends

4.5.1 *Lawki-Karela* (LK) juice and *Lawki-Karela*–Aloe vera (LKA) juice blend

Data on Physico-chemical characteristics of *Lawki-Karela* (LK) juice and *Lawki-Karela* – Aloe vera (LKA) juice blend are depicted in Appendix VIII, Fig. 4.2 (a) and Fig. 4.2 (b).

4.5.1.1 Moisture

The moisture content of *Lawki-karela* (LK) and *Lawki karela* - aloe vera juice (LKA) blend was found to be 96.12 and 96.76 per cent respectively (Appendix VIII). Significant difference was observed in the moisture content of two juice blends. The high moisture content of LKA juice blend might be due to high per cent of moisture in aloe vera juice (99.34 per cent) compared to bottle gourd (95.63 per cent) and bitter gourd (94.43 per cent).

4.5.1.2 Total solids

The total solid content of LK juice (3.87 per cent) blend was found to be significantly higher than LKA juice blend (3.23 per cent). This might be due to higher total solid content of bottle gourd (4.36) and bitter gourd (5.56 per cent) as compared to aloe vera (0.65 per cent).

4.5.1.3 Total soluble solid

The TSS content of LK juice was found to be 3.76˚ brix while LKA juice blend had 2.70 ^{0} brix of TSS. The TSS of LK juice blend had significantly higher value than LKA juice blend (Fig 4.2a).

4.5.1.4 pH

The pH value of LK juice blend was found to be significantly higher than the juice blend having aloe vera juice (LKA). The pH of LK juice blend was observed as 5.55 LKA juice blend had 5.05 (Fig 4.2a).

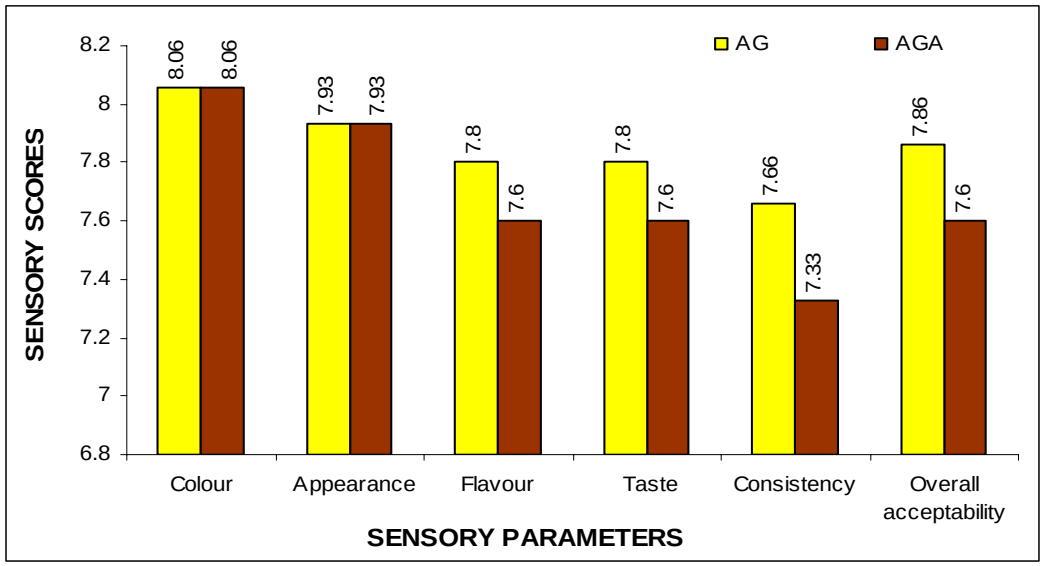


Fig. 4.1 (c) Organoleptic evaluation of AG and AGA juice blend

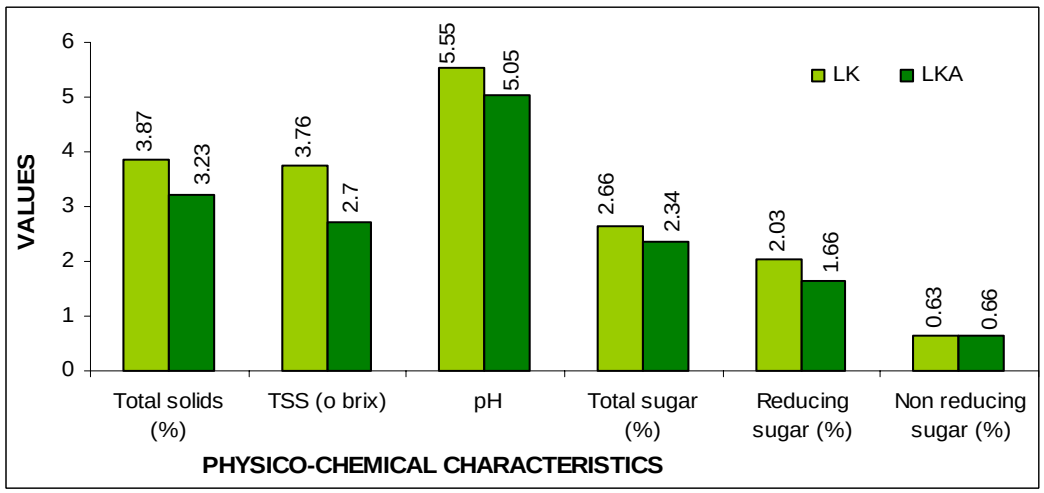


Fig. 4.2(a) Physico chemical composition of LK and LKA juice

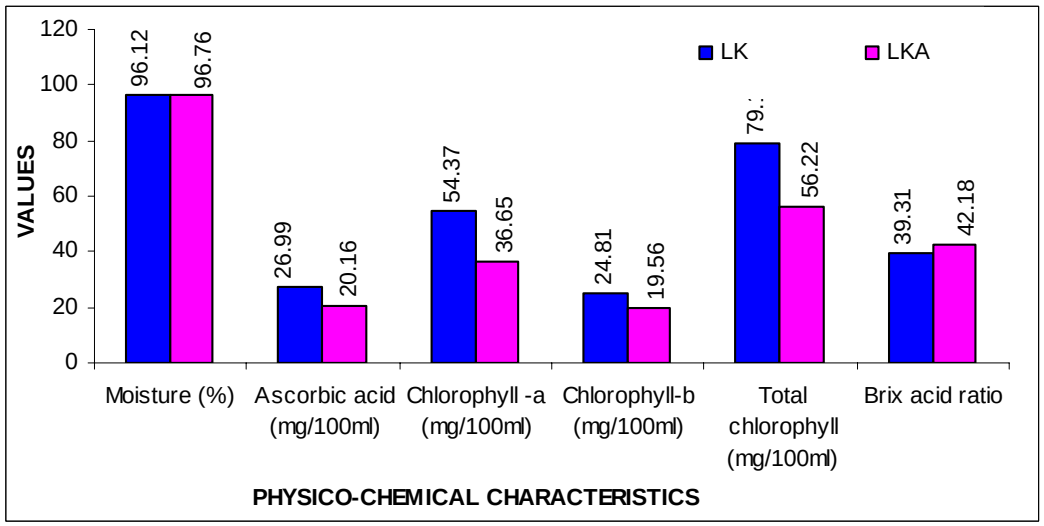


Fig. 4.2(b) Physico chemical and nutritional composition of LK and LKA juice

4.5.1.5 Titrable acidity

The titrable acidity of LK juice and LKA juice blend was found to be 0.10 per cent and 0.064 per cent in terms of citric acid. No significant difference was observed in titrable acidity of juice blends on addition of aloe vera juice (Appendix VIII).

4.5.1.6 Brix acid ratio

The brix acid ratio of LK juice and LKA juice blend was observed as 39.31 and 42.18 respectively. The brix acid ratio of LKA juice blend was found to be higher than LK juice blend. However no significant difference was observed (Fig 4.2b).

4.5.1.7 Reducing sugar

The reducing sugar content of LK juice and LKA juice blend was observed as 2.03 and 1.66 per cent respectively (Fig 4.2a). The reducing sugar content of LK juice was found to be higher than LKA juice blend. Data showed significant difference in the reducing sugar content of both juice blends. This might be due to higher value of reducing sugar in bottle gourd (1.74 per cent) and bitter gourd (3.40 per cent) than aloe vera juice (0.17 per cent).

4.5.1.8 Non reducing sugar

The non - reducing sugar content of LK juice and LKA juice blend was observed as 0.62 per cent and 0.66 per cent respectively. No significant difference was seen in the non reducing sugar content of LK juice and LKA juice blend (Fig 4.2a).

4.5.1.9 Total sugar

The total sugar content of LK juice was observed as significantly higher than LKA juice blend. The LK juice had 2.66 per cent while LKA juice blend had 2.34 per cent total sugar content (Fig 4.2a). This difference might be due to

high level of total sugar in bottle gourd (2.78 per cent) and bitter gourd juice (4.08 per cent).

4.5.1.10 Ascorbic acid

The ascorbic acid content (mg/100ml) of LK juice (26.99) was found to be significantly higher than the aloe vera incorporated LKA juice blend (20.16). This might be due to higher ascorbic acid (mg/100g) content of bottle gourd (12.24) and bitter gourd (87.48) juice than aloe vera (0.80) (Fig 4.2b).

4.5.1.11 Chlorophyll

The chlorophyll– a (mg/100ml) content of LK juice and LKA juice blend was observed as 54.37 and 36.65 respectively. The significant difference might be due to higher content of chlorophyll- a in *karela* (168.605 mg/100g).

The Chlorophyll-b content of LK juice (24.81 mg/100ml) was found to be significantly higher than LKA juice blend (19.56 mg/100ml). This might also be due to high content of chlorophyll- b in *karela* juice (73.54 mg/100g).

The total chlorophyll content (mg/100ml) of LKA juice blend (56.22) was found to be significantly lower than LK juice (79.19). The high content of total chlorophyll in bitter gourd (242.15 mg/100g) might be responsible for higher total chlorophyll content of LK juice blend (Fig 4.2b).

4.5.2 Carrot-Orange (CO) and Carrot Orange - Aloe vera (COA) juice blend.

Data on physico- chemical characteristics of Carrot - Orange (CO) and Carrot Orange - Aloe vera (COA) juice blend are depicted in Appendix VIII and Figure 4.3.

4.5.2.1 Moisture

The moisture content of CO juice blend and COA juice blend was found to be 89.97 per cent and 91.98 per cent respectively (Appendix–VIII). The moisture

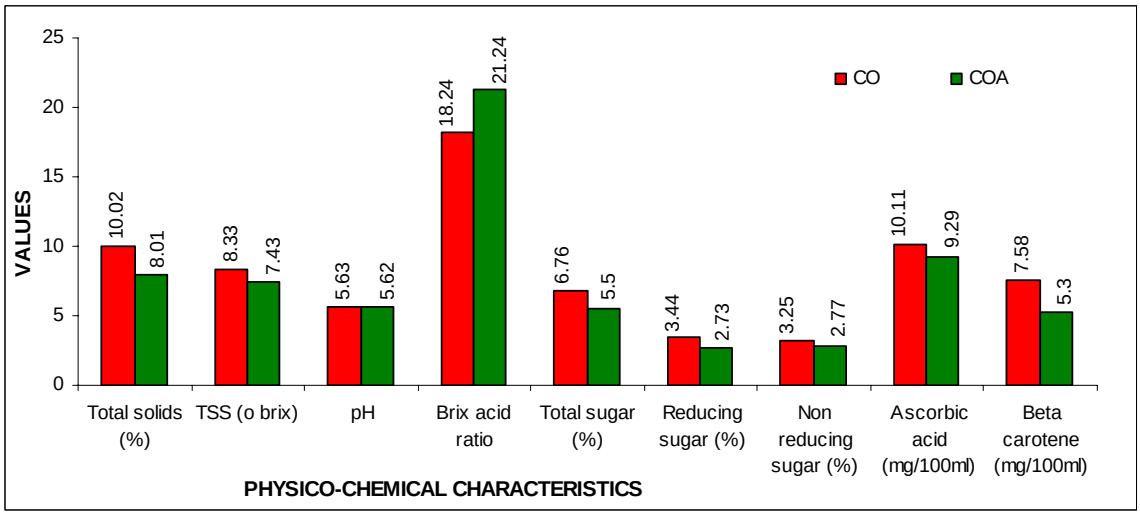


Fig. 4.3 Physico chemical and nutritional composition of CO and COA juice

content of COA juice blend was found to be significantly higher than CO juice blend. This might be due to higher moisture content of aloe vera juice (99.34 per cent) than corresponding carrot (91.42 per cent) and orange juice (88.88 per cent).

4.5.2.2 Total solids

The total solids content of CO juice blend (10.02 per cent) was found to be significantly higher than COA juice blend (8.01 per cent). This might be due to higher total solid contents of carrot (8.56 per cent) and orange (11.11 per cent) than aloe vera juice (0.65 per cent) (Fig 4.3).

4.5.2.3 Total soluble solids (TSS)

The TSS content of CO juice and COA juice blend was observed to be 8.33 and 7.43 ^{0} brix respectively (Fig 4.3). Addition of aloe vera juice was found to lower the TSS content of COA juice blend. This might be due to low TSS content of aloe vera juice (0.68 ^{0} brix) than carrot (7.53^{0} brix) and orange (11.36 ^{0} brix). Sahota *et al.* (2009) reported that increase in per cent of *aonla* juice having TSS of 6.00 ^{0} brix in carrot juice having TSS 8.50 ^{0} brix lowered the TSS from 3.0 to 2.0 ^{0} brix of carrot- *aonla* juice blend.

4.5.2.4 pH

The pH of CO juice and COA juice blend was observed as 5.63 and 5.62 respectively (Fig 4.3). The pH of COA juice blend was found to be slightly lower than CO juice blend. No significant difference was observed. Dhaliwal and Hira (2001) reported that addition of beetroot juice to carrot juice at different levels brought about decrease in pH from 3.80 to 3.60.

4.5.2.5 Titrable acidity

Addition of aloe vera juice to CO juice blend decreased the titrable acidity significantly. The titrable acidity of CO juice and COA juice blend was found to be 0.45 and 0.35 per cent respectively in terms of citric acid (Appendix VIII). Shiv Kumar *et al.* (2006) reported that increase of orange juice in tomato juice decreased the titrable acidity from 0.66 to 0.63 per cent. Garg *et al.* (2008) reported that increase in percentage of apple juice in *aonla* – apple - ginger fruit drink decreased the titrable acidity from 0.33 to 0.32 per cent. Same trend was further observed in *aonla*- pear- ginger fruit drink in which increase in per cent of pear juice brought about decrease in titrable acidity from 31.0 to 29.0 per cent.

4.5.2.6 Brix acid ratio

The brix acid ratio of CO juice COA juice blend was found to be 18.24 and 21.24 respectively. Brix acid ratio of COA juice blend was found to be higher than CO juice however, no significant difference was found in brix acid ratio of two juice blends (Fig 4.3).

4.5.2.7 Reducing sugar

The reducing sugar content of CO juice blend (3.44 per cent) was found to be higher than COA juice blend (2.73 per cent). There was significant difference in the reducing sugar content of both juice blends. This might be due to higher reducing sugar content of carrot (3.48 per cent) and orange juice (5.29 per cent) than aloe vera juice (0.17 per cent). Dhaliwal and Hira (2001) reported that addition of beetroot juice to carrot juice at varying proportion brought about decrease in reducing sugar from 3.16 to 2.52 per cent (Fig 4.3).

4.5.2.8 Non- reducing sugar

The non - reducing sugar content of aloe vera juice incorporated (COA) juice blend (3.25 per cent) was found to be significantly lower than non - reducing sugar content of CO juice blend (2.77 per cent). This might be due to low non - reducing sugar content of aloe vera juice (0.14 per cent) than carrot (2.04 per cent) and orange (4.25 per cent) juice. Dhaliwal and Hira (2004) reported that non - reducing sugar content of carrot - pineapple juice blend decreased with increase in addition of pineapple juice (Fig 4.3).

4.5.2.9 Total sugar

The total sugar content of CO juice and COA juice blend was found to be 6.76 per cent and 5.50 per cent respectively (Fig 4.3). Significant difference was observed in the total sugar content of both the juice blends. This might be due to higher total sugar content of carrot (5.53 per cent) and orange (9.55 per cent) juice. Deka *et al.* (2000) reported that higher total sugar content in grape - mango RTS might be due to higher sugar content in grape juice (15.19 per cent) and mango pulp (13.97 per cent) as compared to other fruits. Dhaliwal and Hira (2001) reported that increase in the level of black carrot juice to carrot decreased the total sugar content from 7.46 to 7.25 per cent. They further reported in 2004 that same trend was seen when pineapple juice was added to carrot juice and total sugar content decreased from 7.04 to 6.85 per cent.

4.5.2.10 Ascorbic acid

The ascorbic acid (mg/100ml) content of aloe vera juice incorporated COA juice blend (9.29) was found to be significantly lower than CO juice blend (10.11). This might be due to low ascorbic acid content of aloe vera (0.8 mg/100g) as

compared to carrot (8.74 mg/100g) and orange (23.50 mg/100g) juice. Garg *et al.* (2008) reported that as the level of apple juice incorporation was increased the ascorbic acid content of fruit drink decreased from 78.9 to 10.6. They further reported that incorporation of pear juice brought about decrease in ascorbic acid content of fruit drink from 79.4 to 70.3 mg/100g. Shivkumar *et al.* (2009) observed that as the percentage of orange juice in tomato juice was increased the ascorbic acid (mg/100ml) decreased from 51.35 to 47.76 (Fig 4.3).

4.5.2.11 Beta - Carotene

The beta carotene content of aloe vera incorporated COA juice blend (29.16 mg/100 ml) was found to be significantly lower than CO juice blend (35.41 mg/100 ml). This might be due to higher beta - carotene content of carrot (7.2 mg/100 ml) and orange juice (mg/100 ml) than aloe vera. Gowda *et al.* (1995) observed that there was significant reduction in carotenoid content of watermelon juice due to addition of spices like ginger and black pepper. Dhaliwal anf Hira (2004) also reported that incorporation of pineapple juice to carrot juice brought about decrease in beta - carotene content of carrot- pineapple juice blend from 4.44 to 4.38 mg/100 ml (Fig 4.3).

4.5.3 *Aonla* – Ginger juice (AG) and *Aonla* – Ginger - Aloe vera juice (AGA) blend Moisture

Data on physico-chemical characteristics of *Aonla* – Ginger juice (AG) and *Aonla* – Ginger - Aloe vera juice (AGA) blend are presented in Appendix VIII, Fig 4.4(a) and Fig 4.4(b) .

4.5.3.1 Moisture

The moisture content of AG and AGA juice blends showed that AGA juice blend had higher moisture content (87.29 per cent) than AG juice blend (83.87 per

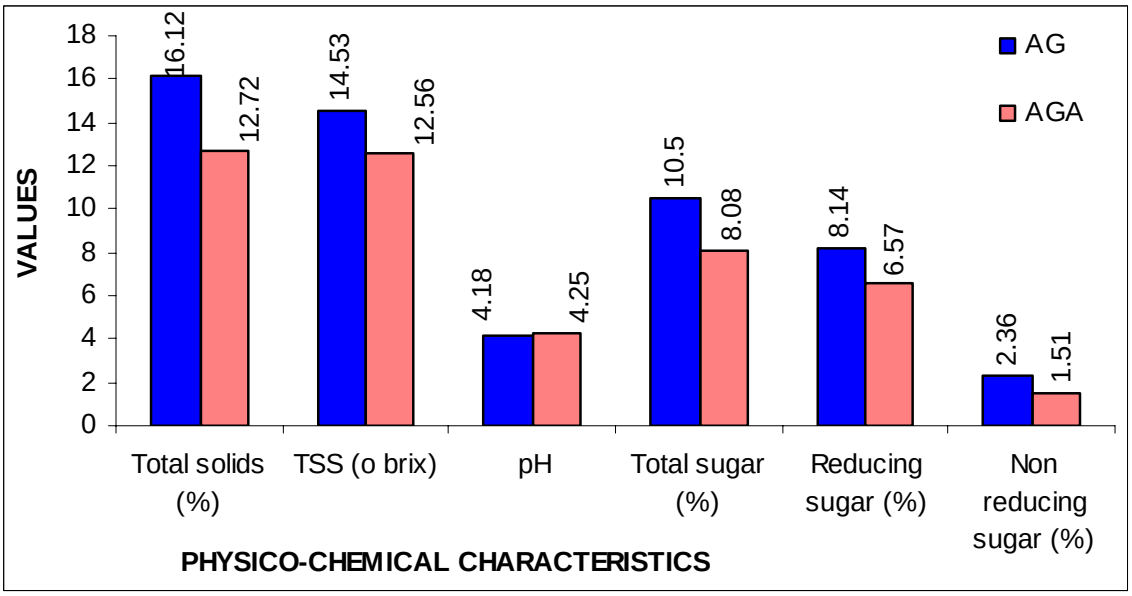


Fig. 4.4(a) Physico chemical composition of AG and AGA juice

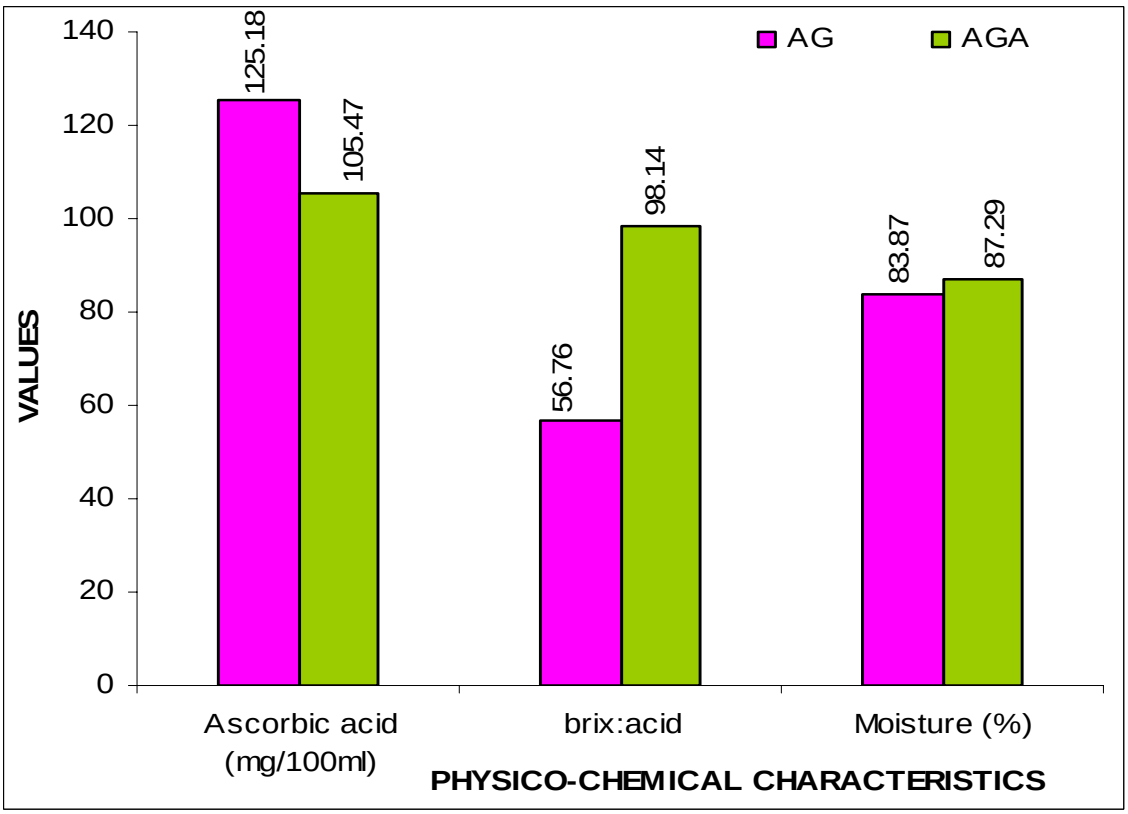


Fig. 4.4 (b) Physico-chemical and nutritional composition of AG and AGA juice

cent). Significant difference was observed between the moisture content of two juice blends. This might be due to the addition of aloe vera juice which had higher moisture content (99.34 per cent) as compared to *aonla* and ginger which had 88.65 per cent and 87.14 per cent moisture respectively (Appendix VIII).

4.5.3.2 Total solids

The total solid content of AGA juice blend (12.72 per cent) was found to be significantly lower than the AG juice blend (16.12 per cent). This might be due to low total solid content of aloe vera (0.65 per cent) as compared to *aonla* and ginger juice having total solids content of 11.33 per cent and 12.85 per cent respectively (Fig 4.4a).

4.5.3.3 Total soluble solids (TSS)

The total soluble solid content of AG juice and AGA juice blend was found to be 14.53 per cent and 12.56 per cent respectively. Significant difference was observed in the TSS content of both juice blends (Appendix VIII). Bhosale *et al.* (2000) also reported decrease in TSS content of *aonla* - mango RTS with increase in the addition of mango pulp.

4.5.3.4 pH

The pH of AG and AGA juice blend was found to 4.18 and 4.25 respectively. No significant difference was observed between the pH values of both juice blends (Appendix VIII).

4.5.3.5 Titrable acidity

The titrable acidity of AG juice blend was found to be higher (0.26 per cent) than AGA juice blend i.e. 0.13 per cent. Significant difference was observed in the titrable acidity of both juice blends. Joshi *et al.* (1993) reported that addition

of spices like ginger to the plum squash reduced the acidity of the product (Appendix VIII).

4.5.3.6 Brix acid ratio

The brix acid ratio of aloe vera containing AGA juice blend (98.14) was found to be higher than AG juice blend (56.76). Significant difference was observed in the brix acid ratio of both juice blends indicating more sweetness in AGA juice blend ((Fig 4.4b).

4.5.3.7 Reducing sugar

The reducing sugar content of aloe vera incorporated juice blend AGA (6.57 per cent) was found to be lower than AG juice (8.14). Addition of aloe vera juice brought about decrease in reducing sugar content of juice blend. This might be due to low reducing sugar content of aloe vera juice (0.17 per cent) than *aonla* juices (7.80 per cent). Significant difference was observed in the reducing sugar content of AG and AGA juice blend (Fig 4.4a).

4.5.3.8 Non reducing sugar

The non - reducing sugar content of AG juice was found to be significantly higher (2.36 per cent) than aloe vera incorporated juice blend (1.51 per cent). This might be due to high non – reducing sugar content of *aonla* (3.05 per cent) than aloe vera juice (0.14 per cent) (Fig 4.4a).

4.5.3.9 Total Sugar

Total sugar content of AG juice blend was found to be 10.50 per cent while of aloe vera incorporated AGA juice blend was 8.08 per cent (Fig 4.4a). Significant difference was observed in the total sugar content of these two juice blends. This might be due to higher total sugar content of *aonla* juice (10.86 per

cent) than aloe vera juice alone (0.34 per cent). Deka *et al.* (2000) reported that higher total sugar contents in grape - mango (95:5) RTS might be due to the higher sugar contents in grape juice (15.19 per cent) and mango pulp (13.97 per cent).

4.5.3.10 Ascorbic acid

The ascorbic acid content of AG juice blend (125.18 mg/100ml) was found to be significantly high than AGA juice blend (Fig 4.4b). This might be due to low ascorbic acid content of aloe vera juice 0.80 mg/100ml as compared to *aonla* juice 624.56 mg/100ml. Inyang and Abah (1997) reported that the extracted juice of cashew apple when blended in various proportions with sweet orange juice, their ascorbic acid content decreased after mixing as compared to the juice of cashew apple alone. Bhosle *et al.* (2000) also reported that increase in level of mango pulp in *aonla* juice from 0 to 50 per cent decreased the ascorbic acid content (mg/100g) from 49.20 to 25.82.

4.5.3.11 Chlorophyll

The AGA juice blend was found to contain 0.26 and 0.19 mg/100ml Chlorophyll- a and chlorophyll- b respectively. While AG juice blend contained 0.32 and 0.24 mg/100ml respectively. No significant difference was observed in the chlorophyll-a content of both juice blends while chlorophyll - b showed significant difference. The total chlorophyll content of AG and AGA juice blend was found to be 0.57 and 0.42 mg/100ml respectively. No significant difference was found between the two juice blends with respect to total chlorophyll content.

4.6 Mineral composition of aloe vera incorporated juice blends

4.6.1 *Lawki-Karela* (LK) juice and *Lawki-Karela*–Aloe vera (LKA) juice blend

Data on mineral composition of LK and LKA juice blend are depicted in Table 4.5 (a). The sodium, potassium, copper, iron, manganese, zinc and calcium

Table 4.5 (a) Mineral composition of *Lawki-Karela* (LK) juice and *Lawki Karela* – Aloe vera (LKA) juice blend

Minerals (mg/100ml)	LK Juice	LKA Juice	S.Em	CD at 5%
Sodium	1.256	2.243	0.103	0.403*
Potassium	116.3	172.43	0.125	0.488*
Copper	0.0334	0.0274	0.014	0.056*
Iron	0.333	0.304	0.0063	0.025*
Manganese	0.0614	0.0986	0.0013	.0052*
Zinc	0.2194	0.1825	0.0016	0.0064*
Calcium	20.322	25.616	0.093	0. 366*

Table 4.5 (b) Mineral composition of Carrot – Orange juice (CO) and Carrot Orange juice - Aloe vera juice (COA) blend

Mineral (mg/100ml)	CO Juice	COA Juice	S.Em	CD at 5%
Sodium	42.656	35.163	0.090	0.355*
Potassium	141.34	103.55	0.125	0.498*
Copper	0.0403	0.0303	0.0013	0.0052*
Iron	1.0713	1.0283	0.0016	0.0063*
Manganese	0.2026	0.215	0.0012	0.0048*
Zinc	0.1826	0.1556	0.0017	0.0068*
Calcium	54.156	40.37	0.073	0.285*

Table 4.5 (c) Mineral composition of *Aonla* – Ginger juice (AG) and *Aonla* Ginger - Aloe vera juice (AGA) blend

Mineral (mg/100ml)	AG Juice	AGA Juice	S.Em	CD at 5%
Sodium	2.53	2.826	0.014	0.056*
Potassium	61.85	30.46	0.021	0.083*
Copper	0.0773	0.0338	0.00857	0.00335*
Iron	0.2305	0.2233	0.00023	0.00091*
Manganese	0.1883	0.2205	0.0026	0.0101*
Zinc	2.0826	0.0953	0.059	0.233*
Calcium	19. 425	30.58	0.134	0.524*

content of aloe vera incorporated LKA juice blend were observed as 2.243, 172.43, 0.0274, 0.304, 0.0986, 0.1825 and 25.616 mg/100 ml respectively while sodium, potassium, copper, iron, manganese, zinc and calcium content of LK juice blend were observed as 1.25, 116.30, 0.0334, 0.333, 0.0614, 0.2194, and 20.322 mg/100 ml respectively. Calcium, manganese and sodium content of LK juice blend showed significantly lower value than aloe vera incorporated LKA juice blend.

4.6.2 Carrot – Orange juice (CO) and Carrot – Orange juice - Aloe vera juice (COA) blend

Data regarding mineral composition of CO and COA juice blends are tabulated in Table 4.5 (b). The CO juice blend had sodium, potassium, copper, iron, manganese, zinc and calcium content of 42.656, 141.34, 0.0403, 1.0713, 0.2026, 0.1826 and 54.156 mg/100 ml respectively whereas the sodium, potassium, copper, iron, manganese, zinc and calcium content of aloe vera incorporated COA juice blend were found to be 35.163, 103.55, 0.0303, 1.0283, 0.215, 0.1556 and 40.37 mg/100 ml. Except for manganese, the calcium, copper, iron, zinc, sodium and potassium content of CO juice blend is significantly higher than the aloe vera incorporated CO juice blend. This might be due to higher mineral content of individual fruit and vegetable than aloe vera which brought about the lower mineral content of COA juice blend.

4.6.3 *Aonla*–Ginger juice (AG) and *Aonla*–Ginger-Aloe vera juice (AGA) blend

Data pertaining to mineral composition of AG and AGA juice blends are depicted in Table 4.5 (c). The sodium, potassium, copper, iron, manganese, zinc and calcium content of AGA juice blend were observed as 2.826, 30.46, 0.0338, 0.2233, 0.2205, 0.0953 and 30.58 mg/100 ml respectively. Whereas the CO juice

blend were found to have 2.53, 61.85, 0.0773, 0.2305, 0.1883, 2.0826 and 19.425 mg/100 ml of sodium, potassium, copper, iron, manganese, zinc and calcium respectively. Calcium, manganese, zinc and sodium content of aloe vera incorporated AGA juice blend had significantly higher values than AG juice blend while copper, iron and potassium content of AGA juice blend were found to be significantly lower than AG juice blend. This might be due to lower or higher mineral content of individual fruit and vegetables as compared to aloe vera.

4.7 Shelf life study of juice blends

4.7.1 Microbiological quality of juice blends during storage

Micro organisms use food material for their own growth. They utilize more nutrients and cause enzymatic changes contributing off flavour by breakdown or synthesis of new compounds spoiling the food. These organisms are either present in fruit or get incorporated and multiply tremendously during storage, if proper care and treatment are not given (Deka *et al.*, 2002).

4.7.1.1 *Lawki-Karela* Juice (LK) and *Lawki-Karela* - Aloe vera (LKA) juice blend

Data on Total plate count (TPC), total coliform count (TCC) and Yeast and mold count (YMC) of LK and LKA juice blends stored at ambient temperature (30 ± 5^0C) and refrigeration temperature (5 ± 1^0C) for seven days is given in Table 4.6 (a).

4.7.1.1.1 Total plate count (TPC)

Total plate count (cfu / ml) of fresh LK and LKA juice blend was found to be 5.6×10^1 and 3.5×10^1 respectively (Table 4.6a). LKA juice blend had lower count as compared to LK juice blend on 0 day of storage. Khattak *et al.,* 2005 reported 2.2×10^5 cfu/g in minimally processed bitter gourd which was found to be higher than the count of present investigation.

Table 4.6 (a) Changes in microbial count of *Lawki- Karela* Juice (LK) and *Lawki Karela* - Aloe vera (LKA) juice blend during storage under ambient and refrigeration temperature

Storage period	Storage temperature	LK juice blend			LKA juice blend		
		TPC	TCC	YMC	TPC	TCC	YMC
0 day	Fresh juice	5.6×10^1	8.5×10^1	2.54×10^1	3.5×10^1	4.6×10^1	2.34×10^1
1st day	A	2.69×10^3	2.26×10^2	2.8×10^2	2.26×10^3	1.89×10^2	2.65×10^2
	R	2.63×10^2	1.5×10^2	2.71×10^2	2.40×10^2	1.11×10^2	2.54×10^2
2nd day	A	1.78×10^6	2.45×10^6	2.67×10^5	1.39×10^6	2.59×10^5	2.45×10^5
	R	1.34×10^4	1.03×10^4	2.36×10^4	1.18×10^4	2.54×10^4	2.26×10^4
3rd day	A	6.4×10^7	2.73×10^7	2.62×10^7	2.47×10^7	1.67×10^7	2.37×10^6
	R	2.33×10^6	2.0×10^7	2.73×10^6	2.05×10^6	1.01×10^7	2.45×10^5
7th day	A	Discarded	Discarded	Discarded	Discarded	Discarded	Discarded
	R	1.84×10^8	2.53×10^8	2.8×10^8	2.3×10^7	2.27×10^7	2.69×10^8

TPC- Total plate count
TCC- Total Coliform count
YMC- Yeast and mold count
LK= *Lawki- Karela* juice blend
LKA = *Lawki Karela* - Aloe vera juice blend
A =Ambient temperature (30 ± 5^0 C)
R = Refrigeration temperature (5 ± 1^0 C)

Permissible limits-
TPC = $< 10^5$ cfu / ml (IS: 5402, 1969)
TCC = $< 10^2$ cfu / ml (IS: 5401, 1969)
YMC = $< 10^5$ cfu / ml (Frazier, 1967)

The TPC of LK juice blend kept at ambient temperature and at refrigeration temperature was found to increase from 5.6×10^1 cfu / ml to 6.4×10^7 and from 5.6×10^1 to 2.33×10^6 respectively on 3rd day of storage. Similarly aloe vera incorporated LKA juice kept at ambient temperature and at refrigeration temperature showed increase in TPC from 3.5×10^1 on 0 day of storage to 2.47×10^7 and 2.05×10^6 respectively on third day of storage. The TPC of LK and LKA juice kept at ambient temperature was found to be higher than the LK and LKA juice blend kept at refrigeration temperature on 3rd day of storage.

It was further observed the TPC of LK juice kept at ambient temperature and at refrigeration temperature was higher than aloe vera incorporated LKA juice blend kept at ambient temperature and at refrigeration temperature during the entire storage period of 7 days. On 7th day of storage, the LK juice and LKA juice stored at ambient temperature were discarded due to heavy microbial load and also at refrigeration temperature; both LK juice and LKA juice blend had very high microbial count.

4.7.1.1.2 Total Coliform count (TCC)

The total coliform count (TCC) of LK and LKA juice was found to be 8.5×10^1 cfu / ml and 4.6×10^1 cfu / ml respectively on 0 day of storage. LK juice blend was found to have higher count than LKA juice even on 0 day of storage.

The TCC of LK juice kept at ambient temperature and refrigeration was found to increase from 8.5×10^1 to 2.73×10^7 and from 8.5×10^1 to 2.0×10^7 on 3rd day of storage respectively. Similarly aloe vera incorporated LKA juice blend followed the same trend of increase. The TCC of LKA juice blend kept at ambient temperature and at refrigeration temperature was found to increase from 4.6×10^1

on 0 day to 1.67×10^7 cfu / ml and from 4.6×10^1 on 0 day to 1.01×10^7 respectively during 3 days storage period. It was also concluded that TCC of LK juice and LKA juice blend kept at refrigeration temperature was lower than the juices kept at ambient temperature. It was further seen that TCC of aloe vera incorporated LKA juice blend kept at ambient temperature and at refrigeration temperature was lower than LK juice kept at the ambient temperature and at refrigeration temperature (Table 4.6a).

4.7.1.1.3 Yeast and mold count (YMC)

The yeast and mold count of fresh LK and aloe vera incorporated LKA juice blend was observed as 2.54×10^1 and 2.34×10^1 respectively. The YMC of LKA juice blend was found to be lower than LK juice blend on 0 day of storage.

The YMC of LK juice kept at ambient temperature and at refrigeration temperature was found to increase from 2.54×10^1 on 0 day of storage to 2.62×10^7 and from 2.54×10^1 to 2.73×10^6 respectively on 3rd day of storage. In the same way aloe vera incorporated LKA juice blend kept at ambient temperature and at refrigeration temperature showed increase in YMC from 2.34×10^1 on 0 day of storage to 2.37×10^6 and from 2.34×10^1 to 2.45×10^5 respectively on 3rd day of storage. The YMC of juices kept at refrigeration temperature was found to be lower than the juices kept at ambient temperature.

During storage period of 7 days, it was also observed that YMC of aloe vera incorporated LK juice blend was lower than the YMC of LK juice blend kept at ambient temperature and at refrigeration temperature. Pandey *et al.* (2003) reported the TPC of carrot juice (1.5×10^1 to1.7×10^5) kept at ambient temperature is higher than the carrot juice kept at refrigeration temperature ($1.5 \times$

10^1 to 2.6×10^4) during 90 days storage period. They further reported the same trend in YMC. The present study is in line with the reported microbial count.

The TPC, TCC and YMC of LKA juice kept at ambient temperature and refrigeration temperature was found to be lower than LK juice kept at ambient temperature and refrigeration temperature during 7 days storage period. This might be due to anti microbial activity of aloe vera juice. Arunkumar and Muthuselvan (2009) reported antibacterial activity of aloe vera against pathogenic bacteria *Staphylococus aureus, Streptococcus pyrogenes, Pseudomonas aeruginosa* and *E. Coli.* They also showed antifungal activity of aloe vera against *Aspergillus flavus* and *Aspergillus niger*. Ferro *et al.* (2003), Agarry *et al.* (2005) and Habeeb *et al.*(2007) reported antimicrobial activity of aloe vera gel and leaf against *S. aureus.* Yesilada *et al.* (1999) showed antibacterial activity of bitter gourd against *Helicobacter pylori* organism (Table 4.6a).

4.7.1.1.4 Shelf life of LK juice and LKA juice blend

Data on shelf life of LK and LKA juice blend are given in Table 4.7. The TPC of LK and LKA juice blend kept at refrigeration temperature were found to be within the permissible limit of standard given by IS: 5402, 1969 ($<10^5$ cfu / ml) for 2 days during 7 days of storage period while the juices kept at ambient temperature had limits upto one day. The TCC of LK and LKA juice blend were found to be in limit of standard given by IS: 5401, 1969 ($<10^2$) for one day. While yeast and mold count of juices were within the limit of $<10^5$ cfu /ml for 2 days (Frazier, 1967).

4.7.1.2 Carrot – Orange (CO) Juice and Carrot – Orange - Aloe vera (COA) juice blend

Data on Total plate count (TPC), total coliform count (TCC) and Yeast and mold count (YMC) of CO and COA juice blends stored at ambient temperature

Table 4.6 (b) Changes in microbial count of Carrot Orange (CO) juice and Carrot - Orange Aloe (COA) juice blends during storage under ambient and refrigeration temperature

Storage period	Storage temperature	CO juice blend			COA juice blend		
		TPC	TCC	YMC	TPC	TCC	YMC
0 day	Fresh	2.5×10^1	2.43×10^1	1.80×10^2	1.5×10^1	1.3×10^1	1.45×10^2
1st day	A	2.45×10^3	3.6×10^2	1.36×10^3	5.46×10^2	1.4×10^2	5.9×10^2
	R	1.51×10^2	2.66×10^2	7.4×10^2	1.24×10^1	6.1×10^1	5.2×10^2
2nd day	A	1.08×10^5	1.42×10^3	1.37×10^4	1.84×10^3	1.11×0^2	2.45×10^3
	R	2.55×10^3	1.23×10^3	8.3×10^3	4.4×10^2	9.33×10^1	6.26×10^2
3rd day	A	1.46×10^6	2.43×10^3	2.84×10^5	6.46×10^4	2.45×10^2	1.89×10^4
	R	1.46×10^4	1.78×10^3	2.21×10^4	1.94×10^3	1.95×10^2	9.33×10^2
7th day	A	Discarded	Discarded	Discarded	Discarded	Discarded	Discarded
	R	2.58×10^9	1.68×10^8	2.03×10^8	4.83×10^8	2.37×10^7	2.29×10^7

TPC- Total plate count
TCC- Total Coliform count
YMC- Yeast and mold count
LK= Carrot- Orange juice blend
LKA = Carrot Orange - Aloe vera juice blend
A =Ambient temperature (20 ± 5^0 C)
R = Refrigeration temperature (5 ± 1^0 C)

Permissible limits-
TPC = $< 10^5$ cfu / ml (IS: 5402, 1969)
TCC = $< 10^2$ cfu / ml (IS: 5401, 1969)
YMC = $< 10^5$ cfu / ml (Frazier, 1967)

(30 ± 5^0C) and refrigeration temperature (5 ± 1^0C) for seven days is given in Table 4.6 (b).

4.7.1.2.1 Total plate count (TPC)

The total plate count of fresh CO and COA juice blend was found to be 2.5×10^1 and 1.5×10^1 cfu / ml respectively on 0 day of storage (Table 4.6b). Jia *et al.* (1999) reported TPC (cfu/ml) of fresh squeezed orange juice as 5.4 x 10^3 cfu/ml. The TPC of various fresh juice combinations were reported as 138×10^{10} to 141×10^{10} by Dhaliwal and Hira (2001) while Hsieh and Ko (2008) observed TPC in the carrot juice as 3.4×10^3 which were found to be higher than the count observed in present study. The TPC (cfu / ml) of aloe vera incorporated COA juice blend kept at ambient temperature and refrigeration temperature was found to increase from 1.5×10^1 on 0 day of storage to 6.46×10^4 and from 1.5×10^1 to 1.94×10^3 respectively on 3rd day of storage. Similarly TPC of CO juice blend kept at ambient temperature and refrigeration temperature was found to increase from 2.5×10^1 on 0 day of storage to 1.46×10^6 and from 2.5×10^1 to 1.46×10^4 respectively on 3rd day of storage. The total plate count of CO and COA juice kept at ambient temperature was found to be higher than the CO and COA juice blend kept at refrigeration temperature. Temperature is said to play an important role on biochemical changes in the products which lead to development of off flavour due to storage (Pandey and Singh, 1999). Pandey *et al.* (2003) reported that carrot juice kept at ambient temperature had higher TPC (2.7×10^3) than juice kept at refrigeration temperature (3.0×10^2) after 45 days of storage.

Pandey *et al.* (2003) also showed that TPC of carrot juice kept at ambient temperature and at refrigeration temperature increased from 1.5×10^1 to 1.7×10^5 and from 1.5×10^1

to 2.6×10^4 respectively during 90 days of storage. This trend was found to be in line with the present study. Goyal and Ojha (1998) reported increase in TPC (cfu / ml) of orange juice with time kept at refrigerated temperature for 4 weeks. It was further observed that TPC of aloe vera incorporated COA juice blend kept at ambient temperature and at refrigeration temperature was lower than the CO juice blend kept at corresponding ambient and refrigeration temperatures.

4.7.1.2.2 Total Coliform Count (TCC)

The TCC of fresh CO and COA juice blend was found to be 2.43×10^1 and 1.3×10^1 Cfu / ml respectively. The TCC of COA juice was observed as lower than CO juice blend.

During 7 days of storage period, it was found that total coliform count aloe vera incorporated COA juice blend kept at ambient temperature and refrigeration temperature increased from 1.3×10^1 on 0 day of storage to 2.45×10^2 Cfu / ml and from 1.3×10^1 to 2.37×10^7 Cfu / ml on 7^{th} day of storage respectively. Similarly CO juice blend showed the same trend and TCC of CO juice kept at ambient temperature and at refrigeration temperature increased from 2.43×10^1 on 0 day of storage to 2.43×10^3 and from 2.43×10^1 to1.68×10^8 respectively on 7^{th} day of storage to. It was seen that juices kept at ambient temperature had higher TCC than juices kept at refrigeration temperature during storage. It was further observed that TCC of CO juice kept at ambient temperature and at refrigeration temperature was higher than aloe vera incorporated COA juice blend kept at corresponding ambient and refrigeration temperature during the entire 7 days storage period (Table 4.6b).

4.7.1.2.3 Yeast and mold count (YMC)

The yeast and mold count of fresh CO and COA juice blend was found to be 1.80×10^2 and 1.45×10^2 respectively. Jia *et al.* (1999) reported YMC of freshly squeezed orange juice as 2.8×10^3 cfu/ml while Michelle *et al.* 2004 reported the initial populations of yeast and moulds in untreated Valencia and Navel orange juice as 4.8×10^1 and 3.1×10^1 cfu/ml respectively which is higher than the values reported in present study. During storage period, the YMC of CO juice kept at ambient temperature and refrigeration temperature was found to increase from 1.80×10^2 on 0 day of storage to 2.84×10^5 and from 1.80×10^2 to 2.21×10^4 respectively on 3rd day of storage. The aloe vera incorporated COA juice blend showed the same pattern and YMC of COA juice at ambient and refrigeration temperature was found to increase from 1.45×10^2 to 1.89×10^4 and from 1.45×10^2 to 9.93×10^2 respectively on 3rd day of storage. The same trend is shown by Pandey *et al.* (2003) who reported increase in YMC from 0 to 29.0 cfu/ml and from 0 to 21.0 cfu/ml in carrot juice stored at ambient and refrigeration temperature for 90 days respectively. During the storage period of 7 days it was also found that YMC of aloe vera containing COA juice blend had lower YMC than the CO juice having no aloe vera stored at ambient and refrigeration temperature. as in present study. Ladaniya *et al.* (2004) also reported higher YMC in orange juice kept at ambient temperature than at refrigerated temperature for 180 days. The microbial load of aloe vera incorporated COA juice blend was found to be lower than CO juice having no aloe vera during 7 days of storage study at both ambient and refrigeration temperature. This might be due to antimicrobial activity of aloe vera. According to Habeeb *et al.*(2007) and Agarry

et al. (2005), the aloe vera gel and leaf had antimicrobial activity against *S. aureus,* this could be responsible for the popular use of aloe vera gel and leaf to relieve many types of GIT irritations (Foster 1999 and Grindlay and Reynolds, 1986), since *S. aureus* form part of the normal microbial flora of intestinal tract (Cheesbeough, 1984). However, most of the constituents are found in the gel and not on the leaf, hence the gel is likely to be more active and effective than the leaf. Ferro *et al.* (2003) have shown that aloe vera gel can inhibit the growth of the *streptococcus pyrogenes*. Cock (2008) reported antibacterial activity of aloe vera juice against *E. Coli* and also showed antifungal activity against *Aspergillus niger (*Table 4.6b).

4.7.1.2.4 Shelf life of CO and COA juice blend

Data on shelf life of CO and COA juice blend are given in Table 4.7. The TPC of CO and COA juice kept at refrigeration temperature were found to be within the admissible limit of standards given by IS: 5402, 1969 ($<10^5$ cfu/ml) for 3 days. COA juice kept at ambient temperature followed the same pattern but CO juice at ambient temperature was within the limit of standard for 2 days. The TCC of CO juice at ambient and refrigeration temperature were found to be within permissible limit of standard given by IS: 5401, 1969 ($<10^2$ cfu / ml) for 2 days while COA juice blend for 3 days. The YMC of CO juice at ambient and refrigeration temperature was found to be within limit of standards of $<10^5$ cfu / ml (Frazier, 1967) for one day and three days respectively while COA juice blend at ambient and refrigerated temperature were within the limits for 2 days and 3 days respectively. Fresh orange juice has a limited shelf-life (12–14 days at 4 °C). Although acid concentration and the low pH of fruit juices may be antagonistic

towards most pathogenic bacteria (García *et al.* 2001).The natural acid also helps to preserve the juice's natural colour and essential nutrients. According to Nguyen & Carlin (1994) fresh carrot juice, not thermally treated, should generally be consumed within 1–2 days while Michelle *et al.* (2004) found untreated juice stored at 4 ^{0} C to be microbiologically acceptable for 14 days and juice stored at 10 ^{o} C for 7 days.

4.7.1.3 *Aonla*-Ginger (AG) juice and *Aonla*-Ginger-Aloe vera (AGA) juice blend

Data on Total plate count (TPC), total coliform count (TCC) and Yeast and mold count (YMC) of AG and AGA juice blends stored at ambient temperature (30 ± 5^{0}C) and refrigeration temperature (5 ± 1^{0}C) for seven days is given in Table 4.6 (c).

4.7.1.3.1 Total plate count (TPC)

The TPC (cfu / ml) of fresh AG and AGA juice blend was observed as 1.23×10^{1} and 1.16×10^{1} respectively on 0 day of storage. The TPC of AG juice at refrigeration and ambient temperature was found to increase from 1.23×10^{1} on 0 day of storage to 2.72×10^{5} and from 1.23×10^{1} to 2.56×10^{6} respectively on 7th day of storage. Similar pattern of microbial growth was seen in AGA juice blend. The TPC of juices kept at ambient temperature and at refrigeration temperature was found to increase from 1.23×10^{1} on 0 day to 2.56×10^{6} and from 1.23×10^{1} to 2.72×10^{5} respectively during 7 days of storage period. It was further noticed that aloe vera incorporated AGA juice blend kept at ambient temperature and at refrigerated temperature showed lower count than AG juice blend during entire period of storage of 7 days (Table 4.6c).

Table 4.6 (c) Changes in microbial count of *Aonla*-Ginger (AG) juice and *Aonla* Ginger - Aloe (AGA) juice blend during storage under ambient and refrigeration temperature

Storage period	Storage temperature	AG juice blend			AGA juice blend		
		TPC	TCC	YMC	TPC	TCC	YMC
0 day	Fresh juice	1.23×10^1	2.9×10^1	4.8×10^1	1.16×10^1	2.1×10^1	3.1×10^1
1st day	A	8.6×10^1	8.4×10^1	1.16×10^3	5.1×10^1	3×10^1	1.05×10^3
	R	4.73×10^1	6.1×10^1	5.2×10^2	1.9×10^1	2×10^1	4.16×10^2
2nd day	A	1.68×10^2	1.67×10^2	1.64×10^3	8.5×10^1	1.4×10^1	1.34×10^3
	R	7.23×10^1	9.33×10^1	6.8×10^2	3.93×10^1	8.33×10^1	5.2×10^2
3rd day	A	2.82×10^2	1.19×10^3	4.03×10^3	1.27×10^2	4.93×10^1	1.60×10^3
	R	1.31×10^2	2.24×10^2	8×10^2	7.16×10^1	2.53×10^1	7.03×10^2
7th day	A	2.56×10^6	2.3×10^3	2.68×10^6	2.59×10^5	2.33×10^2	2.23×10^6
	R	2.72×0^5	1.75×10^3	1.3×10^5	2.0×10^4	1.18×10^2	1.13×10^5

TPC- Total plate count
TCC- Total Coliform count
YMC- Yeast and mold count
AG = Aonla - Ginger juice blend
AGA = Aonla - Ginger - Aloe vera juice blend
A =Ambient temperature (20 ± 5^0 C)
R = Refrigeration temperature (5 ± 1^0 C)

Permissible limits
TPC = $< 10^5$ cfu / ml (IS: 5402, 1969)
TCC = $< 10^2$ cfu / ml (IS: 5401, 1969)
YMC = $< 10^5$ cfu / ml (Frazier, 1967)

4.7.1.3.2 Total coliform count (TCC)

The TCC of fresh AG and AGA juice blend was found to be 2.9×10^1 and 2.1×10^1 respectively on o day of storage indicating that TCC of AG juice was found to be higher than AGA juice blend. The TCC of AG and AGA juice kept at ambient temperature was found to increase from 2.9×10^1 on 0 day of storage to 2.3×10^3 and from 2.1×10^1 to 2.33×10^2 cfu / ml respectively on 7^{th} day of storage.

The TCC of AG and AGA juice blend kept at refrigeration temperature was found to increase from 2.9×10^1 on 0 day of storage to 1.75×10^3 and from 2.1×10^1 on 0 day of storage to 1.18×10^2 cfu/ml on 7^{th} day of storage. The juices kept at refrigeration temperature showed lower TCC than those kept at ambient temperature. Further aloe vera incorporated AGA juice blend showed lower count than AG juice blend during entire period of 7 days storage (Table 4.6c).

4.7.1.3.3 Yeast and mold count (YMC)

The yeast and mold count of fresh AG juice and AGA juice blend was found to be 4.8×10^1 and 3.1×10^1 respectively. The AGA juice blends count being lower than AG juice. The YMC of AG juice blend at ambient and refrigeration temperature was found to increase from 4.8×10^1 on 0 day of storage to 2.68×10^6 and from 4.8×10^1 to 1.31×10^5 respectively on 7^{th} day of storage. The YMC of AGA juice blend at ambient and refrigeration temperature was also found to increase from 3.1×10^1 on 0 day of storage to 2.23×10^6 and from 3.1×10^1 to 1.13×10^5 respectively on 7^{th} day of storage. It was also noticed that AGA juice blend showed lower count than AG juice which was without aloe vera incorporation. Pandey *et al.* (2003) reported lower TPC of carrot juice at

refrigeration temperature than at ambient temperature during 90 days of storage period. They also reported same trend with YMC. Nagpal and Rajalakshmi (2009) showed increase in microbial load of RTS beverages on 60 days storage.

The microbial load of AG juices kept at ambient temperature and refrigeration temperature were found to be higher than AGA juice blend kept at corresponding ambient and refrigeration temperature due to antimicrobial properties of aloe vera, ginger, honey and *aonla*. Cock (2008) reported antibacterial and antifungal activity of aloe vera juice against *E. coli* and *Aspergillus niger* respectively. Gur *et al.* (2006) reported antibacterial activity of ginger extract against *Bacillus subtilis, E. coli* and Staphylococcus. Jain *et al.* (2009) found ginger as effective against *B. Subtilis* and *E. coli*. Ginger was found to inhibit the growth of *E. coli,* Staphylococcus, Strepto Coci and Salmonella. Ginger also inhibits aspergillus fungus that produce aflatoxin. Fresh ginger juice showed inhibitory action against *A niger, S. cerevisiae* and. *L. acidophilus* at ambient temperature (ICMR Bulletin, 2003). Treadway (1994) showed antibacterial and antifungal property of *aonla*. Saeed and Tarig (2007) showed maximum activity of aqueous infusion of *aonla* against *B. subtilis*. Honey was found to have antibacterial activity against *Staphylococcus aureus* (Cooper *et al.* 1999) and antifungal activity against *aspergillus flavus and Aspergillus niger* (Sheikh *et al,* 1995). Mundo *et al.* (2002) reported antibacterial activity of honey against *E. coli* and *Salmonella*. Kacaniona *et al.* (2009) reported antifungal activity against yeast of Candida species. Throat *et al.* (2007) noticed decrease in microbial count with increase in the level of aloe vera juice (Table 4.6b).

Table 4.7 Shelf life of different juice blends at different temperature

Type of juice blends	Storage temperature	Shelf life (Days)
Lawki- Karela (LK) juice	Ambient temperature (30 ± 5^0 C)	1
	Refrigeration temperature (5 ± 1^0 C)	2
Lawki Karela- Aloe vera (LKA) juice	Ambient temperature (30 ± 5^0 C)	1
	Refrigeration temperature (5 ± 1^0 C)	2
Carrot – Orange (CO) juice	Ambient temperature (20 ± 5^0 C)	2
	Refrigeration temperature (5 ± 1^0 C)	3
Carrot – Orange- Aloe vera (COA) juice	Ambient temperature (20 ± 5^0 C)	3
	Refrigeration temperature (5 ± 1^0 C)	3
Aonla-Ginger (AG) juice	Ambient temperature (20 ± 5^0 C)	3
	Refrigeration temperature (5 ± 1^0 C)	3
Aonla Ginger-Aloe vera (AGA) juice	Ambient temperature (20 ± 5^0 C)	3
	Refrigeration temperature (5 ± 1^0 C)	7

4.7.1.3.4 Shelf life of AG and AGA juice blend

Data on shelf life of AG and AGA juice blend are given in Table 4.7. The TPC, TCC and YMC, of AG juice at refrigeration and ambient temperature were found to be in permissible limit of (IS: 5402, 1969; IS: 5401, 1969 and Frazier, 1967) for 3 days. AGA juice blend had 3 days shelf life at ambient temperature while at refrigeration temperature it had 7 days shelf life. Ogiehor *et al.* (2008) reported that extract of ginger alone or in combination with low temperature storage (refrigeration) extended the shelf life of beverage for a minimum of 6 weeks and contributed to the overall quality and acceptability.

4.7.2 Organoleptic evaluation of juice blend during storage

4.7.2 .1 *Lawki-karela* (LK) and *Lawki karela*-aloe vera (LKA) juice blends

4.7.2 .1.1 Color

Data regarding mean sensory scores for color of LK and LKA juice blends stored at ambient and refrigeration temperature up to 3 days are presented in Table 4.8 (a). The results exhibited that mean sensory score for color of LK and LKA juice blends was significantly highest (7.93) on 0 day of storage period while lowest on 3rd day of storage period. Significant difference in color due to storage at ambient (5.16) and refrigeration (7.77) temperature was seen in juice blends. Incorporation of aloe vera juice blends brought no significant difference in the color of LK (6.64) and LKA (6.50) juice blends. However Juice blends kept for 3 days at ambient and refrigeration temperature showed significant difference in color. The scores decreased in both the cases of temperature with subsequent storage period but scores for color was higher (7.93-7.63) in Juice blends at refrigeration temperature than juice blends at ambient temperature (7.93 to 7.56).

Table 4.8 (a) Mean sensory scores of colour of *Lawki-Karela* (LK) and *Lawki Karela*-Aloe vera (LKA) juice blends during storage

Juice	Temperature	D0	D1	D2	Mean (JT)
LK	A	7.93	7.53	0.00	5.51
	R	7.93	7.73	7.53	7.73
	Mean (DJ)	7.93	7.63	3.76	6.64 Mean (J)
LKA	A	7.93	7.60	0.00	5.17
	R	7.93	7.80	7.73	7.82
	Mean (DJ)	7.93	7.70	3.86	6.50 Mean (J)
	Mean (D)	7.93	7.66	3.81	-

	A	R
D0	7.93	8.23
D1	7.56	8.10
D2	0.00	7.36
Mean (T)	5.16	7.77

Source of variation	S.Em±	CD at 5%
D	0.05	0.15
J	0.04	NS
T	0.04	0.12
D×J	0.07	NS
D×T	0.07	0.21
J×T	0.06	NS
D×J×T	0.11	NS

D- Days
J- Juice type
T- Temperature
D0 – Day 0
D1 – Day 1
D2 – Day 2

A- Ambient temperature (30±5 ^{0}C)
R- Refrigeration temperature (5±1 ^{0}C)
LK- Lawki-Karela juice
LKA – Lawki-Karela-Aloe vera juice
* Maximum score = 10

Table 4.8 (b) Mean sensory scores of appearance of *Lawki-Karela* (LK) and *Lawki Karela*-Aloe vera (LKA) juice blends during storage

Juice	Temperature	D0	D1	D2	Mean (JT)
LK	A	7.86	7.53	0.00	5.13
	R	7.86	7.66	7.53	7.68
	Mean (DJ)	7.86	7.60	3.76	6.41 Mean (J)
LKA	A	7.86	7.60	0.00	5.15
	R	7.86	7.73	7.66	7.75
	Mean (DJ)	7.86	7.66	3.83	6.45 Mean (J)
	Mean (D)	7.86	7.63	3.80	-

Days	A	R
D0	7.86	7.86
D1	7.56	7.70
D2	0.00	7.60
Mean (T)	5.14	7.72

Source of variation	S.Em±	CD at 5%
D	0.06	0.17
J	0.04	NS
T	0.04	0.13
D×J	0.08	NS
D×T	0.08	0.24
J×T	0.07	NS
D×J×T	0.12	NS

D- Days
J- Juice type
T- Temperature
D0 – Day 0
D1 – Day 1
D2 – Day 2

A- Ambient temperature (30±5 ^{0}C)
R- Refrigeration temperature (5±1 ^{0}C)
LK- Lawki-Karela juice
LKA – Lawki-Karela-Aloe vera juice
* Maximum score = 10

Juice blends kept at ambient temperature were discarded on second day of storage due to their higher microbial load. However the overall effect of aloe vera incorporation, storage days and storage temperature had non significant effect on color of juice blends.

4.7.2 .1.2 Appearance

The mean sensory scores for appearance of LK and LKA juice blends stored at ambient temperature and refrigeration temperature for three days are presented in Table 4.8 (b). The results showed significant difference in appearance of juice blends stored for 3 days i.e. highest on 0 day (7.86) and lowest on second day (3.80). Initially no significant difference in the appearance of two juice blends was observed. However mean sensory scores of juice blends stored at ambient temperature (5.14) and refrigeration temperature (7.72) showed significant difference in appearance of juice blends. This might be due to degradation of pigments of juice blends at ambient temperature. It was further observed that both days and temperature had significant effect on appearance of juice blends with increase in storage period. The appearance of juice blends at ambient and refrigeration declined significant from 7.86 to 7.56 and from 7.86 to 7.60 respectively as the storage period increased from 0 to 3 days. However the overall effect of interaction of aloe vera incorporation, storage period and storage temperature was found non-significant.

4.7.2 .1.3 Flavor

Data pertaining to interaction of sensory scores for flavor of LK and LKA juice blends stored at ambient and refrigeration temperature upto 3 days are depicted in Table 4.8 (c). The results indicated that days of storage had significant

Table 4.8 (c) Mean sensory scores of flavour of *Lawki-Karela* (LK) and *Lawki Karela*-Aloe vera (LKA) juice blends during storage

Juice	Temperature	D0	D1	D2	Mean (JT)	Days	A	R
LK	A	5.86	5.73	0.00	3.86	D0	6.13	6.13
	R	5.86	5.80	5.66	5.77	D1	5.96	6.03
	Mean (DJ)	5.86	5.76	2.83	4.82 Mean (J)	D2	0.00	5.90
LKA	A	6.40	6.20	0.00	4.20	Mean (T)	4.03	6.02
	R	6.40	6.26	6.13	6.26			
	Mean (DJ)	6.40	6.23	3.06	5.23 Mean (J)			
	Mean (D)	6.13	6.00	2.95	-			

	Source of variation	S.Em±	CD at 5%
	D	0.14	0.39
D- Days	J	0.11	0.32
J- Juice type	T	0.11	0.32
T- Temperature	D×J	0.19	NS
D0 – Day 0	D×T	0.19	0.55
D1 – Day 1	J×T	0.16	NS
D2 – Day 2	D×J×T	0.28	NS

A- Ambient temperature (30±5 ^{0}C)
R- Refrigeration temperature (5±1 ^{0}C)
LK- Lawki-Karela juice
LKA – Lawki-Karela-Aloe vera juice
* Maximum score = 10

Table 4.8 (d) Mean sensory scores of taste of *Lawki-Karela* (LK) and *Lawki Karela*-Aloe vera (LKA) juice blends during storage

Juice	Temperature	D0	D1	D2	Mean (JT)	Days	A	R
LK	A	5.80	5.53	0.00	3.77	D0	6.23	6.23
	R	5.80	5.66	5.53	5.66	D1	6.00	6.10
	Mean (DJ)	5.80	5.60	2.76	4.72 Mean (J)	D2	0.00	5.96
LKA	A	6.66	6.46	0.00	4.37	Mean(T)	4.07	6.10
	R	6.66	6.53	6.40	6.53			
	Mean (DJ)	6.66	6.50	3.20	5.45 Mean (J)			
	Mean (D)	6.23	6.05	2.98	-			

	Source of variation	S.Em±	CD at 5%
	D	0.13	0.37
D- Days	J	0.10	0.30
J- Juice type	T	0.10	0.30
T- Temperature	D×J	0.18	NS
D0 – Day 0	D×T	0.18	0.52
D1 – Day 1	J×T	0.15	NS
D2 – Day 2	D×J×T	0.26	NS

A- Ambient temperature (30±5 ^{0}C)
R- Refrigeration temperature (5±1 ^{0}C)
LK- Lawki-Karela juice
LKA – Lawki-Karela-Aloe vera juice
* Maximum score = 10

effect on flavour of juice blends i.e. 6.13 on 0 day and 2.95 on second day. The mean sensory score for flavour of AG (4.82) was found significantly lower than AGA (5.23) juice blends. Significant difference was observed in the flavour of juice blends kept at ambient temperature (4.03) and refrigeration temperature (6.02). Mean sensory score of storage days and juice blends for flavour showed no significant difference in interaction of days of storage and type of juice blends on flavour of both AG and AGA juice blends. However interaction of days of storage and temperature showed significant difference in flavour. Juice blends at refrigeration temperature scored higher than ambient temperature. While juice blends kept at ambient temperature were discarded on second day due to safety point of view. However the overall effect of interaction of juice blends type, storage period and storage temperature on flavor was observed non-significant.

4.7.2 .1.4 Taste

Data related to sensory score for taste of LK and aloe vera incorporated LKA juice blends stored for 3 days at ambient temperature and refrigeration temperature are tabulated in Table 4.8 (d). The result showed that there is significant difference in the taste of juice blends and days of storage. The mean score for taste is high (6.23) at 0 day and low at end of storage day (2.98). Incorporation of aloe vera also brought significant difference in the taste of juice blends. Mean sensory score for taste of juice blends without aloe vera LK was observed low (4.72) LKA. Juice blends (5.45) having aloe vera juice blends. Similar trend was also seen in taste of juice blends kept at different temperature. Mean score for taste was higher in juice blends kept at refrigeration temperature (6.10) than juice blends kept at ambient temperature (4.07) no significant effect of

days of storage and type of juice blends on taste was found but significant effect of both days of storage and temperature of storage was found. However the combined effect of interaction of days of storage, type of juice blends and temperature of storage was found non-significant.

4.7.2 .1.5 Consistency

Data pertaining to the effect of storage days, storage temperature and aloe vera juice blends incorporation on the consistency of juice blends are tabulated in Table 4.8 (e). The result showed that with increase in storage days the mean score for consistency decreased. This might be due to degradation of constituents of juice blends. Significant difference was observed in the consistency juice blends with aloe vera and without aloe vera juice blends incorporation. The mean score for consistency of LK juice blends (5.87) was found to be significantly lower than aloe vera incorporated LKA juice blends (6.04). This might be due preservative action of aloe vera on juice blends component. The storage temperature also showed significant difference in the consistency of the juice blends. The mean score for consistency of juice blends at ambient temperature was found to be lower (4.77) than refrigeration temperature (7.14). This might be due to low temperature that prevents degradation of juice blends components. The combined effect of days and juice blends type was found non-significant. However the combined effect of days storage days and storage temperature was found significant with increase in storage days. The consistency of juice blends at ambient and refrigeration temperature decreased significantly, more pronounced at ambient temperature while the overall effect of interaction of juice blends type storage temperature and storage days was found non-significant.

Table 4.8 (e) Mean sensory scores of consistency of *Lawki-Karela* (LK) and *Lawki Karela*-Aloe vera (LKA) juice blends

Juice	Temperature	D0	D1	D2	Mean (JT)	Days	A	R
LK	A	7.13	7.00	0.00	4.71	D0	7.23	7.23
	R	7.13	7.06	6.93	7.04	D1	7.10	7.16
	Mean (DJ))	7.13	7.03	3.46	5.87 Mean (J)	D2	0.00	7.03
LKA	A	7.33	7.20	0.00	4.84	Mean (T)	4.77	7.14
	R	7.33	7.26	7.13	7.24			
	Mean (DJ)	7.33	7.23	3.56	6.04 Mean (J)			
	Mean (D)	7.23	7.13	3.51	-			

	Source of variation	S.Em±	CD at 5%
	D	0.06	0.18
D- Days	J	0.05	0.14
J- Juice type	T	0.05	0.14
T- Temperature	D×J	0.09	NS
D0 – Day 0	D×T	0.09	0.25
D1 – Day 1	J×T	0.07	NS
D2 – Day 2	D×J×T	0.13	NS

A- Ambient temperature (30±5 ^{0}C)
R- Refrigeration temperature (5±1 ^{0}C)
LK- Lawki-Karela juice
LKA – Lawki-Karela-Aloe vera juice
* Maximum score = 10

Table 4.8 (f) Mean sensory scores of overall acceptability of *Lawki-Karela* (LK) and *Lawki-Karela*-Aloe vera (LKA) juice blends during storage

Juice	Temperature	D0	D1	D2	Mean (JT)	Days	A	R
LK	A	6.20	6.06	0.00	4.08	D0	6.33	6.33
	R	6.20	6.13	6.06	6.13	D1	6.20	6.26
	Mean (DJ))	6.20	6.10	3.03	5.11 Mean(J)	D2	0.00	6.16
LKA	A	6.46	6.33	0.00	4.26	Mean (T)	4.17	6.25
	R	6.46	6.40	6.26	6.37			
	Mean (DJ)	6.46	6.36	3.13	5.32 Mean (J)			
	Mean (D)	6.33	6.23	3.08	-			

	Source of variation	S.Em±	CD at 5%
	D	0.12	0.34
D- Days	J	0.09	NS
J- Juice type	T	0.09	0.27
T- Temperature	D×J	0.17	NS
D0 – Day 0	D×T	0.17	0.48
D1 – Day 1	J×T	0.14	NS
D2 – Day 2	D×J×T	0.24	NS

A- Ambient temperature (30±5 ^{0}C)
R- Refrigeration temperature (5±1 ^{0}C)
LK- Lawki-Karela juice
LKA – Lawki-Karela-Aloe vera juice
* Maximum score = 10

4.7.2 .1.6 Overall acceptability

Data related to the effect of juice blends type, storage temperature and storage days on the consistency of juice blends are depicted in Table 4.8 (f). The result showed that days of storage had significant effect on the overall acceptability of juice blends. The mean score for overall acceptability was observed higher at 0 day (6.33) and lower on 2 days of storage. Storage at ambient temperature and refrigeration temperature also showed significant effect on the overall acceptability of juice blends. Juice blends stored at refrigeration temperature had higher score (6.25) than at ambient temperature (4.17) for overall acceptability. Further significant difference was also observed in the combined effect of storage days and storage temperature for overall acceptability of juice blends. Further no significant difference for overall acceptability of juice blends was found in the combined effect of juice blends type, storage days and storage temperature.

4.7.2.2 Carrot-orange (CO) and carrot orange -aloe vera (COA) juice blends

4.7.2.2.1Color

Data pertaining to the effect of storage days, juice type and storage temperature on the color of juice blends are tabulated in Table 4.9 (a). The result showed that storage period had significant effect on the color of juice blends. The mean sensory score for color was found highest at 0 day (8.23) and lowest on third day (3.41) of storage. Addition of aloe vera juice blends also brought about significant difference in the color of juice blends. The mean score of CO juice blends was observed higher (7.51) than COA (5.75) juice blends. Storage temperature was also found to have profound effect on the color of juice blends.

Table 4.9(a) Mean sensory scores of colour of Carrot-Orange (CO) and Carrot-Orange -Aloe vera (COA) juice blends during storage

Juice	Temperature	D0	D1	D2	D3	Mean (JT)
CO	A	8.26	7.86	6.60	6.43	7.30
	R	8.26	8.06	7.40	7.20	7.73
	Mean (DJ)	8.26	7.96	7.00	6.83	7.51 Mean(J)
COA	A	8.20	7.93	6.20	0.00	5.58
	R	8.20	8.13	7.33	0.00	5.91
	Mean (DJ)	8.20	8.03	6.76	0.00	5.75 Mean(J)
	Mean (D)	8.23	8.08	6.88	3.41	

Days	A	R
D0	8.23	8.23
D1	7.90	8.10
D2	6.40	7.36
D3	3.23	3.60
Mean (T)	6.44	6.82

Source of variation	S.Em±	CD at 5%
D	0.09	0.26
J	0.06	0.18
T	0.06	0.18
D×J	0.13	0.37
D×T	0.13	0.37
J×T	0.09	0.26
D×J×T	0.19	NS

D- Days
J- Juice type
T- Temperature
D0 – Day 0
D1 – Day 1
D2 – Day 2
D3 – Day 3

A- Ambient temperature (20±5 ^{0}C)
R- Refrigeration temperature (5±1 ^{0}C)
CO- Carrot-Orange juice
COA – Carrot-Orange - Aloe vera juice
* Maximum score = 10

Table 4.9 (b) Mean sensory scores of appearance of Carrot-Orange (CO) and Carrot-Orange –Aloe vera (COA) juice blends during storage

Juice	Temperature	D0	D1	D2	D3	Mean (JT)
CO	A	8.20	7.73	6.53	6.33	7.20
	R	8.20	7.93	7.26	7.06	7.61
	Mean (DJ)	8.20	7.83	6.90	7.40	7.40 Mean (J)
COA	A	8.13	7.80	6.26	0.00	5.55
	R	8.13	8.00	7.33	0.00	5.86
	Mean (DJ)	8.13	7.90	6.80	0.00	5.70 Mean (J)
	Mean (D)	8.16	7.86	6.85	3.35	

Days	A	R
D0	8.16	8.16
D1	7.76	7.96
D2	6.40	7.30
D3	3.16	3.53
Mean (T)	6.37	6.74

Source of variation	S.Em±	CD at 5%
D	0.09	0.26
J	0.06	0.18
T	0.06	0.18
D×J	0.13	0.36
D×T	0.13	0.36
J×T	0.09	0.26
D×J×T	NS	NS

D- Days
J- Juice type
T- Temperature
D0 – Day 0
D1 – Day 1
D2 – Day 2
D3 – Day 3

A- Ambient temperature (20±5 ^{0}C)
R- Refrigeration temperature (5±1 ^{0}C)
CO- Carrot-Orange juice
COA – Carrot-Orange - Aloe vera juice
* Maximum score = 10

Juice blends stored at refrigeration temperature scored higher (6.82) than juice blends stored at ambient temperature (6.44). This might be due to degradation of color components of juice blends at ambient temperature. Significant difference in the color of juice blends due to storage days and aloe vera incorporation was also observed. The scores for the color of juice blends kept at refrigeration temperature during three days of storage ranged from 8.23 to 3.60 which were found to be significantly higher than juice blends stored at ambient temperature which scored 8.23 to 3.23 during 3 days of storage. Mean sensory score for color of CO juice blends at ambient temperature (7.30) was found significantly higher than COA juice blends (5.58) stored at same temperature. Similar trend was observed in both Co and COA juice blends stored at refrigeration temperature. However, the combined interaction of storage days, juice blends type and storage temperature was observed non-significant.

4.7.2.2.2 Appearance

Data regarding the effect of interaction of storage days, type of juice blends and storage temperature are depicted in Table 4.9 (b). Mean sensory score for appearance was observed significantly higher (8.16) on 0 day of storage which declined to 3.35 on last day of storage. Aloe vera incorporated juice blends (COA) scored significantly lower (5.70) for appearance than Co juice blends (7.40). Further juice blends stored at refrigeration temperature scored significantly higher (6.74) for appearance than those stored at ambient temperature (6.37). Mean score for appearance of Co juice blends decreased significantly from 8.20 to 7.40 with advancement in storage period. Similar trend was observed in case of COA juice blends.

Mean sensory score for appearance of juice blends at refrigeration

temperature was observed in the range of 8.16 to 6.74 during storage period. The range was found to be significantly higher than those stored at ambient temperature i.e. 8.16 to 3.16 during storage period. Significant difference in the appearance of juice blends due to combined effect of juice type and temperature was also observed. COA juice blends kept at refrigeration temperature scored lower (5.86) than CO juice blends kept at same temperature (7.61). Similar trend was observed in both Co and COA juice blends stored at ambient temperature. However the overall effect of days, juice blends type and storage temperature was found non-significant.

4.7.2.2.3 Flavour

Data related to the effect of storage days, juice blends type and storage temperatures are depicted in Table 4.9 (c). The data revealed that as storage days increased the score for flavour decreased significantly from 7.73 at 0 day to 2.56 at the end of storage period. Juice blends having aloe vera (COA) scored significantly lower (2.56) than without aloe vera juice blends (CO) (5.13). Similarly juice blends kept at refrigeration temperature scored higher (5.45) for flavor than at ambient temperature (4.95). Mean sensory score for flavor of Co juice blends decreased significantly from 7.93 to 5.13 with increment in storage period. Similar trend was observed in COA juice blends. Mean sensory score for flavour of juice blends at ambient temperature was noted in the range of 7.73 to 2.46 during 3 days of storage period. The range was found to be significantly lower than juice blends stored at refrigeration temperature i.e. 7.73 to 2.66. Significant difference in the flavor of juice blends due to combined effect of juice blends type was also observed. Mean sensory score for flavour of CO juice blends

kept at ambient temperature was found to be significantly higher than COA juice blends kept at same temperature. Similar trend was seen in both CO and COA juice blends kept at refrigeration temperature. However, the overall effect of juice blends type, storage period and storage days on flavour was found to be non-significant.

4.7.2.2.4 Taste

Data pertaining to the effect of storage days, storage temperature and juice blends type are shown in Table 4.9 (d). The result showed that with increase in storage days, the mean sensory score for taste of juice blends declined significantly from 7.66 to 2.98. Mean sensory score for taste of juice blends stored at refrigeration temperature was found to be significantly higher (5.50) than those stored at ambient temperature (5.10). The mean score for taste of juice blends having aloe vera juice was observed significantly lower (3.92) than those without aloe vera juice blends incorporation (6.69). Mean score for taste of CO juice blends declined significantly from 7.86 to 5.96 as the storage period progressed from zero day to 3rd day. Similar effect of storage days and juice blends type was observed in COA juice blends but the score was found higher in case of CO than COA juice blends. COA juice blends at ambient temperature was discarded on third day due to its unacceptability. The unacceptability was due to development of bitterness imparted by aloe vera juice and orange juice in blends with storage period. COA juice blends having aloe vera kept at refrigeration temperature scored mean sensory score as 4.00 for taste while CO juice blends scored significantly higher 7.01 kept at same temperature. Similar effect of juice blends type and storage temperature was observed in juice blends kept at ambient temperature.

Table 4.9 (c) Mean sensory scores of flavour of Carrot-Orange (CO) and Carrot-Orange – Aloe vera (COA) juice blends during storage

Juice	Temperature	D0	D1	D2	D3	Mean (JT)
CO	A	7.93	6.20	5.20	4.93	6.06
	R	7.93	7.80	6.13	5.33	6.80
	Mean (DJ)	7.93	7.00	5.66	5.13	6.43 Mean (J)
COA	A	7.53	5.13	2.73	0.00	3.85
	R	7.53	5.53	3.33	0.00	4.10
	Mean (DJ)	7.53	5.33	3.03	0.00	3.97 Mean (J)
	Mean (D)	7.73	6.16	4.35	2.56	

Days	A	R
D0	7.73	7.73
D1	5.66	6.66
D2	3.96	4.73
D3	2.46	2.66
Mean (T)	4.95	5.45

Source of variation	S.Em±	CD at 5%
D	0.12	0.34
J	0.08	0.24
T	0.08	0.24
D×J	0.17	0.48
D×T	0.17	0.48
J×T	0.12	0.34
D×J×T	0.24	NS

D- Days
J- Juice type
T- Temperature
D0 – Day 0
D1 – Day 1
D2 – Day 2
D3 – Day 3

A- Ambient temperature (20±5 ^{0}C)
R- Refrigeration temperature (5±1 ^{0}C)
CO- Carrot-Orange juice
COA – Carrot Orange - Aloe vera juice
* Maximum score = 10

Table 4.9 (d) Mean sensory scores of taste of Carrot-Orange (CO) and Carrot-Orange –Aloe vera (COA) juice blends during storage

Juice	Temperature	D0	D1	D2	D3	Mean (JT)
CO	A	7.86	6.20	5.86	5.58	6.36
	R	7.86	7.06	6.73	6.40	7.01
	Mean (DJ)	7.86	6.63	6.30	5.96	6.69 Mean (J)
COA	A	7.46	4.86	3.06	0.00	3.85
	R	7.46	5.06	3.46	0.00	4.00
	Mean (DJ)	7.46	4.96	3.26	0.00	3.92 Mean (J)
	Mean (D)	7.66	5.80	4.78	2.98	

Days	A	R
D0	7.66	7.66
D1	5.53	6.06
D2	4.46	5.10
D3	2.76	3.20
Mean (T)	5.10	5.50

Source of variation	S.Em±	CD at 5%
D	0.12	0.35
J	0.08	0.24
T	0.08	0.24
D×J	0.17	0.49
D×T	0.17	NS
J×T	0.12	0.35
D×J×T	0.25	NS

D- Days
J- Juice type
T- Temperature
D0 – Day 0
D1 – Day 1
D2 – Day 2
D3 – Day 3

A- Ambient temperature (20±5 ^{0}C)
R- Refrigeration temperature (5±1 ^{0}C)
CO- Carrot-Orange juice
COA – Carrot-Orange - Aloe vera juice
* Maximum score = 10

Whereas no significant effect of storage days juice blends type and storage temperature on taste of juice blends was observed.

4.7.2.2.5 Consistency

Data related to effect of storage days, storage temperature and type of juice blends on consistency of juice blends are given in Table 4.9 (e). Perusal of data showed that mean sensory score for consistency of juice blends declined significantly from 7.60 to 2.80 as the storage days progressed. Consistency of juice blends having aloe vera had lower mean sensory score (4.90) than without aloe vera (6.68). It was further observed that juice blends stored at ambient temperature scored significantly lower (5.66) for consistency than those stored at refrigeration temperature. The combined effect of storage days and juice blends type on consistency revealed that as the storage period progressed the mean score for CO juice blends declined from 7.86 to 0 day to 5.66 at 3rd days of storage.

Similar trend was shown by COA juice blends but the score was significantly lower than CO juice blends. With increment in storage days, the mean score of juice blends at ambient and refrigeration temperature declined significantly from 7.60 to 2.60 and 7.60 to 3.06 respectively but the reduction was more significant in juice blends at ambient temperature this may be due to some preservative action of low temperature on juice blends component. However, no significant difference in the combined effect of juice blends type and temperature on consistency was observed. Similarly the overall effect of storage days, juice blends type and storage temperature on consistency of juice blends was observed.

4.7.2.2.6 Overall acceptability

Data pertaining to the effect of storage days, juice blends type and storage temperature on overall acceptability of juice blends are tabulated in Table 4.9 (f). Data indicated that overall acceptability of juice blends declined significantly from 8.03 to 3.10 during 3 days of storage period. Mean score for overall acceptability of CO juice blends was found significantly higher than (7.25) than COA juice blends (4.64). The effect of temperature on overall acceptability of juice blends showed that juice blends stored at refrigeration temperature scored significantly higher (6.25) than those stored at ambient temperature (5.64). The combined effect of storage days and juice blends type on overall acceptability of juice blends showed that mean score of Co juice blends and COA juice blends declined significantly from 8.13 to 6.20 and 7.93 to 3.00 respectively with increment in storage period. It was further observed that COA juice blends was found acceptable for 2 days only although juice blends were found safer from microbial point of view. So with days the overall acceptability of CO juice blends was found higher than COA juice blends. The effect of both storage days and temperature on overall acceptability of juice blends was found significant. It was observed that overall acceptability of juice blends stored at ambient and refrigeration temperature declined significantly from 8.03 to 2.63 and 8.03 to 3.56 respectively with advancement in storage period. The mean scores were higher in case of juice blends stored at refrigeration temperature. Significant difference was observed in the overall acceptability of juice blends due to combined effect of juice blends type and temperature.

The result exhibited that CO juice blends at ambient temperature scored significantly lower (6.71) than same juice blends at

Table 4.9 (e) Mean sensory scores of consistency of Carrot-Orange (CO) and Carrot-Orange –Aloe vera (COA) juice blends during storage

Juice	Temperature	D0	D1	D2	D3	Mean (JT)	Days	A	R
CO	A	7.86	7.66	5.33	5.20	6.51	D0	7.60	7.60
	R	7.86	7.20	6.20	6.13	6.85	D1	7.36	7.23
	Mean (DJ)	7.86	7.43	5.76	5.66	6.68 Mean(J)	D2	5.10	5.80
COA	A	7.33	7.06	4.86	0.00	4.81	D3	2.60	3.06
	R	7.33	7.26	5.40	0.00	5.00	Mean(T)	5.66	5.92
	Mean (DJ)	7.33	7.16	5.13	0.00	4.90 Mean(J)			
	Mean (D)	7.60	7.30	5.45	2.80				

Source of variation	S.Em±	CD at 5%
D	0.12	0.34
J	0.08	0.24
T	0.08	0.24
D×J	0.17	0.49
D×T	0.17	0.49
J×T	0.12	NS
D×J×T	0.24	NS

D- Days
J- Juice type
T- Temperature
D0 – Day 0
D1 – Day 1
D2 – Day 2
D3 – Day 3

A- Ambient temperature (20±5 ^{0}C)
R- Refrigeration temperature (5±1 ^{0}C)
CO- Carrot-Orange juice
COA – Carrot-Orange - Aloe vera juice
* Maximum score = 10

Table 4.9 (f) Mean sensory scores of overall acceptability of Carrot-Orange (CO) and Carrot-Orange –Aloe vera (COA) juice blends during storage

Juice	Temperature	D0	D1	D2	D3	Mean (JT)	Days	A	R
CO	A	8.13	7.80	5.66	5.26	6.71	D0	8.03	8.03
	R	8.13	8.06	7.80	7.13	7.78	D1	7.66	7.90
	Mean (DJ)	8.13	7.93	6.73	6.20	7.25 Mean (J)	D2	4.23	5.50
COA	A	7.93	7.53	2.80	0.00	4.50	D3	2.63	3.56
	R	7.93	7.73	3.20	0.00	4.71	Mean (T)	5.64	6.25
	Mean (DJ)	7.93	7.63	3.00	0.00	4.64 Mean (J)			
	Mean (D)	8.03	7.78	4.86	3.10				

Source of variation	S.Em±	CD at 5%
D	0.09	0.27
J	0.06	0.19
T	0.06	0.19
D×J	0.13	0.38
D×T	0.13	0.38
J×T	0.09	0.27
D×J×T	0.19	0.54

D- Days
J- Juice type
T- Temperature
D0 – Day 0
D1 – Day 1
D2 – Day 2
D3 – Day 3

A- Ambient temperature (20±5 ^{0}C)
R- Refrigeration temperature (5±1 ^{0}C)
CO- Carrot-Orange juice
COA – Carrot-Orange - Aloe vera juice
* Maximum score = 10

refrigeration temperature (7.78) for overall acceptability. Similar trend was observed in COA juice blends having aloe vera stored at ambient temperature and at refrigeration temperature for overall acceptability. The scores were found higher in Co juice blends for overall acceptability. Significant difference in overall acceptability of juice blends due to interaction of storage days, juice type and storage temperature was observed.

4.7.2.3 *Aonla*-ginger juice (AG) and *aonla* ginger–aloe vera (AGA) juice blend

4.7.2.3.1 Color

Color is the first and foremost criteria which contribute much to the acceptability of the food products. The mean sensory scores for color of AG and aloe vera incorporated AGA juice blends stored at ambient temperature and refrigeration temperature upto 3 days are presented in Table 4.10 (a). The results exhibited that mean sensory score of color was high at the beginning (8.06) but the scores declined significantly with increase in storage time i.e. 3.66 on third day of storage. No significant effect of temperature was observed in color scores in AG and AGA juice blends. The mean sensory score of color for AG and AGA juice blends i.e. 7.65 and 5.88 respectively showed significant difference but the overall effect of storage days, type of juice blends and storage temperature on mean sensory score for colour was non-significant.

4.7.2.3.2 Appearance

The mean sensory scores for appearance of aloe vera incorporated juice blends during storage period are presented in Table 4.10 (b). The mean sensory score of appearance decreased significantly from 7.93 to 3.66 during 3 days storage period. No significant effect of temperature on the appearance of AG and

Table 4.10 (a) Mean sensory scores of color of *Aonla* - Ginger juice (AG) and *Aonla* - Ginger –Aloe vera (AGA) juice blends during storage

Juice	Temperature	D0	D1	D2	D3	Mean (JT)	Days	A	R
AG	A	8.06	7.60	7.40	7.26	7.58	D0	8.06	8.06
	R	8.06	7.80	7.60	7.40	7.71	D1	7.66	7.86
	Mean (DJ)	8.06	7.70	7.50	7.33	7.65 **Mean(J)**	D2	7.46	7.66
AGA	A	8.06	7.73	7.53	0.00	5.83	D3	3.63	3.70
	R	8.06	7.93	7.73	0.00	5.93	**Mean(T)**	6.70	6.82
	Mean (DJ)	8.06	7.83	7.63	0.00	5.88 **Mean (J)**			
	Mean (D)	8.06	7.76	7.56	3.66				

	Source of variation	**S.Em±**	**CD at 5%**
D- Days	D	0.05	0.11
J- Juice type	J	0.04	0.11
T- Temperature	T	0.04	NS
D0 – Day 0	D×J	0.08	0.23
D1 – Day 1	D×T	0.08	NS
D2 – Day 2	J×T	0.05	NS
D3 – Day 3	D×J×T	0.11	NS

A- Ambient temperature (20±5 ^{0}C)
R- Refrigeration temperature (5±1 ^{0}C)
AG- Aonla ginger juice
AGA – Aonla ginger aloe vera juice
* Maximum score = 10

Table 4.10 (b) Mean sensory scores of appearance of *Aonla* - Ginger juice (AG) and *Aonla*-Ginger–Aloe vera (AGA) juice blends during storage

Juice	Temperature	D0	D1	D2	D3	Mean (JT)	Days	A	R
AG	A	7.93	7.60	7.40	7.26	7.55	**D0**	7.93	7.93
	R	7.93	7.80	7.60	7.40	7.68	**D1**	7.66	7.86
	Mean (DJ)	7.93	7.70	7.50	7.33	7.61**Mean (J)**	**D2**	7.46	7.66
AGA	A	7.93	7.73	7.53	0.00	5.80	**D3**	3.63	3.70
	R	7.93	7.93	7.73	0.00	5.90	**Mean(T)**	6.75	6.79
	Mean (DJ)	7.93	7.83	7.63	0.00	5.85**Mean (J)**			
	Mean (D)	7.93	7.76	7.56	3.66				

D- Days	**Source of variation**	**S.Em±**	**CD at 5%**
J- Juice type	D	0.06	0.17
T- Temperature	J	0.04	0.12
D0 – Day 0	T	0.04	NS
D1 – Day 1	D×J	0.09	0.25
D2 – Day 2	D×T	0.09	NS
D3 – Day 3	J×T	0.06	NS
	D×J×T	0.12	NS

A- Ambient temperature (20±5 ^{0}C)
R- Refrigeration temperature (5±1 ^{0}C)
AG- Aonla ginger juice
AGA – Aonla ginger aloe vera juice
* Maximum score = 10

AGA juice blends was observed. The mean score for appearance of AG and AGA juice blends declined significantly with increase in storage time. Addition of aloe vera juice blends showed significant difference in appearance of juice blends. The mean score for appearance of AG juice blends (7.61) was found to be significantly higher than aloe vera incorporated AGA juice blends (5.85). The overall effect of storage period, juice blends type and temperature was observed non-significant.

4.7.2.3.3 Flavor

The mean sensory scores of flavor of AG and AGA juice blends stored at ambient and refrigeration temperature upto 3 days are presented in Table 4.10 (c). The mean sensory score for flavor of both AG and AGA juice blends was recorded as 7.70 at 0 day which declined significantly as storage period proceeded. Significant difference was also found in flavor of AG and aloe vera incorporated AGA juice blends i.e. 6.50 and 3.70 respectively.

The mean sensory score for flavour of AG and AGA juice blends kept at ambient temperature (4.93) was found to be significantly lower than AG and AGA juice blends kept at refrigeration temperature (5.27). The mean sensory score of flavour were recorded as 7.80 (AG) and 7.80 (AGA) at 0 day which was found to decrease significantly 5.53 (AG) and 0.00 (AGA) respectively on last day of storage period. The scores for flavour of AG and AGA juice blends kept at ambient and refrigeration temperature for 3 days storage period showed significant decrement with subsequent increment in storage period. However the overall effect of storage period and temperature on two types of juice AG and AGA blends was observed as non-significant.

Table 4.10 (c) Mean sensory scores of flavour of *Aonla* - Ginger juice (AG) and *Aonla* - Ginger –Aloe vera (AGA) juice blends during storage

Juice	Temperature	D0	D1	D2	D3	Mean (JT)
AG	A	7.80	6.20	6.00	5.33	6.33
	R	7.80	6.80	6.40	5.73	6.68
	Mean (DJ)	7.80	6.50	6.20	5.53	6.50 Mean(J)
AGA	A	7.80	4.20	2.33	0.00	3.53
	R	7.80	4.73	3.13	0.00	3.86
	Mean (DJ)	7.80	4.46	2.73	0.00	3.70 Mean (J)
	Mean (D)	7.80	5.48	2.76	3.66	

Days	A	R
D0	7.70	7.70
D1	5.20	5.76
D2	4.16	4.76
D3	2.66	2.86
Mean (T)	4.93	5.27

A- Ambient temperature (20±5 ^{0}C)
R- Refrigeration temperature (5±1 ^{0}C)
AG- Aonla ginger juice
AGA – Aonla ginger aloe vera juice
* Maximum score = 10

D- Days
J- Juice type
T- Temperature
D0 – Day 0
D1 – Day 1
D2 – Day 2
D3 – Day 3

Source of variation	S.Em±	CD at 5%
D	0.14	0.39
J	0.10	0.27
T	0.10	0.27
D×J	0.20	0.55
D×T	0.20	NS
J×T	0.14	NS
D×J×T	0.28	NS

Table 4.10 (d) Mean sensory scores of taste of *Aonla* - Ginger juice (AG) and *Aonla* - Ginger –Aloe vera (AGA) juice blends during storage

Juice	Temperature	D0	D1	D2	D3	Mean (JT)
AG	A	7.80	6.13	5.93	5.60	6.36
	R	7.80	6.86	6.46	6.26	6.85
	Mean (DJ)	7.80	6.50	6.20	5.93	6.60 Mean(J)
AGA	A	7.60	4.06	2.40	0.00	3.51
	R	7.60	4.66	3.20	0.00	3.86
	Mean (DJ)	7.60	4.36	2.80	0.00	3.69 Mean(J)
	Mean (D)	7.70	5.43	4.50	2.96	

Days	A	R
D0	7.70	7.70
D1	5.10	5.76
D2	4.16	4.83
D3	2.80	3.13
Mean(T)	4.94	5.35

A- Ambient temperature (20±5 ^{0}C)
R- Refrigeration temperature (5±1 ^{0}C)
AG- Aonla ginger juice
AGA – Aonla ginger aloe vera juice
* Maximum score = 10

D- Days
J- Juice type
T- Temperature
D0 – Day 0
D1 – Day 1
D2 – Day 2
D3 – Day 3

Source of variation	S.Em±	CD at 5%
D	0.13	0.38
J	0.09	0.27
T	0.09	0.27
D×J	0.19	0.54
D×T	0.19	0.54
J×T	0.13	NS
D×J×T	0.27	NS

4.7.2.3.4 Taste

The data on effect of interaction of AG and AGA juice blends, kept at ambient and refrigeration temperature for 3 days storage period on taste is presented in Table 4.10 (d). The results indicated that mean score for taste was high (7.70) at 0 day which declined significantly with subsequent storage period. Significant difference was observed in the taste of two types of juice blends i.e. AG (6.60) and AGA (3.69). Juice blends kept at ambient temperature (4.94) scored less for taste than juice blends kept at refrigeration temperature (5.35) for 3 days storage period. The mean score of AG and AGA juice blends for taste showed significant decline with increase in storage days, the scores of AG juice blend was found higher than AGA juice blend during three days of storage period. This might be due to slight bitterness that developed by the addition of aloe vera juice blends. The overall effect of juice blends type, storage days and temperature on taste of two juice blends was non-significant.

4.7.2.3.5 Consistency

The mean sensory scores of AG and AGA juice blends for consistency during storage are tabulated in Table 4.10 (e). The mean sensory scores for AG and AGA juice blend were obtained as 7.66 and 7.33 respectively at 0 days of storage. The scores declined significantly to 5.90 (AG) and 0.00 (AGA) at the end of storage period. Significant difference was observed in consistency of juice blends stored at different temperatures. Juice blends stored at refrigeration temperature scored higher for consistency that juice blends at ambient temperature. Mean sensory score for consistency of AG and AGA juice blends was observed as 7.66 and 7.33 respectively at 0 days of storage which

Table 4.10 (e) Mean sensory scores of consistency of *Aonla* - Ginger juice (AG) and *Aonla* - Ginger –Aloe vera (AGA) juice blends during storage

Juice	Temperature	D0	D1	D2	D3	Mean (JT)
AG	A	7.66	6.06	5.93	5.73	6.35
	R	7.66	6.53	6.20	6.06	6.61
	Mean (DJ)	7.66	6.30	6.06	5.90	6.48 Mean (J)
AGA	A	7.33	5.26	4.93	0.00	4.38
	R	7.33	5.93	5.40	0.00	4.60
	Mean (DJ)	7.33	5.60	5.16	0.00	4.52 Mean (J)
	Mean (D)	7.50	5.95	5.61	2.95	-

Days	A	R
D0	7.50	7.50
D1	5.66	6.23
D2	5.43	5.80
D3	2.86	3.03
Mean (T)	5.36	5.64

Source of variation	S.Em±	CD at 5%
D	0.14	0.40
J	0.10	0.28
T	0.10	0.28
D×J	0.20	0.57
D×T	0.20	NS
J×T	0.14	NS
D×J×T	0.29	NS

D- Days
J- Juice type
T- Temperature
D0 – Day 0
D1 – Day 1
D2 – Day 2
D3 – Day 3

A- Ambient temperature (20±5 ^{0}C)
R- Room temperature
AG- Aonla ginger juice
AGA – Aonla ginger aloe vera juice
* Maximum score = 10

Table 4.10 (f) Mean sensory scores of overall acceptability of *Aonla* - Ginger juice (AG) and *Aonla* - Ginger –Aloe vera (AGA) juice blends during storage

Juice	Temperature	D0	D1	D2	D3	Mean (JT)
AG	A	7.86	6.06	5.93	5.73	6.40
	R	7.86	6.86	6.40	6.26	6.85
	Mean (DJ)	7.86	6.46	6.16	6.00	6.62 Mean (J)
AGA	A	7.60	4.13	2.26	0.00	3.50
	R	7.60	4.73	3.13	0.00	3.86
	Mean (DJ)	7.60	4.43	2.70	0.00	3.68 Mean (J)
	Mean (D)	7.73	5.45	4.43	3.00	

Days	A	R
D0	7.73	7.73
D1	5.10	5.80
D2	4.10	4.76
D3	2.86	3.13
Mean (T)	4.95	5.35

Source of variation	S.Em±	CD at 5%
D	0.13	0.37
J	0.09	0.26
T	0.09	0.26
D×J	0.19	0.53
D×T	0.19	0.53
J×T	0.13	NS
D×J×T	0.27	NS

D- Days
J- Juice type
T- Temperature
D0 – Day 0
D1 – Day 1
D2 – Day 2
D3 – Day 3

A- Ambient temperature (20±5 ^{0}C)
R- Room temperature
AG- Aonla ginger juice
AGA – Aonla ginger aloe vera juice
* Maximum score = 10

significantly decreased to 5.90 and 0.00 respectively at the end of storage period. It was further observed that scores of AG juice blends was significantly higher than AGA juice blends during storage period.

4.7.2.3.6 Overall acceptability

Data pertaining to the effect of interaction of storage days, juice blends type and temperature on the overall acceptability of juice blends are presented in Table 4.10 (f). It revealed significant difference in the overall acceptability of juice blends i.e. highest at 0 day (7.73) and lowest at third day (3.00) of storage. Further both juice blends showed significant difference in overall acceptability. AG juice blend scored 6.62 while AGA scored 3.68 mean sensory scores for overall acceptability. It was also found that temperature also brought about significant difference in the overall acceptability of juice blends. The score was observed higher (5.35) for juice blends at refrigeration temperature than at ambient temperature (4.95). The mean sensory score for overall acceptability decreased significantly as the storage period progressed from 0 day to 3 days. It decreased in the range of 7.86 to 6.62 for AG juice blends and 7.60 to 2.70 for AGA juice blends. Whereas the score for overall acceptability declined significantly with increase in storage time. The overall effect of storage period, type of juice blends and storage temperature was observed non-significant.

4.7.3 Effect of storage days, juice type and storage temperature on physico-chemical composition of juice blends during storage

4.7.3.1 *Lawki-karela* (LK) juice and *Lawki karela*-aloe vera (LKA) juice blends

4.7.3.1.1 Total sugar content

Perusal of data in Table 4.11(a) regarding total sugar content of LK and LKA juice blends yielded significant result during storage period of three days. The total

Table 4.11 (a) Effect of storage days, juice type and storage temperature on total sugar Content of LK and LKA juice blend

Storage Days (D)	**Total Sugar (per cent)**
Day 0	2.495
Day 1	2.197
Day 2	1.766
S. Em	0.003
CD at 5 %	0.011
Types of juice (J)	**Total Sugar (per cent)**
LK juice	2.329
LKA juice	1.976
S. Em	0.003
CD at 5 %	0.009
Storage temperature (T)	**Total Sugar (per cent)**
Ambient temperature (30±5 ^{0}C)	2.023
Refrigeration temperature (5±1 ^{0}C)	2.282
S. Em	0.003
CD at 5 %	0.009

Table 4.11 (b) Effect of storage days and juice type on total sugar content of LK and LKA juice blend

Types of juice (J)	**Storage days (D)**			**Mean (J)**
	D0	**D1**	**D2**	
LK juice	2.650	2.40	2.098	2.329
LKA juice	2.340	2.155	1.435	1.976
Mean (D)	2.495	2.197	1.766*	-
Source of variation		**S. Em**		**CD at 5 %**
D (Days)		0.003		0.011
J (Juice)		0.003		0.009
D*J		0.005		0.016

Table 4.11 (c) Effect of juice type and storage temperature on total sugar Content of LK and LKA juice blend

Type of Juice (J)	**Storage temperature (T)**		**Mean (J)**
	Ambient temperature (30±5 ^{0}C)	**Refrigeration temperature (5±1 ^{0}C)**	
LK juice	2.151	2.507	2.329
LKA juice	1.896	2.056	1.976
Mean (T)	2.023	2.282	

Source of variation	**S. Em**	**CD at 5 %**
J (Juice)	0.003	0.009
T (Temperature)	0.003	0.009
D*J	0.004	0.013

sugar content of juice was found to decrease from 2.495 to 1.766 per cent as the storage period progressed from 0 to 3rd day. The result of present study is in complete agreement with studies of earlier responses. Barwal *et al.* (2006) reported decrease in total sugar content of bitter gourd RTS during storage. Deore *et al.* (2008) reported similar trend in bottle gourd juice. The loss of total sugar during storage may be attributed to maillard reaction, other chemical reaction of sugars in presence of acids and co-polymerization of sugar with organic acid particularly at high temperature (Saini and Grewal, 1995 and Thakur and Barwal, 1998).

The Table also showed significantly lower total sugar in LKA juice than LK juice blends. This may be due to lower content of total sugar in aloe vera which was incorporated into juice.

Data presented in Table 4.11(a) also depicts significant effect of temperature on total sugar content of juice blends. Juice blends stored at refrigeration temperature had significantly higher total sugar content (2.282 per cent) than juice blends stored at ambient temperature (2.023 per cent).

Data depicted in Table 4.11(b) showed that as the storage days progressed from 0 to 3rd day, the total sugar content of LK and LKA juice blends decreased significantly from 2.650 to 2.098 and from 2.340 to 1.435 per cent respectively but the rate of reduction was found to be less in LKA juice blends. This may be due to aloe vera incorporation that resulted in increased stability of biochemical parameters (Thorat *et al.,* 2007).

Data presented in Table 4.11(c) revealed that total sugar content of LK juice at ambient temperature (2.151 per cent) is higher than LKA juice (1.896 per cent) at same temperature. Similar trend was found in case of LK and LKA juice blends stored at refrigeration temperature.

Table 4.11 (d) Effect of storage days and Storage temperatures on total sugar Content of LK and LKA juice blend

Storage temperature (T)	Storage days (D)			Mean (T)
	D0	D1	D2	
Ambient temperature (30±5 ^{0} C)	2.495	2.150	1.426	2.023
Refrigeration temperature (5±1 ^{0} C)	2.495	2.245	2.106	2.282
Mean (D)	2.495	2.197	1.766	

Source of variation	S. Em	CD at 5 %
D (Days)	0.003	0.011
T (Temperature)	0.003	0.009
D*T	0.005	0.016

Table 4.11 (e) Effect of interaction between storage days, type of juice and storage temperature on total sugar Content of LK and LKA juice blend

Storage days (D)	LK juice		LKA juice		Mean (D)
	Ambient temperature (30±5 ^{0} C)	Refrigeration temperature (5±1 ^{0} C)	Ambient temperature (30±5 ^{0} C)	Refrigeration temperature (5±1 ^{0} C)	
D 0	2.650	2.650	2.340	2.340	2.495
D 1	2.220	2.260	2.080	2.230	2.197
D 2	1.583	2.613	1.270	1.600	1.766
Mean (T)	2.150	2.507	2.30	2.056	

Source of variation	S. Em	CD at 5 %
D (Days)	0.003	0.011
J (Juice)	0.003	0.009
T (Temperature)	0.003	0.009
D*J*T	0.007	0.022

There was a significant effect of storage days and storage temperature on the total sugar content of juice blends as shown in Table 4.11(d). Data revealed that with increase in storage days, total sugar content of juice blends at ambient and refrigeration temperature decreased significantly from 2.495 to 1.426 and 2.495 to 2.106 on 3rd day of storage. However, the rate of degradation of total sugar during storage was found more in juice blends stored at ambient temperature than at refrigeration temperature.

Data presented in Table 4.11(e) revealed significant variation in the overall effect of interaction between storage days, juice type and storage temperature on total sugar content of juice blends.

4.7.3.1.2 Ascorbic acid

Data presented in Table 4.12 (a) regarding ascorbic acid content of juice blends yielded significant result during storage period of three days. The ascorbic acid (mg/100g) content of juice blends was found to decrease significantly as the storage days progressed. These results were found in complete agreement with results of Dhaliwal and Hira (2004), Majumdar *et al.* (2009) and Krishaveni *et al.* (2001) who reported significant loss of ascorbic acid during storage in carrot-spinach and carrot-pine apple blended juice, cucumber-litchi-lemon juice blend and jack fruit beverage respectively.

Barwal *et al.* (2006) reported similar trend of ascorbic acid loss during storage in bitter gourd RTS drink. Majumdar *et al.* (2010) reported loss of ascorbic acid during storage in bottle gourd-basil leaves juice. The decrease in ascorbic acid during storage may be attributed to its degradation into dehydro ascorbic acid or furfural or hydroxy methyl furfural during storage (Pandey *et al.* 1995).

Table 4.12 (a) Effect of storage days, juice type and storage temperature on ascorbic acid Content of LK and LKA juice blend

Storage Days (D)	**Ascorbic acid (mg/100ml)**
D 0	23.571
D 1	18.453
D 2	14.008
S. Em	0.252
CD at 5 %	0.736
Type of juice (J)	**Ascorbic acid (mg/100ml)**
LK	21.467
LKA	15.887
S. Em	0.205
CD at 5 %	0.601
Storage temperature (T)	**Ascorbic acid (mg/100ml)**
Ambient temperature (30±5 ^{0}C)	17.630
Refrigeration temperature (5±1 ^{0}C)	19.725
S. Em	0.205
CD at 5 %	0.601

Table 4.12 (b) Effect of storage days and juice type on ascorbic acid Content of LK and LKA juice blend

Type of juice (J)	**Storage days (D)**			**Mean (J)**
	D0	**D1**	**D2**	
LK juice	26.986	21.176	16.240	21.46
LKA juice	20.15 6	15.730	11.776	15.887
Mean (D)	23.571	18.453	14.008	
Source of variation		**S. Em**		**CD at 5 %**
D		0.252		0.737
J		0.205		0.601
D*J		0.356		1.041

Table 4.12 (c) Effect of juice type and storage temperature on ascorbic acid Content of LK and LKA juice blend

Type of juice (J)	**Storage temperature (T)**		**Mean (J)**
	Ambient temperature (30±5 ^{0}C)	**Refrigeration temperature (5±1 ^{0}C)**	
LK juice	20.215	22.720	21.467
LKA juice	15.045	16.730	15.887
Mean (T)	17.63	19.725	
Source of variation	**S. Em**	**CD at 5 %**	
D	0.205	0.601	
T	0.205	0.601	
D*T	0.291	0.850	

The Table 4.12 (a) also reveled that ascorbic acid content of LK juice (21.467 mg/100ml) is greater than LKA juice (15.887 mg/100ml) which may be due to low ascorbic acid content of aloe vera juice than *Karela* and *Lawki* juice.

Data also showed significant variation on the ascorbic acid content of juice blends stored at ambient and refrigeration temperature. The juice blends stored at ambient temperature had significantly lower ascorbic acid (17.630 mg/100ml) than juice blends stored at refrigeration temperature (19.725 mg/100ml). Effect of temperature on ascorbic acid content of juice blends was also reported Tiwari *et al.* (2000) and Ewaidah (1992) reported higher loss of ascorbic acid during 6 months storage of guava and papaya beverage and 12 months storage of apple juice and pineapple juice respectively. However Cortes *et al.* (2005) reported lower loss of ascorbic acid in orange carrot juice stored at -40^{0}C for 132 days.

Data in Table 4.12 (b) revealed significant effect of storage days and juice type (LK and LKA) on ascorbic acid content of juice blends. With advancement in storage days, the ascorbic acid content of LK and LKA juice blends decreased significantly from 26.986 to 16.240 and 20.156 to 11.776 mg/100ml on 3rd day of storage. It was also noted that although LKA juice blend contained less ascorbic acid than LK juice, the rate of degradation of ascorbic acid was more in LK juice blend. This may be attributed to aloe vera juice incorporation which brought about stability of biochemical parameters during storage.

Data depicted in Table 4.12 (c) showed significant effect of juice type and storage temperature on the ascorbic acid content of juice blends. LK juice stored at refrigeration temperature had significantly higher ascorbic acid (22.720 mg/100ml) than at ambient temperature (20.215 mg/100ml). Similar trend was

Table 4.12 (d) Effect of storage days and Storage temperature on ascorbic acid Content of LK and LKA juice blend

Storage temperature (T)	Storage days (D)			Mean (T)
	D0	D1	D2	
Ambient temperature (30±5 ^{0}C)	23.571	17.241	12.078	17.630
Refrigeration temperature (5±1 ^{0}C)	23.571	19.665	15.938	19.725
Mean (D)	23.571	18.453	14.008	

Source of variation	S. Em	CD at 5 %
D	0.252	0.736
T	0.205	0.601
D*T	0.356	1.041

Table 4.12 (e) Effect of interaction between storage days, type of juice and storage temperature on ascorbic acid (mg/100g) Content of LK and LKA juice blend

Storage days (D)	LK juice		LKA juice		Mean (D)
	Ambient temperature (30±5 ^{0}C)	Refrigeration temperature (5±1 ^{0}C)	Ambient temperature (30±5 ^{0}C)	Refrigeration temperature (5±1 ^{0}C)	
D 0	26.986	26.986	20.156	20.156	23.571
D 1	19.696	22.656	14.786	16.673	18.453
D 2	13.963	18.516	10.913	13.360	14.008
Mean (T)	20.215	22.720	15.045	16.730	

Source of variation	S. Em	CD at 5 %
D	0.252	0.736
J	0.205	0.601
T	0.205	0.601
D*J*T	0.504	1.472

observed in case of LKA juice blend stored at ambient and refrigeration temperature.

Data in Table 4.12 (d) showed significant effect of storage days and storage temperature on ascorbic acid content of LK and LKA juice blend. It was found that with increase in storage days, the ascorbic acid content of LK and LKA juice blends stored at ambient and refrigeration temperature decreased significantly from 23.571 to 12.078 mg/100ml and from 23.571 to 15.938 mg/100ml. The rate of ascorbic acid decrement was found high in juice blends stored at ambient temperature. This may be due to sensitivity of ascorbic acid to high temperature.

Data presented in Table 4.12 (e) showed significant variation in effect of interaction between storage days, juice type and storage temperature on ascorbic acid content of juice blends (LK and LKA).

4.7.3.1.3 Total chlorophyll

Data presented in Table 4.13 (a) pertaining to total chlorophyll content of juice blends showed significant loss of total chlorophyll with increment of storage days. The chlorophyll content of juice blends was found to be 67.701 mg/100ml at the 0 day which deceased to 55.547 mg/100ml at the 3rd day of storage period. Deore *et al.* (2008) reported similar trend of chlorophyll loss during storage of bottle gourd juice.

The data also revealed significant variation in the chlorophyll content of LK and LKA juice blend. The total chlorophyll content of LK juice (74.410 mg/100ml) was found to be higher than LKA juice (51.295 mg/100ml). This may be attributed to less chlorophyll content in aloe vera juice that was incorporated into juice blend.

Table 4.13 (a) Effect of storage days, juice type and storage temperature on total chlorophyll Content of LK and LKA juice blend

Storage Days (D)	**Total chlorophyll (mg/100ml)**
D 0	67.701
D 1	63.310
D 2	57.547
S. Em	0.251
CD at 5 %	0.734
Type of juice (J)	**Total chlorophyll (mg/100ml)**
LK juice	74.410
LKA juice	51.295
S. Em	0.205
CD at 5 %	0.599
Storage temperature (T)	**Total chlorophyll (mg/100ml)**
Ambient temperature (30±5 ^{0}C)	61.150
Refrigeration temperature (5±1 ^{0}C)	64.555
S. Em	0.205
CD at 5 %	0.599

Table 4.13 (b) Effect of storage days and juice type on total chlorophyll Content of LK and LKA juice blend

Type of juice (J)	**Storage days (D)**			**Mean (J)**
	D0	**D1**	**D2**	
LK juice	79.186	74.903	69.141	74.410
LKA juice	56.216	51.716	45.953	51.295
Mean (D)	67.701	63.310	57.547	

Source of variation	**S. Em**	**CD at 5 %**
D	0.251	0.734
J	0.205	0.599
D*J	0.355	1.038

Table 4.13 (c) Effect of juice type and storage temperature on total chlorophyll Content of LK and LKA juice blend

Type of juice (J)	**Storage temperature (T)**		**Mean (J)**
	Ambient temperature (30±5 ^{0}C)	**Refrigeration temperature (5±1 ^{0}C)**	
LK juice	72.874	75.946	74.410
LKA juice	49.426	53.164	51.295
Mean (T)	61.150	64.555	

Source of variation	**S. Em**	**CD at 5 %**
J	0.205	0.601
T	0.205	0.601
J*T	0.290	0.847

There was significant difference in the chlorophyll content of juice blends stored at ambient (61.150 mg/100ml) temperature and refrigeration temperature (64.555 mg/100ml). The difference may be attributed to low temperature that prevented degradation of chlorophyll at refrigeration temperature. Moura *et al.* (1996) reported that low temperature storage contribute to a delay in chlorophyll breakdown. Albanese *et al.* (2007) observed significant loss of chlorophyll content during storage period in all asparagus samples.

Data presented in Table 4.13 (b) showed significant variation in the effect of storage days and juice type on total chlorophyll content of juice blends. With increase in storage days, the total chlorophyll content of LK and LKA juice decreased significantly with increment in storage days from 79.186 to 69.141 mg/100ml and 56.216 to 45.953 mg/100ml respectively. The rate of chlorophyll degradation was found to be more in LK juice than LKA juice blend. This may be attributed to aloe vera juice that stabilized biochemical parameters during storage.

Data depicted in Table 4.13 (c) showed significant variation in the effect of juice type and storage temperature on total chlorophyll content during storage. It was observed that LK and LKA juice blends stored at ambient temperature had significantly lower chlorophyll content (72.874 and 49.426 mg/100ml) respectively than LK and LKA juice blends stored at refrigeration temperature i.e. 75.946 and 53.164 mg/100ml respectively.

Data presented in Table 4.13 (d) showed significant variation in the effect of storage days and storage temperature on total chlorophyll content of juice blends. With increase in storage days, in juice blends stored at ambient and refrigeration temperature total chlorophyll decreased significantly from 67.701 to

Table 4.13 (d) Effect of storage days and Storage temperatures on total chlorophyll Content of LK and LKA juice blend

Storage temperature (T)	Storage days (D)			Mean (T)
	D0	D1	D2	
Ambient temperature (30±5 ^{0}C)	67.701	61.416	54.333	61.150
Refrigeration temperature (5±1 ^{0} C)	67.701	65.203	60.761	64.555
Mean (D)	67.701	63.310	57.547	-

Source of variation	S. Em	CD at 5 %
D	0.251	0.734
T	0.205	0.599
D*T	0.355	1.038

Table 4.13 (e) Effect of interaction between storage days, type of juice and storage temperature on total chlorophyll Content of LK and LKA juice blend

Storage days (D)	LK juice		LKA juice		Mean (D)
	Ambient temperature (30±5 ^{0}C)	Refrigeration temperature (5±1 ^{0} C)	Ambient temperature (30±5 ^{0}C)	Refrigeration temperature (5±1 ^{0} C)	
D 0	79.186	79.186	56.216	56.216	67.701
D 1	73.143	76.663	49.690	53.743	63.310
D 2	66.293	71.990	42.373	49.533	57.547
Mean(T)	72.874	75.946	49.426	53.164	

Source of variation	S. Em	CD at 5 %
D	0.251	0.734
J	0.205	0.601
T	0.205	0.601
D*J*T	0.503	1.468

54.333 mg/100ml and 67.701 to 60.761 mg/100ml respectively. However, the rate of chlorophyll loss was found to be more in juice blends stored at ambient temperature.

Data tabulated in Table 4.13 (e) showed significant variation in the overall effect of interaction between storage days, juice type and storage temperature on the total chlorophyll content of juice blends.

4.7.3.2 Carrot-orange (CO) and carrot-orange-aloe vera (COA) juice blend

4.7.3.2.1 Total sugar

Data presented in Table 4.14 (a) showed significant variation during storage period of three days. The total sugar content of juice blends was found to be 6.133 per cent on 0 day of storage which increased to 6.281 per cent on third day of storage. Similar findings were observed in enzyme liquefied carrot juice (Pandey *et al.,* 2003), apple blends (Shrestha and Bhatia 1982), pear juice blends (Attri *et al.,* 1998). The increase in total sugar during storage may be attributed to hydrolysis of starch into sugar or conversion of non reducing sugar to reducing sugar during storage (Barwal and Shere, 2008). The data also revealed that there is significant variation in the total sugar content of CO (6.838 per cent) and COA (5.568 per cent) juice. This may be due to lower sugar content of aloe vera which was incorporated into COA juice blend.

It was further noted that there is significant variation in the total sugar content of juice blends stored at ambient and refrigeration temperature. Juice blends stored at refrigeration temperature was found to have significantly lower total sugar content (6.189 per cent) than juice blends stored at ambient temperature (6.217 per cent).(Table CO-1a) This may be attributed to preservative action of

Table 4.14 (a) Effect of storage days, juice type and storage temperature on total sugar content of CO and COA juice blends

Storage Days (D)	**Total Sugar (per cent)**
D 0	6.133
D 1	6.177
D 2	6.221
D 3	6.281
S. Em	0.006
CD at 5 %	0.018
Type of juice (J)	**Total Sugar (per cent)**
CO juice	6.838
COA juice	5.568
S. Em	0.004
CD at 5 %	0.012
Storage temperature (T)	**Total Sugar (per cent)**
Ambient temperature (20±5 ^{0}C)	6.217
Refrigeration temperature (5±1 ^{0}C)	6.189
S. Em	0.004
CD at 5 %	0.012

Table 4.14 (b) Effect of storage days and juice type on total sugar content of CO and COA juice blends

Type of juice (J)	**Storage days (D)**				**Mean (J)**
	D0	**D1**	**D2**	**D3**	
CO juice	6.763	6.810	6.856	6.923	6.838
COA juice	5.503	5.545	5.586	5.640	5.568
Mean (D)	6.133	6.177	6.221	6.281	-

Source of variation	**S. Em**	**CD at 5 %**
D	0.006	0.018
J	0.004	0.012
D*J	0.008	0.250

Table 4.14 (c) Effect of juice type and storage temperature on total sugar content of CO and COA juice

Type of juice (J)	**Storage temperature (T)**		**Mean (J)**
	Ambient temperature (20±5 ^{0}C)	**Refrigeration temperature (5±1 ^{0}C)**	
CO juice	6.862	6.814	6.838
COA juice	5.571	5.565	5.568
Mean (T)	6.217	6.189	-

Source of variation	**S. Em**	**CD at 5 %**
D	0.004	0.012
J	0.004	0.012
D*J	0.006	0.018

low temperature that prevent conversion of non- reducing sugar to reducing sugar during storage. Similar results on effect of temperature on total sugar of juice blends was reported by Ghosh *et al.* (1981) in fruit juice blends and pulp, Saini and Grewal (1995) in sand pear juice and Sirohi (1998) in Sapota, amla and kinnow RTS.

Data presented in Table 4.14 (b) revealed that there was a significant effect of storage days and juice type on total sugar content. With increase in storage period, total sugar content of CO and COA juice increased significantly from 6.763 to 6.923 per cent and 5.503 to 5.640 per cent respectively but CO juice blends had higher total sugar than COA juice blend. The rate of increment in total sugar content was found higher in CO than COA juice blend. This may be due to addition of aloe vera juice that resulted in increased stability of biochemical parameter (Thorat *et al.,* 2007).

There was significant effect of juice type and storage temperature on the total sugar content of juice blends. It was found that total sugar content of CO juice blend stored at ambient temperature had significantly higher total sugar (6.862 per cent) than COA juice blend (6.814 per cent) stored at ambient temperature. Similar trend was observed in juice blends kept at refrigeration temperature. This may be due to aloe vera that kept the biochemical parameter stable during storage (Table 4.14c).

Data pertaining to the effect of storage days and storage temperature on the total sugar content of juice blends are depicted in Table 4.14 (d). The data revealed that with increase in storage days, the total sugar content of juice blends kept at ambient and refrigeration temperature increased significantly (6.133 to 6.281 per

Table 4.14 (d) Effect of storage days and Storage temperature on total sugar content of CO and COA juice blend

Storage temperature (T)	Storage days (D)				Mean (T)
	D0	D1	D2	D3	
Ambient temperature (20±5 ^{0}C)	6.133	6.190	6.243	6.301	6.217
Refrigeration temperature (5±1 ^{0}C)	6.133	6.165	6.199	6.261	6.189
Mean (D)	6.133	6.177	6.221	6.281	

Source of variation	S. Em	CD at 5 %
D	0.006	0.018
T	0.004	0.012
D*T	0.008	0.025

Table 4.14 (e) Effect of interaction between storage days, type of juice and storage temperature on total sugar content of CO and COA juice blends

Storage days (D)	CO juice		COA juice		Mean (D)
	Ambient temperature (20±5 ^{0} C)	Refrigeration temperature (5±1 ^{0} C)	Ambient temperature (20±5 ^{0} C)	Refrigeration temperature (5±1 ^{0} C)	
D 0	6.763	6.763	5.503	5.503	6.133
D 1	6.823	6.796	5.556	5.533	6.177
D 2	6.890	6.823	5.596	5.576	6.221
D 3	6.973	6.873	5.630	5.670	6.281
Mean (T)	6.862	6.814	5.571	5.565	-

Source of variation	S. Em	CD at 5 %
D	0.006	0.018
J	0.004	0.012
T	0.004	0.012
D*J*T	0.012	0.036

cent), higher at ambient temperature (6.217 per cent) than at refrigeration temperature (6.189 per cent).

Data tabulated in Table 4.14 (e) showed that there is significant variation in the overall effect of interaction between storage days, juice type (CO and COA) and storage temperature on the total sugar content of juice blends.

4.7.3.2.2 Ascorbic acid

Ascorbic acid degradation reactions are often responsible for important quality changes that occur during the storage of foods, limiting shelf life (Rojas and Gerschenson, 1997), with formation of unstable intermediate compounds such as furfural (Robertson and Saminego-Esguerra, 1986).

There was significant variation in ascorbic acid (mg/100ml) content of CO and COA juice blends during storage period of three days (Table 4.15a). Ascorbic acid content of juice blends (CO and COA) decreased steadily and significantly from initial value of 9.700 to 5.592 mg/100ml throughout three days of storage period. Similar results were observed by Pandey *et al.* (2003) in carrot juice, Dhaliwal and Hira (2001) in carrot-beetroot and carrot-black carrot juice blends, Dhaliwal and Hira (2004) in carrot-spinach and carrot-pineapple juice. The decrease may be due to conversion of ascorbic acid to dehydro ascorbic acid and could be attributed to oxidation, light and storage temperature. Data also revealed significant variation in ascorbic acid content of two juice blends CO and COA. The ascorbic acid content of COA juice was found higher (7.747 per cent) than CO juice (7.370 per cent). However, the data on the effect of storage temperature on ascorbic acid content of juice presented in Table 4.15(a) showed that the ascorbic acid content of juice at ambient temperature was found significantly

Table 4.15 (a) Effect of storage days, juice type and storage temperature on ascorbic acid (mg/100ml) content of CO and COA juice blends

Storage Days (D)	**Ascorbic acid (mg/100ml)**
D 0	9.700
D 1	8.282
D 2	6.659
D 3	5.592
S. Em	0.089
CD at 5 %	0.256
Type of juice (J)	**Ascorbic acid (mg/100ml)**
CO juice	7.370
COA juice	7.747
S. Em	0..062
CD at 5 %	0.181
Storage temperature (J)	**Ascorbic acid (mg/100ml)**
Ambient temperature (20±5 ^{0}C)	6.894
Refrigeration temperature (5±1 ^{0}C)	8.222
S. Em	0.062
CD at 5 %	0.181

Table 4.15 (b) Effect of storage days and juice type on ascorbic acid (mg/100g) content of CO and COA juice blends

Type of juice (J)	**Storage days (D)**				**Mean (J)**
	D0	**D1**	**D2**	**D3**	
CO juice	10.113	8.121	6.378	4.866	7.370
COA juice	9.286	8.443	6.940	6.318	7.747
Mean (D)	9.700	8.282	6.659	5.59	

Source of variation	**S. Em**	**CD at 5 %**
D	0.089	0.256
J	0.062	0.181
D*J	0.125	0.362

Table 4.15 (c) Effect of juice type and storage temperature on ascorbic acid (mg/100g) content of CO and COA juice blends

Type of juice (J)	**Storage temperature (T)**		**Mean (J)**
	Ambient temperature (20±5 ^{0}C)	**Refrigeration temperature (5±1 ^{0}C)**	
CO juice	6.910	7.830	7.370
COA juice	6.879	8.615	7.747
Mean (T)	6.894	8.222	

Source of variation	**S. Em**	**CD at 5 %**
D	0.062	0.181
T	0.062	0.181
D*T	0.089	0.256

lower (6.894) than juice blends stored at refrigeration temperature (8.222). This may be due to low temperature that prevented oxidation of ascorbic acid. Sharma *et al.* (2009) showed inverse relation of ascorbic acid with the temperature in the carrot juice. Ladaniya *et al.* (2004) reported significant decrease in ascorbic acid content during storage under both ambient and refrigerated conditions. The decline in ascorbic acid could be attributed to oxidation of ascorbic acid to dehydro ascorbic acid and/or some other biochemical reactions like browning.

Data presented in Table 4.15 (b) showed significant effect of storage days and juice type (without aloe vera and with aloe vera juice) on the ascorbic acid content of juice blends. With progress in storage days, ascorbic acid content of CO and COA juice decreased significantly from 10.113 to 4.866 mg/100ml and from 9.286 to 6.318 mg/100ml respectively but ascorbic acid was found significantly higher in COA (7. 747 mg/100ml) than CO (7.370 mg/100ml). This reduced rate of decrease in ascorbic acid content of COA juice blend may be attributed to high level of aloe vera juice. Similar results were stated by Thorat *et al.* (2007) who found highest ascorbic acid retention at both ambient and refrigeration temperature in beverages having aloe vera juice.

Tripathi *et al.* (1992) reported continuous decrease in ascorbic acid content in all the blends of pineapple - guava RTS beverage. Ascorbic acid is unstable and decrease on storage has been reported earlier, (Shaw and Moshonas, 1991; Pandey *et al.,* 2003; Tanushree *et al.,* 2009 and Tiwari *et al.,* 2010). Higher ascorbic acid content of COA juice blend may be due to aloe vera which resulted in increased stability of biochemical parameters during storage. Similar findings were reported by Thorat *et al.* (2007) in amla based carbonated health drink.

Table 4.15 (d) Effect of storage days and Storage temperature on ascorbic acid (mg/100g) content of CO and COA juice

Storage temperature (T)	Storage days (D)				Mean (T)
	D0	D1	D2	D3	
Ambient temperature (20±5 ^{0}C)	9.700	7.816	5.725	4.336	6.894
Refrigeration temperature (5±1 ^{0}C)	9.700	8.748	7.593	6.848	8.222
Mean (D)	9.700	8.282	6.659	5.592	

Source of variation	S. Em	CD at 5 %
D	0.089	0.256
T	0.062	0.181
D*T	0.125	0.362

Table 4.15 (e) Effect of interaction between storage days, type of juice and storage temperature on ascorbic acid (mg/100g) content of CO and COA juice blend

Storage days (D)	CO juice		COA juice		Mean (D)
	Ambient temperature (20±5 ^{0}C)	Refrigeration temperature (5±1 ^{0}C)	Ambient temperature (20±5 ^{0}C)	Refrigeration temperature (5±1 ^{0}C)	
D 0	10.113	10.113	9.286	9.286	9.700
D 1	7.773	8.470	7.860	9.026	8.282
D 2	5.788	6.970	5.663	8.216	6.659
D 3	3.966	5.766	4.706	7.930	5.592
Mean(T)	6.910	7.830	6.879	8.615	

Source of variation	S. Em	CD at 5 %
D	0.089	0.256
J	0.062	0.181
T	0.062	0.181
D*J*T	0.178	0.512

Data showed that there was a significant effect of juice type and storage temperature on the ascorbic acid content of juice blends Table 4.15 (c). It was observed that mean ascorbic acid content of juice blends stored at ambient temperature (6.894 mg/100ml) is lower than refrigeration temperature (8.222 mg/100ml) however ascorbic acid content of COA juice (7.747 mg/100ml) was found higher than CO juice (7.370 mg/100ml).

Data pertaining to the effect of storage days and storage temperature on the ascorbic acid content of juice blends are given in Table 4.15 (d). It is revealed that with progress in storage days, the ascorbic acid content (mg/100ml) of juice blends stored at ambient and refrigerated temperature decreased significantly from 9.700 to 4.336 and 9.700 to 6.848 respectively. However, the rate of ascorbic acid decrement with increase in storage days was more at ambient temperature them at refrigeration temperature. Shere *et al.* (2008) reported that ascorbic acid content of carrot juice gradually decreased as storage time and temperature increased.

Data presented in Table 4.15 (e) revealed that there was a significant variation in the overall effect of interaction between storage days, juice type and storage temperature on the ascorbic acid content of juice blends.

4.7.3.2.3 Beta- carotene

Data presented in Table 4.16 (a) regarding beta carotene content of CO and COA juice blends showed significant result during storage period of three days. The beta carotene content of juice blends was observed as 6.440 mg/100ml on 0 day of storage which was decreased to 4.200 mg/100ml on 3rd day of storage. Madan and Dhawan (2005) reported linear reduction in beta carotene content of carrot juice with increment in storage period. Similar findings were reported by

Table 4.16 (a) Effect of storage days, juice type and storage temperature on beta carotene content of CO and COA juice

Storage Days (D)	**Beta – carotene (mg/100ml)**
D 0	6.440
D 1	5.925
D 2	5.231
D 3	4.220
S. Em	0.070
CD at 5 %	0.202
Types of juice (J)	**Beta – carotene (mg/100ml)**
CO juice	6.365
COA juice	4.542
S. Em	0.049
CD at 5 %	0.143
Storage temperature (T)	**Beta – carotene (mg/100ml)**
Ambient temperature (20±5 ^{0}C)	5.213
Refrigeration temperature (5±1 ^{0}C)	5.695
S. Em	0.049
CD at 5 %	0.143

Table 4.16 (b) Effect of storage days and juice type on beta carotene content of CO and COA juice

Type of juice (J)	**Storage days (D)**				**Mean (J)**
	D0	**D1**	**D2**	**D3**	
CO juice	7.800	6.828	6.065	4.988	6.365
COA juice	5.300	5.021	4.398	3.451	4.542
Mean (D)	6.440	5.925	5.231	4.220	

Source of variation	**S. Em**	**CD at 5 %**
D	0.070	0.202
J	0.049	0.143
D*J	0.099	0.287

Table 4.16 (c) Effect of juice type and storage temperature on beta carotene content of CO and COA juice blends

Type of juice (J)	**Storage temperature (T)**		**Mean (J)**
	Ambient temperature (20±5 ^{0}C)	**Refrigeration temperature (5±1 ^{0}C)**	
CO juice	6.072	6.658	6.365
COA juice	4.354	4.731	4.542
Mean (T)	5.213	5.695	

Source of variation	**S. Em**	**CD at 5 %**
J	0.049	0.143
T	0.049	0.143
J*T	0.099	0.287

Dhaliwal and Hira (2004) and Dhaliwal and Hira (2001) in carrot- beetroot, Carrot- black carrot, carrot- pineapple and carrot- spinach juices.

The data also revealed significant variation in the beta carotene content of CO and COA juice blend during storage. The beta carotene content of CO juice blend (6.365 mg/100ml) was found significantly higher than COA (4.542 mg/100ml). This may be attributed to low beta carotene content of aloe vera juice that brought about reduction in beta carotene content of COA juice blend.

The Table also showed that temperature played important role in stability of the beta carotene content of juice. Beta carotene content (mg/100ml) of juice blends stored at refrigeration temperature was found to be higher (5.695) than stored at ambient temperature (5.695). Chen *et al.* (1996) reported the similar trend in carrot juice and reported decrease in beta carotene content with increase in storage temperature. They reported that the decline was due to effect of light and oxygen on the juice preparation process as well as during storage and also while opening the bottle in which it was kept.

Perusal of data in Table 4.16 (b) showed significant effect of storage days and juice type on beta carotene content of juice blends. The results showed that with increase in storage period, the beta carotene (mg/100ml) content of CO and COA juice blend decreased significantly from 7.800 to 4.988 and from 5.300 to 3.451respectively. The result revealed that although COA juice blend contained less beta carotene (4.542 mg/100ml) them CO juice (6.365 mg/100ml), the rate of beta carotene reduction was found to be more in CO juice and lesser in COA juice blend. This may be attributed to aloe vera incorporation that stabilized biochemical parameters during storage.

Table 4.16 (d) Effect of storage days and Storage temperature on beta carotene content of CO and COA juice blends

Storage temperature (T)	Storage days (D)				Mean (T)
	D0	D1	D2	D3	
Ambient temperature (20±5 ^{0}C)	6.440	5.696	4.881	3.835	5.213
Refrigeration temperature (5±1 ^{0}C)	6.440	6.153	5.581	4.605	5.695
Mean (D)	6.440	5.925	5.231	4.220	

Source of variation	S. Em	CD at 5 %
D	0.070	0.202
T	0.049	0.143
D*T	0.099	0.287

Table 4.16 (e) Effect of interaction between storage days, type of juice and storage temperature on beta carotene content of CO and COA juice blends

Storage days (D)	CO juice		COA juice		Mean (D)
	Ambient temperature (20±5 ^{0}C)	Refrigeration temperature (5±1 ^{0}C)	Ambient temperature (20±5 ^{0}C)	Refrigeration temperature (5±1 ^{0}C)	
D 0	7.580	7.580	5.300	5.300	6.440
D 1	6.423	7.233	4.970	5.073	5.925
D 2	5.686	6.443	4.076	4.720	5.231
D 3	4.600	5.376	3.070	3.833	4.220
Mean (T)	6.072	6.658	4.354	4.731	

Source of variation	S. Em	CD at 5 %
D	0.070	0.202
J	0.049	0.143
T	0.049	0.143
D*J*T	0.140	0.405

Data presented in Table 4.16 (c) showed significant effect of juice type and storage temperature on the beta carotene content of juice blends. The beta carotene content (mg/100ml) of CO and COA juice blend stored at refrigeration temperature was found higher i.e. 6.658 and 4.731 respectively than CO and COA juice blend stored at ambient temperature i.e. 6.072 and 4.354 respectively. Although COA juice blend at ambient and refrigeration temperature contained less beta carotene than CO juice but the rate of beta carotene reduction was found less in COA juice blend. This may be due to aloe vera incorporation that kept the biochemical parameters stable during storage.

Data revealed that storage days and storage temperature had significant effect on the beta carotene content of juice blends. With the increase in storage days, the beta carotene content of juice blends stored at ambient and refrigeration temperature decreased significantly from 6.440 to 3.835 mg/100ml and 6.440 to 4.605 mg/100ml but the rate of reduction was found higher in juice blends stored at ambient temperature than at refrigeration temperature (Table 4.16 d).

Data presented in Table 4.16 (e) showed significant variation in the beta carotene content of juice blends due to overall effect of storage days, juice type and storage temperature on the beta carotene content of juice blends.

4.7.3.3 *Aonla*-ginger (AG) & *aonla* ginger-aloe vera (AGA) juice blend

4.7.3.3.1 Total sugar

Data pertaining to total sugar content of AG and AGA juice blend yielded significant result during storage period of 3 days (Table 4.17a). The total sugar content of juice blends was observed 9.29 per cent on 0 day of storage which increased to10.46 per cent on third day of storage. Similar findings were also

Table 4.17 (a) Effect of storage days, juice type and storage temperature on total sugar content of AG and AGA juice blend

Storage Days (D)	**Total Sugar (per cent)**
D 0	9.29
D 1	9.78
D 2	10.02
D 3	10.46
S. Em	0.03
CD at 5 %	0.10
Types of juice (J)	**Total Sugar (per cent)**
AG juice	11.16
AGA juice	8.61
S. Em	0.02
CD at 5 %	0.07
Storage temperature (T)	**Total Sugar (per cent)**
Ambient temperature (20±5 ^{0}C)	10.12
Refrigeration temperature (5±1 ^{0}C)	9.66
S. Em	0.02
CD at 5 %	0.07

Table 4.17 (b) Effect of storage days and juice type on total sugar content of AG and AGA juice blend

Type of juice (J)	**Storage days (D)**				**Mean (J)**
	D0	**D1**	**D2**	**D3**	
AG juice	10.50	11.00	11.33	11.83	11.16
AGA juice	8.08	8.57	8.71	9.09	8.61
Mean (D)	9.29	9.78	10.021	10.464	

Source of variation	**S. Em**	**CD at 5 %**
D	0.03	0.02
J	0.02	0.07
D*J	0.05	0.14

Table 4.17 (c) Effect of juice type and storage temperature on total sugar content of AG and AGA juice blend

Type of juice (J)	**Storage temperature (T)**		**Mean (J)**
	Ambient temperature (20±5 ^{0}C)	**Refrigeration temperature (5±1 ^{0}C)**	
AG juice	11.51	10.82	11.16
AGA juice	8.730	8.50	8.61
Mean (T)	10.12	9.66	

Source of variation	**S. Em**	**CD at 5 %**
D	0.02	0.07
J	0.02	0.07
D*J	0.05	0.14

observed in peach and apricot (Shah and Bains, 1992) and guava (Tandon *et al.,* 1983) pulp during storage. Tiwari *et al.* (2005) and Garg *et al.* (2008) reported similar trend in *aonla* pulp stored for nine months. Increase in sugars might be due to breakdown of hemicelluloses and other soluble saccharides like hydrolysis of starch/sucrose into simple sugar (Deka *et al.,* 2002).

Table also revealed that there was significant difference in the total sugar content of AG (11.16 per cent) and AGA (8.61 per cent) juice. The total sugar content was found to be of higher extent when juice blends were stored at ambient temperature. Further these differences were less at refrigeration temperature (9.66 per cent) as compared to ambient temperature (10.12 per cent). These observations are in conformity with earlier reports (Ghosh *et al.,* 1981; Saini and Grewal, 1995 and Sirohi, 1998). This might be due to low temperature that prevented breakdown of juice components.

It was also seen that there was a significant effect of storage days and juice type on total sugar content of juice blends (Table 4.17 b). With increase in storage days total sugar content (per cent) of AG and AGA juice blends increased significantly from 10.50 to 11.83 and from 8.08 to 9.09 respectively but the total sugar content was found to be significantly higher in AG (11.16 per cent) than AGA (8.61 per cent) juice blends.

Data shown in Table 4.17 (c) revealed that there was a significant effect of juice type and storage temperature on total sugar content of juice blends. Total sugar content (per cent) of AG juice blend kept at ambient temperature (11.51) had significantly higher total sugar content than AGA juice blend (8.73) kept at same ambient temperature. Similar trend was observed in juice blends kept at refrigeration temperature.

Table 4.17 (d) Effect of storage days and Storage temperature on total sugar content of AG and AGA juice blend

Storage temperature (T)	Storage days (D)				Mean (T)
	D0	D1	D2	D3	
Ambient temperature (20±5 ^{0}C)	9.29	10.01	10.32	10.85	10.12
Refrigeration temperature (5±1 ^{0}C)	9.29	9.56	9.71	9.29	9.66
Mean (D)	9.29	9.78	10.02	10.46	

Source of variation	S. Em	CD at 5 %
D	0.03	0.10
T	0.02	0.07
D*T	0.03	0.10

Table 4.17 (e) Effect of interaction between storage days, type of juice and storage temperature on total sugar content of AG and AGA juice blend

Storage Days (D)	AG juice		AGA juice		Mean (D)
	Ambient temperature (20±5 ^{0}C)	Refrigeration temperature (5±1 ^{0}C)	Ambient temperature (20±5 ^{0}C)	Refrigeration temperature (5±1 ^{0}C)	
D 0	10.50	10.50	8.08	8.08	9.29
D 1	11.36	10.64	8.66	8.49	9.78
D 2	11.83	10.82	8.81	8.61	10.02
D 3	12.35	11.32	9.36	8.82	10.46
Mean(T)	11.51	10.82	8.73	8.50	

Source of variation	S. Em	CD at 5 %
D	0.03	0.10
J	0.02	0.07
T	0.02	0.07
D*J*T	0.07	0.20

Data on the effect of storage days and storage temperature on total sugar content of juice blends (Table 4.17d) showed that with increase in storage days, the mean total sugar content of juice blends kept at ambient and refrigeration temperature increased significantly (9.29 to 10.46 per cent), more at ambient temperature (10.12 per cent) than at refrigeration temperature (9.66 per cent).

It was also revealed that there was significant variation in the effect of interaction between storage days, juice type (AG and AGA juice blend) and storage temperature on total sugar content of juice blends (Table 4.17e).

4.7.3.3.2 Ascorbic acid

Data presented in Table 4.18 (a) regarding ascorbic acid (mg/100ml) content of AG and AGA juice blend showed significant variation during storage period of 3 days. Ascorbic acid content (mg/100ml) of AG and AGA juice decreased significantly from initial value of 115.32 to 79.35 during 3 days of storage period. The decrease in ascorbic acid during storage may be attributed to its degradation into dehydro-ascorbic acid or furfural or hydroxy methyl furfural during storage due to oxidation, light and storage temperature (Fennema 1976; Pandey *et al.,* 1995 and Kannan and Banumati 2005). Such type of decrement in ascorbic acid during storage has been observed on phalsa RTS (Dobhal, 2000). Continuous decline in ascorbic acid content of RTS and juice blends throughout the storage period has also been reported by several workers (Dhaliwal and Hira 2001; Tiwari *et al.,* 2005, Shere *et al.,* 2008, Garg *et al.,* 2008 and Nagpal and Rajyalakshmi, 2009). Data also revealed that there was significant variation in the ascorbic acid content of AG (105.02 mg/100ml) and AGA (88.31 per cent) juice.

Table 4.18 (a) Effect of storage days, juice type and storage temperature on ascorbic acid content of AG and AGA juice blend

Storage Days (D)	**Ascorbic acid (mg/100ml)**
D 0	115.32
D 1	100.75
D 2	91.25
D 3	79.35
S. Em	0.61
CD at 5 %	1.75
Type of juice (J)	**Ascorbic acid (mg/100ml)**
AG juice	105.02
AGA juice	88.31
S. Em	0.43
CD at 5 %	1.24
Storage temperature (T)	**Ascorbic acid (mg/100ml)**
Ambient temperature (20±5 ^{0}C)	88.22
Refrigeration temperature (5±1 ^{0}C)	105.11
S. Em	0.43
CD at 5 %	1.24

Table 4.18 (b) Effect of storage days and juice type on ascorbic acid content of AG and AGA juice

Type of juice (J)	**Storage days (D)**				**Mean (J)**
	D0	**D1**	**D2**	**D3**	
AG juice	125.18	109.50	100.22	85.18	105.02
AGA juice	105.46	91.99	82.27	73.52	88.31
Mean (D)	115.32	100.75	91.25	79.35	

Source of variation	**S. Em**	**CD at 5 %**
D	0.61	1.75
J	0.43	1.24
D*J	0.86	2.48

Table 4.18 (c) Effect of juice type and storage temperature on ascorbic acid content of AG and AGA juice blend

Type of juice (J)	**Storage temperature (T)**		**Mean (J)**
	Ambient temperature (20±5 ^{0}C)	**Refrigeration temperature (5±1 ^{0}C)**	
AG juice	93.47	116.57	105.02
AGA juice	82.97	93.66	88.31
Mean (T)	88.22	105.11	

Source of variation	**S. Em**	**CD at 5 %**
D	0.43	1.24
T	0.43	1.24
D*T	0.86	2.48

The data on effect of storage temperature on ascorbic acid content of juice blends presented in Table 4.18 (a) revealed that the ascorbic acid content of AG and AGA juice blend decreased continuously and progressively both at ambient and refrigeration temperature. Among two storage conditions, the juice blends stored in refrigerator had maintained higher ascorbic acid (105.11 mg/100g) throughout the storage period than at ambient temperature (88.22 mg/100g). This may be attributed to sensitivity of ascorbic acid to high temperature. Similar decline has been reported in amla fruit RTS (Shere *et al.,* 2008), mixed fruit juice RTS beverage (Kumar and Mainmegalai 2001) and in sweetened Nagpur mandarin orange juice (Ladaniya *et al.,* 2004).

Data shown in Table 4.18 (b) reveals that there was significant effect of storage days and juice type (AG and AGA) on ascorbic acid content of juice blends. With advancement in storage days ascorbic acid content of AG and AGA juice blend decreased significantly from 125.18 to 85.18 mg/100ml and from 105.46 to 73.52 mg/100ml respectively but ascorbic acid content (mg/100ml) was found significantly higher in AG (105.02) juice than AGA (88.31) juice.

There was a significant effect of juice type and storage temperature on the ascorbic acid content of juice blends. It was observed that ascorbic acid (mg/100g) content of AG juice kept at ambient temperature (93.47) was significantly lower than AG juice (116.57) kept at refrigeration temperature. Similar pattern of ascorbic acid content was found in AGA juice blend kept at ambient and refrigeration temperature. However, the ascorbic acid content (mg/100ml) of AGA juice (88.31) blend was found to be significantly lower than AG juice (105.11) in the present study (Table 4.18c). This may be due to low ascorbic acid content of aloe vera juice as compared to *aonla* and ginger juice.

Table 4.18 (d) Effect of storage days and Storage temperature on ascorbic acid content of AG and AGA juice blend

Storage temperature (T)	Storage days (D)				Mean (T)
	D0	D1	D2	D3	
Ambient temperature (20±5 ^{0}C)	115.32	91.56	79.70	66.29	88.22
Refrigeration temperature (5±1^{0}C)	115.32	109.94	102.79	92.41	105.11
Mean (D)	115.32	100.75	91.25	79.35	

Source of variation	S. Em	CD at 5 %
D	0.61	1.75
T	0.43	1.24
D*T	0.61	1.75

Table 4.18 (e) Effect of interaction between storage days, type of juice and storage temperature on ascorbic acid content of AG and AGA juice blend

Storage Days (D)	AG juice		AGA juice		Mean (D)
	Ambient temperature (20±5 ^{0}C)	Refrigeration temperature (5±1 ^{0} C)	Ambient temperature (20±5 ^{0}C)	Refrigeration temperature (5±1 ^{0} C)	
D 0	125.18	125.18	105.46	105.46	115.32
D 1	98.07	120.93	85.05	98.94	100.75
D 2	83.64	116.81	75.77	88.77	91.25
D 3	67.00	103.36	65.58	81.46	79.35
Mean (T)	93.47	116.57	82.97	93.66	

Source of variation	S. Em	CD at 5 %
D	0.61	1.75
J	0.43	1.24
T	0.43	1.24
D*J*T	1.22	3.51

Data related to the effect of storage days and storage temperature on the ascorbic acid content of juice blends are tabulated in Table 4.18 (d). The results showed that with increase in storage days the ascorbic acid content of juice blends kept at ambient and refrigeration temperature decreased significantly from 115.32 to 66.29 mg/100ml and from 115.32 to 92.41 mg/100ml respectively. However, the rate of decrement was found to be more at ambient temperature than at refrigeration temperature. The ascorbic acid content of juice blends at refrigeration and ambient temperature was observed as 105.11 mg/100ml and 88.22 mg/100ml respectively.

Data shown in Table 4.18 (e) revealed that there was a significant variation in the effect of interaction between storage days, juice type (AG and AGA juice blend) and storage temperature on ascorbic acid content of juice blends.

4.7.3.3.3 Total chlorophyll

The data presented in Table 4.19 (a) regarding total chlorophyll content of AG and AGA juice blend showed significant results during storage period of 3 days. The total chlorophyll content of juice blends was estimated 0.495 on 0 day of storage which decreased to 0.354 on third day of storage. Yusof *et al.* (2000) reported similar findings in sugarcane juice. It was also shown that there was significant difference in the total chlorophyll content (mg/100ml) of AG (0.478) juice and AGA juice (0.376). The total chlorophyll content was found higher in juice blend stored at refrigeration temperature (0.452 mg/100ml) than at ambient temperature (0.402 mg/100ml). Yusof *et al.* (2000) reported that the juice blends of sugar canes stored at higher temperature (27^0C) showed a faster rate of chlorophyll degradation than those stored at lower temperature (10^0C).

Table 4.19 (a) Effect of storage days, juice type and storage temperature on total chlorophyll content of AG and AGA juice blend

Storage Days (D)	**Total chlorophyll (mg/100ml)**
D 0	0.49
D 1	0.45
D 2	0.41
D 3	0.35
S. Em	0.05
CD at 5 %	0.15
Type of juice (J)	**Total chlorophyll (mg/100ml)**
AG juice	0.47
AGA juice	0.37
S. Em	0.03
CD at 5 %	0.10
Storage temperature (T)	**Total chlorophyll (mg/100ml)**
Ambient temperature (20±5 ^{0}C)	0.40
Refrigeration temperature (5±1 ^{0}C)	0.45
S. Em	0.03
CD at 5 %	0.10

Table 4.19 (b) Effect of storage days and juice type on total chlorophyll content of AG and AGA juice blend

Type of juice (J)	**Storage days (D)**				**Mean (J)**
	D0	**D1**	**D2**	**D3**	
AG juice	0.56	0.50	0.45	0.38	0.47
AGA juice	0.42	0.39	0.36	0.32	0.37
Mean (D)	0.49	0.45	0.41	0.35	

Source of variation	**S. Em**	**CD at 5 %**
D	0.05	0.15
J	0.03	0.10
D*J	0.07	0.21

Table 4.19 (c) Effect of juice type and storage temperature on total chlorophyll content of AG and AGA juice blend

Type of juice (J)	**Storage temperature (T)**		**Mean (J)**
	Ambient temperature (20±5 ^{0}C)	**Refrigeration temperature (5±1 ^{0}C)**	
AG juice	0.45	0.50	0.47
AGA juice	0.35	0.40	0.37
Mean (T)	0.40	0.45	

Source of variation	**S. Em**	**CD at 5 %**
J	0.03	0.10
T	0.03	0.10
J*T	0.07	0.21

There was a significant effect of storage days and juice type on total chlorophyll content of juice blends as shown in Table 4.19 (b). With increase in storage days total chlorophyll content of AG and AGA juice blends decreased significantly from 0.566 to 0.383 mg/100ml and 0.423 to 0.321 mg/100ml respectively but AG juice blend was found to have higher (0.478 mg/100ml) mean total chlorophyll than AGA juice blend (0.376 mg/100ml).

Data presented in Table 4.19 (c) revealed that there was no significant effect of juice type and storage temperature on the total chlorophyll content of juice blends.

Data tabulated in on. The data on effect of storage days and storage temperature on total chlorophyll given in Table 4.19 (d) showed significant variation. With increase in storage days, the mean total chlorophyll content of juice blends stored at ambient and refrigeration temperature decreased significantly from 0.495 to 0.354 mg/100ml, values were found lesser at ambient temperature (0.402 mg/100ml) than at refrigeration temperature (0.452 mg/100ml).

Data presented in Table 4.19 (e) indicated that there was significant variation in the effect of interaction between storage days, juice type (AG and AGA juice blend) and storage temperature on total chlorophyll content of juice blends.

4.8 Evaluation of therapeutic value of aloe Vera incorporated juices

Fruits and vegetables and their constituents are potent effectors of biological systems in humans. The health problems related to the digestive system,

Table 4.19 (d) Effect of storage days and Storage temperature on total chlorophyll content of AG and AGA juice blend

Storage temperature (T)	Storage days (D)				Mean (T)
	D0	D1	D2	D3	
Ambient temperature (20±5 ^{0} C)	0.49	0.43	0.37	0.30	0.40
Refrigeration temperature (5±1^{0}C)	0.49	0.46	0.44	0.40	0.45
Mean (D)	0.49	0.45	0.41	0.35	

Source of variation	S. Em	CD at 5 %
D	0.05	0.15
T	0.03	0.10
D*T	0.05	0.15

Table 4.19 (e) Effect of interaction between storage days, type of juice and storage temperature on total chlorophyll content of AG and AGA juice blend

Storage Days (D)	AG juice		AGA juice		Mean (D)
	Ambient temperature (20±5 ^{0} C)	Refrigeration temperature (5±1 ^{0} C)	Ambient temperature (20±5 ^{0} C)	Refrigeration temperature (5±1 ^{0} C)	
D 0	0.56	0.56	0.42	0.42	0.49
D 1	0.48	0.52	0.38	0.41	0.45
D 2	0.42	0.49	0.32	0.40	0.41
D 3	0.34	0.42	0.27	0.37	0.35
Mean (T)	0.45	0.50	0.35	0.40	

Source of variation	S. Em	CD at 5 %
D	0.05	0.15
J	0.03	0.10
T	0.03	0.10
D*J*T	0.10	0.30

such as constipation or the nutrition ones, such as obesity, cardiovascular may be solved only by an adequate nutrition based on fruits and vegetables. Juice is a nutritious beverage that is included as an option within the fruit serving. Hundred per cent fruit juice is a nutrient dense beverage and as such it is important part of a varied and healthy diet as it contributes to a range of nutrients as well as phytonutrients vital for good health and disease prevention (Landon, 2007).

Aloe vera has been used for its medicinal value for several thousands of years in many ancient cultures. Now days aloe vera juice is flooded in the market and is incorporated into various products to get the health benefit. However no systematic study on the health benefits of incorporation of aloe vera juice in 100 per cent fruit and vegetable juice has been conducted. So, keeping in view of different health benefits exhibited by juices, aloe vera incorporated juices were evaluated for therapeutic value on experimental subjects.

4.8.1 Sample selection

For selection of sample, many people from the college of Agriculture, College of Home Science, College of Veterinary Science and residential colonies from Pantnagar Campus were contacted personally. A consent form was developed (Appendix-II) and distributed among those who were ready to participate in study to have their consent. A total of 50 subjects were selected for the study out of which 20 were having constipation, 14 were diabetics and 16 were hypertensive. Subjects in each category were divided equally into control group and experimental group.

4.8.2 Collection of information of the subjects

A pre-survey proforma was developed (Appendix-III) for collecting information regarding general information, work pattern and habits, physical

fitness, diet history and anthropometry of subjects. The data on information about the subjects are presented in Appendix-IX.

4.8.2.1 General information

Information about the general details of subjects pertaining to name, age, sex, occupation, education and marital status was collected (Appendix-IX).

4.8.2.1.1 Age

Result (Figure 4.5a) showed that 28 per cent of the subjects were in the age group of 40-45 years followed by 30 per cent and 38 per cent in the age group of 46-51 years and 52-57 years respectively while only 4 per cent belonged to age group of 58-63 years.

4.8.2.1.2 Sex

Out of total subjects, 64 per cent were females while 36 per cent were males (Figure 4.5b)

4.8.2.1.3 Occupation

Results (Figure 4.5c) revealed that out of total subjects, 30 per cent were housewives, 66 per cent belonged to service class while only 4 per cent contributed business as an occupation The jobs include teaching and office work in university campus.

4.8.2.1.4 Education

Data pertaining to education level of subjects as depicted in Figure 4.5(d) showed that 36 per cent of the total subjects were graduates followed by 32 per cent who were post graduated. Four per cent were educated upto junior high school and intermediate in each category while 24 per cent did high school. Remaining 4 percent were illiterate. Only 6 per cent of the total subjects had educational qualification upto Ph.D level.

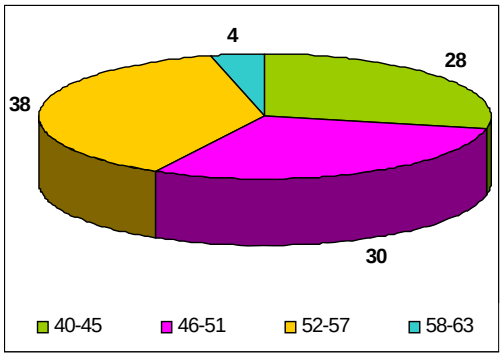


Fig. 4.5 (a) Age of experimental subjects

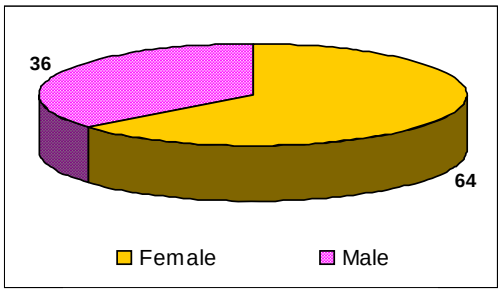


Fig. 4.5(b) Sex of experimental subjects

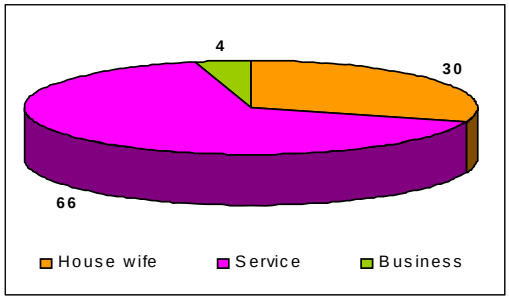


Fig.4.5 (c) Occupation of subjects

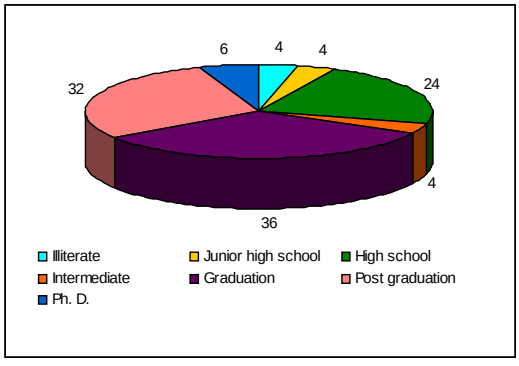


Fig. 4.5 (d) Education status of subjects

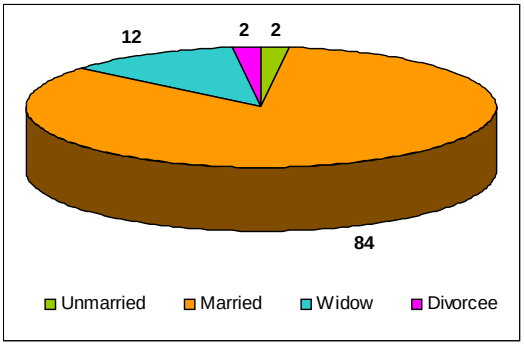


Fig. 4.5 (e) Marital status of subjects

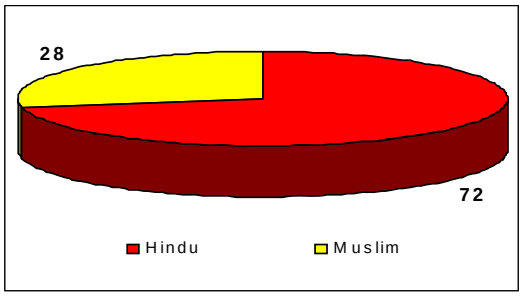


Fig.4.5 (f) Religion of subjects

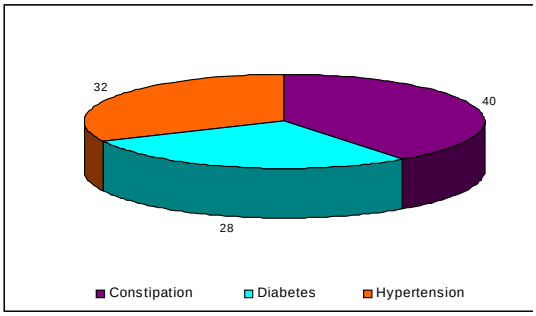


Fig.4.5 (g) Type of disease

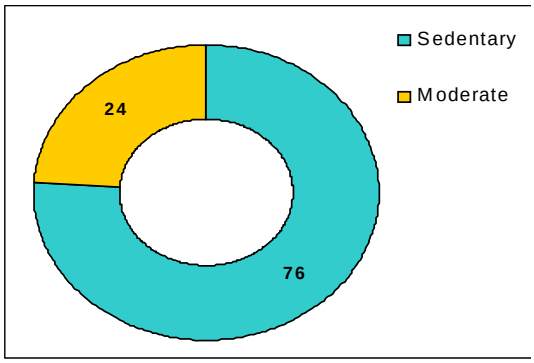


Fig. 4.5 (h) Life style of subjects

4.8.2.1.5 Marital status

Figure 4.5 (e) showed marital status of subjects involved in study. Eighty four per cent subjects were married while only 12 per cent belong to widow category. Unmarried and divorce group contributed only 2 per cent in each category.

4.8.2.1.6 Religion

Data regarding religion of subjects revealed that 72 percent of subjects were Hindu whereas Muslims were 28 per cent (Figure 4.5f).

4.8.2.1.7 Type of disease

Data pertaining to type of disease studied in present investigation showed that 40 per cent subjects had constipation followed by 28 per cent and 32 per cent subjects having diabetes and hypertension (Figure 4.5g)

4.8.2.2 Work pattern and habits

4.8.2.2.1 Life style

Figure 4.5 (h) revealed that 76 per cent subjects had sedentary life style while 24 per cent followed moderate life style. The subjects were either having office work or/and routine work at home having housemaid at their homes.

4.8.2.2.2 Active working hours

Data pertaining to active working hours as presented in Figure 4.5 (i) reflects that 46 per cent of subjects had active working hours of 5-8 hours in a day which included the office work or routine work at home of those subjects having housemaid at their home. Forty six per cent of subjects had active working hours of 9-12 hrs while 6 per cent had active working hours of 13-16. This included the subjects doing more office work and females that were employed. Only 2 per cent of subjects had 17-20 hours of active working hours which included business work.

4.8.2.2.3 Smoking/chewing tobacco

Data presented in Figure 4.5 (j) revealed that of all subjects, 78 per cent did not smoke or chew tobacco while 12 per cent used tobacco daily and 8 per cent used occasionally. Only 2 per cent rarely used tobacco.

4.8.2.2.4 Drinking

A perusal of the data on drinking presented in Figure 4.5 (k) depicts that most of the subjects i.e. 88 per cent did not drink alcohol while only 8 percent rarely drink. Only 4 per cent of subjects used to drink alcohol daily.

4.8.2.3 Physical fitness

4.8.2.3.1 Type of physical exercise

Figure 4.5 (l) revealed that among type of physical exercise, walking was found to be the main exercise i.e. 30 per cent of the subjects involved in it. Twenty eight per cent of subjects were involved in yoga. Two per cent used to do bicycling and other exercise i.e. gardening in each category. Twenty six per cent of the subjects were not engaged in any kind of physical exercise like jogging, evening walk etc. Both walking and yoga was done by 12 per cent.

4.8.2.3.2 Frequency of exercise

Data expressed in Figure 4.5 (m) reveals that 70 per cent of the subjects used to do physical exercise daily while 30 per cent of subjects used to do physical exercise whenever they get time.

4.8.2.3.3 Duration of exercise

Of the 74 per cent engaged in physical exercise, 54 per cent subjects engaged in exercise for less than half an hour were while 38 per cent of subjects performed physical exercise for half an hour. Only 8 per cent subjects perform exercise for one to two (Figure 4.5 n).

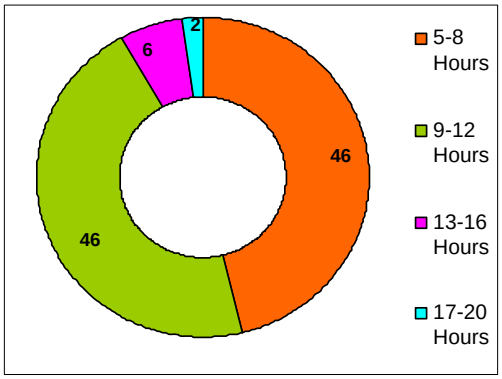


Fig. 4.5 (i) Active working hours of subjects

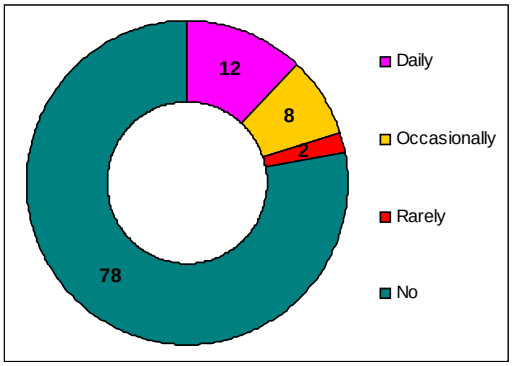


Fig. 4.5 (j) Smoking / chewing tobacco by subjects

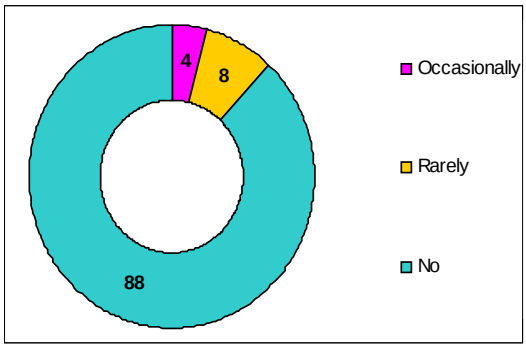


Fig. 4.5(k) Drinking habits of subjects

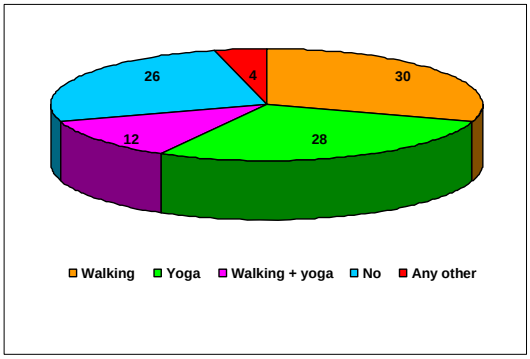


Fig. 4.5 (l) Physical exercise by subjects

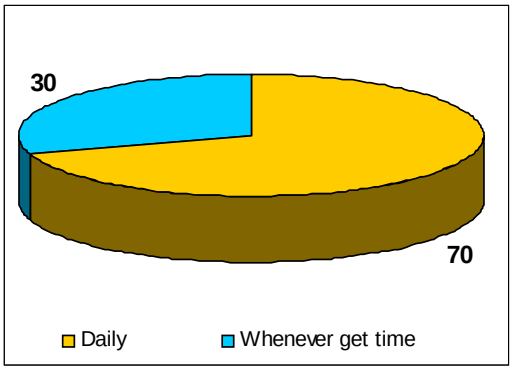


Fig. 4.5 (m) Frequency of exercise by subjects

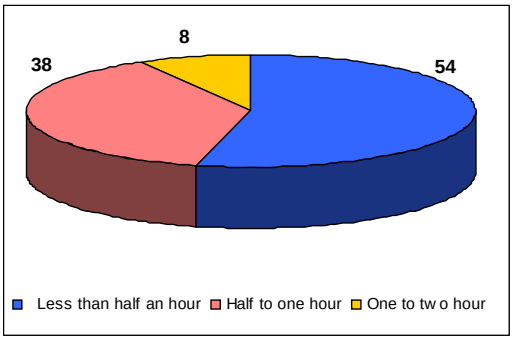


Fig. 4.5 (n) Duration of exercise by subjects

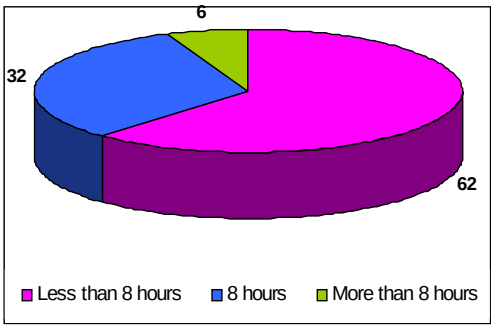


Fig. 4.5 (o) Hours of sleep/rest subjects

4.8.2.3.4 Hours of sleep or rest

The data pertaining to hours of sleep or rest presented in Figure 4.5 (o) indicate that 54 per cent of the subjects used to have rest/sleep for less than 8 hours while subjects taking rest/sleep for 8 hours and more than 8 hours were found to be 38 per cent and 8 per cent respectively.

As per information regarding physical fitness and work pattern is concerned it can be said that although 60 per cent subjects in control group and 90 per cent subjects in experimental group were found to be engaged in physical exercise, the frequency and duration of doing exercise was less. Most of the subjects in both groups had sedentary life style. Lack of physical activity and sedentary life style are also responsible for several chronic degenerative diseases like obesity, diabetes, constipation and cardiovascular diseases.

4.8.2.4 Diet history of subjects

4.8.2.4.1 Food habits

Data on diet history clearly showed that most of the subjects (50 per cent) were vegetarian while 44 per cent subjects were found non –vegetarian. Only 6 per cent were ovo-vegetarian (Table 4.20).

4.8.2.4.2 Number of meals per day

It is evident from Table 4.20 that 82 per cent of subjects used to take three meals in a day i.e. breakfast, lunch and dinner while 18 per cent subjects had two meals in a day and usually used to skip their breakfast or had brunch.

4.8.2.4.3 Normal menu pattern

Five combinations of normal menu pattern viz., Rice+dal, Rice + Dal + Chapati, Rice + dal + Chapati + Vegetable, Dal + Chapati + Vegetable and

Table 4.20 Diet history of experimental subjects

Attributes	N = 50	Attributes	N = 50
Food habits		**Meals per day**	
Vegetarian Non – vegetarian Ovo-vegetarian	25 (50) 22 (44) 3 (6)	Two Three	9 (18) 41 (82)
Normal menu pattern		**Salad with meal**	
Rice + dal Rice + dal + chapati Rice + dal + chapatti + vegetables Dal + chapatti + vegetables Chapatti + vegetables	2 (4) 3 (6) 20 (40) 17 (34) 8 (16)	Always Occasionally Rarely Never	10 (20) 38 (76) 1 (2) 1 (2)
Snacks in between meal		**Tea / coffee consumption per day**	
Yes No	29 (58) 21 (42)	Once Twice Thrice 4 times > 4 times No	4 (8) 23 (46) 15 (30) 5 (10) 2 (4) 1 (2)
Intake of water per day		**Consumption of Cold drink**	
One liter Two liter Three liter Four liter	13 (26) 20 (40) 10 (20) 7 (14)	Occasionally Rarely No	13 (26) 10 (20) 27 (54)
Consumption of Non vegetarian food		**Type of non- vegetarian item**	
Weekly Fortnightly Monthly	5 (23) 7 (32) 10 (45)	Mutton Chicken Chicken + fish	12 (55) 4 (18) 6 (27)
Consumption of vegetables per cent day		**Vegetables preferred**	
Once Twice Thrice	2 (4) 28 (56) 20 (40)	Potatoes + GLV + other vegetables Other vegetables GLV + other vegetables Potatoes + other vegetable	12 (24) 12 (24) 21 (42) 5 (10)

Table 4.20 Contd….

Attributes	N = 50	Attributes	N = 50
Fruits		**Fruit serving**	
Daily	18 (36)	One	34 (69)
Occasionally	30 (60)	Two	14 (29)
Rarely	1 (2)	Three	1 (2)
No	1 (2)		
Form in which fruits are consumed		**Milk and curd**	
Whole fruit	39 (80)	Whole milk + curd	23 (46)
Whole fruit + fresh juice	4 (8)	Skim milk + curd	12 (24)
Whole fruit + ready to drink juice	3 (6)	curd	6 (12)
Whole fruit + ready to drink juice + fresh juice	3 (6)	No	9 (18)
Whole grain cereals and pulses		**Bread in breakfast**	
Yes	36 (72)	Daily	4 (8)
No	14 (28)	Occasionally	11 (22)
		Rarely	7 (14)
		No	28 (56)
Type of bread		**Type of oil/fat consumed**	
White (refined flour)	22 (100)	Refined oil	6 (12)
Brown (multi grain)	-	Mustard oil	18 (36)
		Mixed oil	25 (50)
		Desi ghee	1 (2)
Refined flour / maida products			
Daily	1 (2)		
Occasionally	14 (28)		
Rarely	7 (14)		
No	28 (56)		
Values in parentheses indicate percent			

Chapati + Vegetables were prepared and subjects were asked to tell their most appropriate menu pattern. All the subjects used to take wheat in the from of chapati and rice as a staple food. Maximum subjects i.e. 40 per cent had Rice + dal + chapati + vegetable as their normal meal pattern while 34 per cent of subjects followed normal meal pattern of dal + chapati + vegetable. Subjects following Rice + dal, Rice + dal + chapati and chapati + vegetable as usual meal pattern were 4 per cent, 6 per cent and 16 per cent respectively (Table 4.20).

4.8.2.4.4 Salad with meal

Data presented in Table 4.20 revealed that most of the subjects (76 per cent) consumed salad occasionally with meal while 20 per cent always had salad with meal. Two per cent of subjects rarely consumed salad with meal whereas remaining 2 per cent never consumed salad with meal.

4.8.2.4.5 Snacks in between meal

It is clear from Table 4.20 that 58 per cent of the subjects used to take snacks in between meal while 42 per cent did not take snacks in between meal. The snacks consumed by subjects generally involved fruits, biscuits, namkeen, rusk, roasted *channa, samosa* and *matharis.*

4.8.2.4.6 Frequency of taking tea/coffee consumption per day

Data pertaining to consumption of tea/coffee as presented in Table 4.20 reflects that maximum subjects participating in the study used to take tea/coffee regularly. Most of the subjects i.e. 46 per cent of subjects used to take tea/coffee twice a day followed by 30 and 10 per cent taking tea/coffee thrice and four times a day respectively while 4 per cent and 8 per cent used to take tea/coffee more than four times and once a day respectively. Only a small per cent of subjects i.e. 2 per cent did not consume tea / coffee.

4.8.2.4.7 Amount of water intake per day

Results presented in Table 4.20 indicate that 26 per cent of subjects used to take 1 liter of water per day followed by 40 per cent of subjects having 2 liters of water per day while only 20 per cent consumed 3 liters of water per day. A small group of subjects (14 per cent) used to drink 4 liters of water per day. Low intake of water may be attributed to the problem of constipation in the subjects.

4.8.2.4.8 Frequency of consuming cold drink

Fifty four per cent of subjects did not consume cold drinks while 26 per cent and 20 per cent of the subjects used to consume cold drinks occasionally and rarely respectively (Table 4.20).

4.8.2.4.9 Frequency of consumption of non-vegetarian items

Data regarding consumption of non-vegetarian items presented in Table 4.20 depicts that 32 per cent non- vegetarian group used to consume non-vegetarian food items once in fortnight while 45 per cent of the subjects consume non vegetarian food once in a month. Twenty three per cent subjects used to consume non vegetarian food daily.

4.8.2.4.10 Type of non vegetarian foods

Among non vegetarian items, mutton was consumed by 55 per cent of subjects while chicken, by 18 per cent. Both chicken and fish was consumed by twenty seven per cent of subjects (Table 4.20).

4.8.2.4.11 Frequency of consumption of vegetables per day

Data in Table 4.20 exhibit that 56 per cent of subjects used to consume vegetables twice a day followed by 40 per cent who used to consume vegetables thrice a day while only 4 per cent used to take vegetables once a day.

4.8.2.4.12 Types of vegetables preferred

Data presented in Table 4.20 reveals that subjects consuming potatoes + GLV+ other vegetables and only other vegetables were 24 per cent for each group while 42 per cent of subjects used to consume GLV + other vegetables. Only 10 per cent of subjects used to consume potatoes along with other vegetables.

4.8.2.4.13 Frequency of consumption of fruits

The fruit consumption pattern of subjects as presented in Table 4.20 showed that of all subjects 60 per cent of subjects used to consume fruits occasionally while 36 per cent consumed daily. Two per cent of the subjects consumed fruits rarely whereas remaining 2 per cent did not consume fruits at all.

4.8.2.4.14 Frequency of fruit serving

It is evident from the data presented in Table 4.20 that 69 per cent of subjects used to take one serving of fruits while 29 per cent had 2 servings of fruits. A very less percentage i.e. 2 per cent used to take three servings of fruits.

4.8.2.4.15 Form in which fruits consumed

Result presented in Table 4.20 showed that 80 per cent of subjects used to take whole fruit while 6 per cent of each used to take whole fruit + ready to drink juice and whole fruit + ready to drink juice + fresh juice. Only 8 per cent of the subjects used to consume whole fruit along with fresh juice.

4.8.2.4.16 Consumption of milk and curd

The data presented in Table 4.20 revealed that 46 per cent and 24 per cent of subjects used to consume whole milk and skim milk along with curd respectively. Twelve per cent of subjects used to consume only curd. Remaining 18 per cent of the subjects neither used to consume milk nor curd.

4.8.2.4.17 Consumption of whole grain cereals and pulses

Results depicted in Table 4.20 showed that 72 per cent of subjects used to consume whole grain cereals while 28 per cent did not.

4.8.2.4.18 Consumption and types of bread in breakfast

Data presented in Table 4.20 exhibit that 56 per cent of subjects did not consume bread in breakfast while 22 per cent of subjects consumed occasionally. Bread was consumed daily and rarely by 8 per cent and 14 per cent of subjects respectively. Among bread consumers in all the subjects used to consume white bread.

4.8.2.4.19 Consumption of oil/fat

It is clear from the Table 4.20 that only refined oil was consumed by 12 per cent of subjects while 50 per cent of subjects used to consume mixed oil/fat (refined oil, mustard oil and *desi ghee).* Thirty six per cent of subjects used to consume mustard oil. A very small percentage of subjects i.e. 2 per cent used to consume *desi ghee*.

4.8.2.4.20 Refined/Maida products intake

Products made from *maida* and other refined products was consumed occasionally and rarely by 28 per cent and 14 per cent respectively. Only 2 per cent used refined products daily. Remaining 56 per cent did not consume any such products (Table 4.20).

4.9 Evaluation of therapeutic value of aloe vera incorporated juices in diabetics patients

4.9.1 Medical history of diabetic patients

4.9.1.1 Type of diabetes

Data showed that in control and experimental group, all the subjects i.e. 100 percent were found to have type 2 diabetes mellitus (Table 4.21).

Table 4.21 Medical history of diabetic subjects at baseline

Attributes	Control (n=7)	Experimental (n=7)
Types of diabetes		
Type 1	-	-
Type 2	7 (100)	7 (100)
Duration		
0-10 yrs	4 (57)	5 (71)
11-21 yrs	2 (29)	2 (29)
22-32 yrs	1 (14)	-
Family history		
Yes	2 (29)	5 (71)
No	5 (71)	2 (29)
Any other problem		
Hypertension	2 (29)	1 (14)
Any other	1 (14)	1 (14)
No	4 (57)	5 (72)
Type of treatment		
Oral hypoglycemic drugs (OHD)	6 (86)	3 (43)
Diet alone	-	3 (43)
OHD + diet	1 (14)	1 (14)
Frequency of medication per day		
Once	-	2 (29)
Twice	6 (86)	2 (29)
Thrice	1 (14)	-
No medication	-	3 (42)
Frequency of reducing intake of medicines		
Yes	5 (71)	1 (25)
No	2 (29)	3 (75)
Intake of vitamins/minerals supplement		
Yes	2 (29)	3 (43)
No	5 (71)	4 (57)
Intake of herbal medication to control blood sugar		
Yes	-	2 (29)
No	7 (100)	5 (71)
Frequency of checking blood sugar		
Weekly	1 (14)	-
Fortnightly	1 (14)	1 (14)
Monthly	5 (72)	6 (86)
Use of artificial sweetener		
Yes	2 (29)	3 (43)
No	5 (71)	4 (57)
Salt intake		
Restricted	2 (29)	1 (14)
Normal	5 (71)	6 (86)

Values in parentheses indicate percent

4.9.1.2 Duration of diabetes

Result depicted in Table 4.21 showed that in control group, 57 percent of the subjects were suffering from diabetes since last 10 years. Percentage of subjects suffering from diabetes since 21 and 32 years was observed as 29 and 14 percent respectively. In experimental group, 71 percent of the subject suffered from diabetes since 10 years While 29 percent of subjects had diabetes since 21 years.

4.9.1.3 Family history of diabetes

In control group 29 percent of subjects had family history of diabetes while 71 percent had no such history. In experimental group 71 percent of subjects had family history of diabetes while 29 percent showed no such history of diabetes (Table 4.21).

4.9.1.4 Any other problem

It is evident from Table 4.21 that in control group 29 percent of subjects were having problem of hypertension, 14 percent had gall stones while 57 percent had no problem. In experimental group, subjects having hypertension and other problem like spongylitis were 14 percent in each category while 71 percent of the subject did not show any problem.

4.9.1.5 Type of treatment

Data presented in Table 4.21 indicate that 86 percent of the subjects used to take oral hypoglycemic drugs (OHD) while 14 percent used to take both drug treatment and dietary restrictions in control group. In case of experimental group 43 percent subjects used to take OHD and diet restriction in each category while remaining 14 percent used to take OHD along with dietary restrictions to control blood sugar.

4.9.1.6 Frequency of medication per day

In control group 86 percent of the subjects used to consume medicines twice a day while only 14 percent consumed thrice a day. In experimental group 29 percent of subjects consumed medicines daily once and twice in each category while remaining 42 percent did not consume any medicines (Table 4.21).

4.9.1.7 Frequency of reducing intake of medicines

Among medicine users, 71 percent subjects in control group and 25 percent in experimental group sometimes used to reduce intake of medicines if their blood glucose level decreased below normal while 29 per cent and 75 percent subjects in control group and experimental group did not reduce the frequency of intake of medicines respectively (Table 4.21).

4.9.1.8 Intake of vitamins/minerals supplement

In control group 29 percent of the subjects used to consume supplements while only 71 percent did not. In experimental group only 43 percent of subjects consumed supplements while 57 percent did not (Table 4.21).

4.9.1.9 Intake of herbal medication to control blood sugar

The data pertaining in Table 4.21 revealed that in control group none of the subjects i.e. 100 per cent used to consume herbal medication to control blood sugar while in experimental group only 29 percent of subjects used to consume herbal medication like *kilmora* roots and *madhunashak* while 67 percent did not.

4.9.1.10 Frequency of checking blood sugar

Result presented in Table 4.21 clearly showed that most of the subjects i.e. 86 per cent in experimental group used to check their blood sugar monthly while 14 percent used to check blood sugar fortnightly whereas in control group 14 per

cent of subjects used to check their blood sugar weekly and fortnightly in each category whereas 72 per cent used to check monthly.

From the medical history of the subjects it can be said that large number of subjects were suffering from type 1 diabetes with family history. Most of the subjects in control group were on medication (86 percent) while some subjects were on diet restriction (50 percent) in experiment group. Most of the subjects in both control (72 percent) and experimental (100 percent) group used to check their blood sugar once in a month. Only 33 percent subjects used to take herbal medication to control their blood sugar.

4.9.1.11 Intake of nutrient per day by diabetic subjects

Data presented in Table 4.22 revealed that protein intake of control group (66.42 g/day) is higher than experimental group (60.66 g/day). The carbohydrate, fat, energy and fiber consumption by control group were 223. 53 g/day, 42.61 g/day, 1543.29 kcal/day, 19.77 g/day while by experimental group were 238.80 g/day, 47.59 g/day, 1626.15 kcal/day, 21.33 g/day. Intake of carbohydrate, fat, energy and fiber was higher in experimental than control group.

4.9.2 Anthropometry at baseline

4.9.2.1 Body Mass index (BMI)

Data on BMI of diabetics presented in Fig 4.5 and Appendix-X showed that according to BMI categorization (WHO, 2004) in control group 13 per cent of subjects were in underweight category while 29 per cent were having normal BMI. 29 per cent of subjects were under pre obese and class-1 category of obesity for each category. In experimental group 29 per cent of subjects in each category were normal; pre obese and class 1 obese while 13 per cent were in class 2 category of obesity.

Table 4.22 Intake of nutrient per day by diabetic subjects

Group	Control (n=7)	Experimental (n=7)
Carbohydrate (g)	223. 53±12.49	238.80±14.23
Protein (g)	66.42±3.55	60.66±4.78
Fat (g)	42.61±2.15	47.59±1.81
Energy (kcal)	1543.29±124.68	1626.15±141.13
Fibre (g)	19.77±1.12	21.33±1.00

Table 4.23 Waist to hip ratio classification of diabetic subjects at baseline

Waist to hip ratio Standards	Control group (n=7)		Experimental group (n=7)	
	Male	Female	Male	Female
0.80	-	-	-	1 (14)
> 0.80	-	7 (100)	-	4 (57)
<1.0	-	-	2 (29)	-

Values in parentheses indicate percent

4.9.2.2 Waist to hip ratio

Waist circumference (inches) and hip circumference (inches) of all subjects in control and experimental group were taken and their waist to hip ratio was calculated (Table 4.23).

Result showed that in control group all females i.e. 100 per cent had WHR greater than standard value of 0.80 and are more at the rest of cardiovascular complications. In case of experimental group all males i.e. 29 per cent has waist to hip ratio is less than standard value of 1 and among female only 14 per cent had normal waist to hip ratio (0.80) remaining 57 per cent females had waist to hip ratio greater than standard value of 0.80. Subjects having waist to hip ratio greater than standard value are more at the risk of diabetes and cardiovascular complications.

4.9.3 Experimental study for health benefits of *Lawki karela* juice (LK) blend and aloe vera incorporated *Lawki karela* juice blend (LKA).

Total fourteen diabetics subjects were selected and were divided into two group-control group (n=7) and experimental group (n=7). Prior to experiment, all the subjects were asked to follow their normal daily routine and to avoid fasting during experimental period i.e. 30 days. The control group was provided 150 ml of *Lawki karela* juice blend (LK) while experimental group was provided 150 ml of aloe vera incorporated *Lawki karela* aloe vera juice blend (LKA) for 30 days. Subjects were asked to consume juices just like any other drink.

4.9.3.1 Effect of control and test juice blends on alleviation of sign and symptoms of diabetes

The effect of control and test juice blends consumption on the reduction of sign and symptoms of diabetics was evaluated by post survey proforma (Appendix

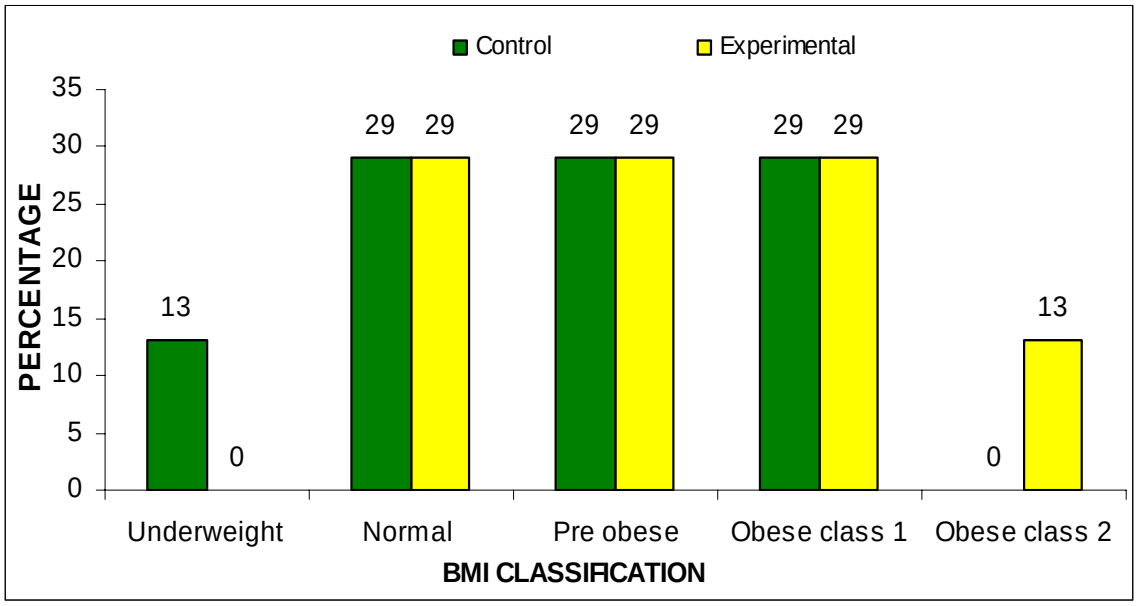


Fig. 4.6 BMI classification of diabetic subjects at baseline

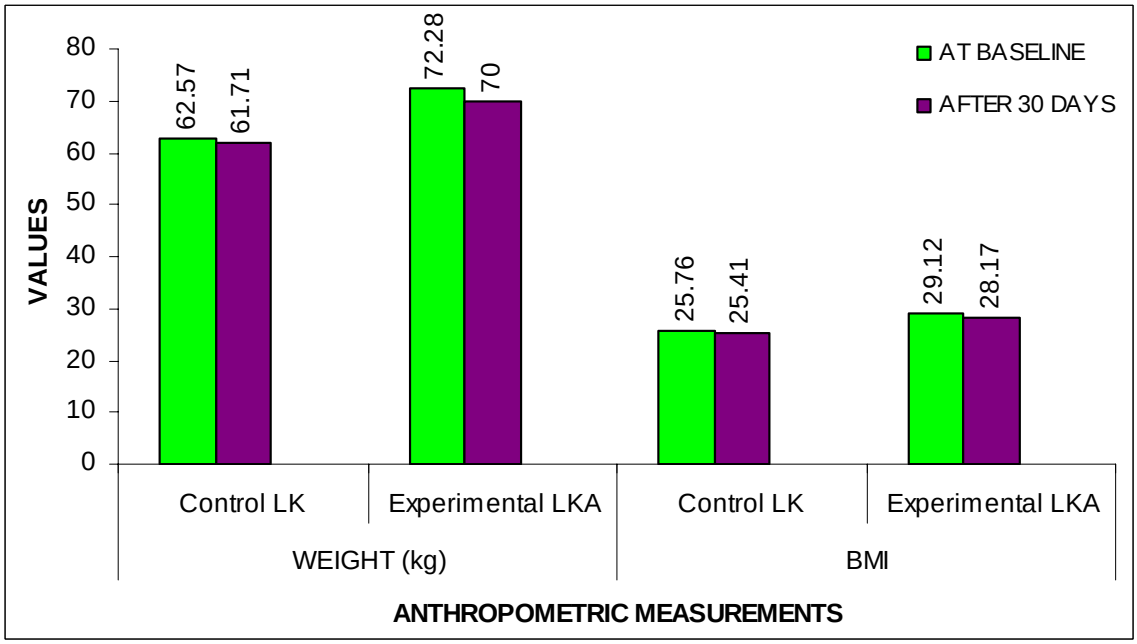


Fig 4.7 Effect of LK and LKA juice blend on weight and BMI of diabetic subjects

IV) and also by analysis of biochemical parameters like blood sugar and lipid profile at baseline and after study period of 30 days. The post survey proforma was filled up weekly i.e. after seven days for total 30 days. The information was collected on following attributes to see the effect of test juice blends. The results are presented on the basis of information obtained from the post survey proforma.

4.9.3.1.1 Found health drink

Data presented in Table 4.24 revealed that in the first week 57 per cent of control subjects found LK juice blend ineffective while only 14 per cent of experimental group found ineffective. During second week 43 per cent control group found drink satisfactory while only 57 per cent in experimental group expressed LKA juice blend satisfactory. In third and fourth week 43 per cent of control subjects found it effective in each week while 57 and 71 per cent of experimental group in third and fourth week found it effective respectively. Thus at the end of study period aloe vera incorporated LKA juice was found to be more effective than LK juice.

4.9.3.1.2 Get relief

A perusal of the data presented in Table 4.24 showed that The LK and LKA juice blend did not provide any relief to 43 per cent of control subject and 14 per cent of experimental subjects in first week of study. In second week fewer subjects in control group (43 per cent) got slight relief than subjects in experimental group (57 per cent). Gross relief was experienced by more subjects in the experimental group (57 percent) than in control group (43 per cent) in third week. In fourth week, percentage of experimental subjects getting gross relief increased to 71 percent as compared to control group i.e. 43 per cent. Thus it was observed that

both LK and LKA juice blend provide relief from symptoms of diabetes but LKA juice blend was found more effective.

4.9.3.1.3 Reduction in medicines consumption

All the control and experimental subjects in first week of study did not reduce the consumption of medicines. However the percentage of subjects who did not reduce medication decreased in second week to 86 per cent in control and 71 percent of experimental group. In third week the percentage of subjects who reduced consumption of medicines increased in both control and experimental group but more in experimental group (43 per cent) as compared to control group (29 per cent). In fourth week the percentage further increased in experimental group i.e. 57 per cent (Table 4.24).

4.9.3.1.4 Other health benefits from consuming LK and LKA juice blends

The data presented in Table 4.24 showed that all the subjects in experimental group i.e. 100 per cent and 86 per cent of subjects in control group also got other benefits from consuming LKA and LK juice blends respectively. These benefits include good digestion, no joint or muscular pain, feeling of freshness, weight reduction and lightness in body.

4.9.3.1.5 Like to continue on own

In control group 57 percent of subjects did not like to consume drink on own while 57 percent of experimental group would like to continue on own. The reason for not continuing drink on their own included lack of equipment, laborious process, lack of time especially those who are in service (Table 4.24).

4.9.3.2 Effect of LK and LKA juice blends consumption on total body weight

Fig 4.6 and Appendix-X showed that although consumption of LK juice blend by control group brought reduction (1.37 per cent) in total body weight after

Table 4.24 Effect of LK and LKA juice blends on diabetic subjects during 30 days of experimental study

Attributes	1st week		2nd week		3rd week		4th week	
	C	E	C	E	C	E	C	E
Found health drink								
Satisfactory	3 (43)	5 (72)	3 (43)	4 (57)	3 (43)	3 (43)	4 (57)	2 (29)
Effective	-	1 (14)	1 (14)		3 (43)	4 (57)	3 (43)	5 (71)
Ineffective	4 (57)	1 (14)	3 (43)	2 (29)	1 (14)	-	-	-
				1 (14)				
Get relief from symptoms of diabetes								
Grossly	1 (14)	1 (14)	1 (14)	2 (29)	3 (43)	4 (57)	3 (43)	5 (71)
Slightly	2 (29)	5 (72)	3 (43)		3 (43)	3 (43)	4 (57)	2 (29)
No	4 (57)	1 (14)	3 (43)	4 (57)	1 (14)	-	-	-
				1 (14)				
Reduce the frequency of taking medicines								
Yes	-	-	1 (14)	2 (29)	2 (29)	3 (43)	3 (43)	4 (57)
No	7 (100)	7 (100)	6 (86)		5 (71)	4 (57)	4 (57)	3 (43)
				5 (71)				

	Control group	Experimental group
Other benefits		
Yes	6 (86)	7 (100)
No	1 (14)	-
Like to continue on own		
Yes	3 (86)	4 (57)
No	4 (57)	3 (43)

C = control group (n=7)
E = experimental group (n=7)
Values in parenthesis indicate percentage

30 days but the reduction was found non significant whereas in experimental group consumption of LKA juice blend for 30 days brought significant reduction (3.22 per cent) in total body weight.

4.9.3.3 Effect of LK and LKA juice blends consumption on BMI

It is clear from the data presented in Appendix-X and Fig. 4.6 that Consumption of LKA juice blend by experimental group for 30 days brought significant reduction (3.22 per cent) in BMI i.e. from 29.12 on 0 day to 28.17 after 30 days whereas consumption of LK juice blend for 30 days by control subjects also brought reduction (1.35 per cent) in BMI but was found non significant. Significant effect of consumption of aloe vera juice for three months on BMI was reported by Arora *et al.* (2009) and stated that reduction in BMI indicates the effect of aloe vera juice administration.

4.9.3.4 Effect of LK and LKA juice blends consumption on waist to hip ratio

Consumption of LK juice and LKA juice blend by control and experimental group respectively for 30 days brought reduction in WHR but was found non significant (Appendix-X). However the reduction was slightly higher in experimental group (3.40 per cent) than in control group (1.16 per cent). Similar results were reported by Arora *et al.* (2009).

4.9.3.5 Effect of LK and LKA juice blends consumption on fasting blood sugar level

It is apparent from the Appendix-X and Fig 4.7 that in control group significant reduction in fasting blood sugar level was seen after consumption of LK juice for 30 days i.e. 194.37 to 131.41 mg/dl. Similar trend was observed in experimental group and significant reduction in fasting blood sugar level was seen

after 30 days of LKA juice consumption i.e. 192.20 to 100.61. It was further noted that percent reduction was found greater in experimental group i.e. 47.65 per cent as compared to control group i.e. 32.39 per cent. Leatherdale, *et al.* (1981) showed that raw *karela* juice improved glucose tolerance in diabetes more pronounced while a small improvement occurred with fried *karela*. Kar *et al.* (2003) reported that *karela* reduced the initial blood glucose reading of 244 mg/dl to 119 mg/dl after a single dose of 250 mg/kg dry ethanol extract for two weeks. Ahmed *et al.* (1998) suggested that oral feeding of *Karela* fruit juice might have a role in the renewal of beta cells in STZ-diabetic rats or alternately may permit the recovery of partially destroyed beta cells. Extract feeding at the level of 25mg, 50mg and 75 mg showed definite improvement in the islets of Langerhans (Singh *et al.,* 2008). Water extracts of bitter melon fruits has higher hypoglycemic and antihyperglycemic potential and may be used as complementary medicine to treat the diabetic population by significantly reducing dose of standard drugs (Yadav *et al.,* 2010). The presence of several trace elements in the aloe vera gel contribute to their hypoglycemic activity (Rajasekaran *et al.,* 2005). A reduction in blood sugar levels was found in over 90% of the cases after feeding 3000 diabetic patients aloe vera gel incorporated bread (Agarwal, 1985). Yongchaiyudha *et al.* (1996) reported oral administration of one tablespoon of aloe vera juice twice daily for 42 days vs. placebo brought decrease in blood glucose level. Yagi *et al.* (2009) found hypoglycemic effect of high molecular weight fractions of aloe vera gel on type 2 diabetic patients. Arora *et al.* (2009) showed reduction in fasting blood glucose level after feeding aloe vera juice for three months. The result of present study was found in accordance with reported investigations.

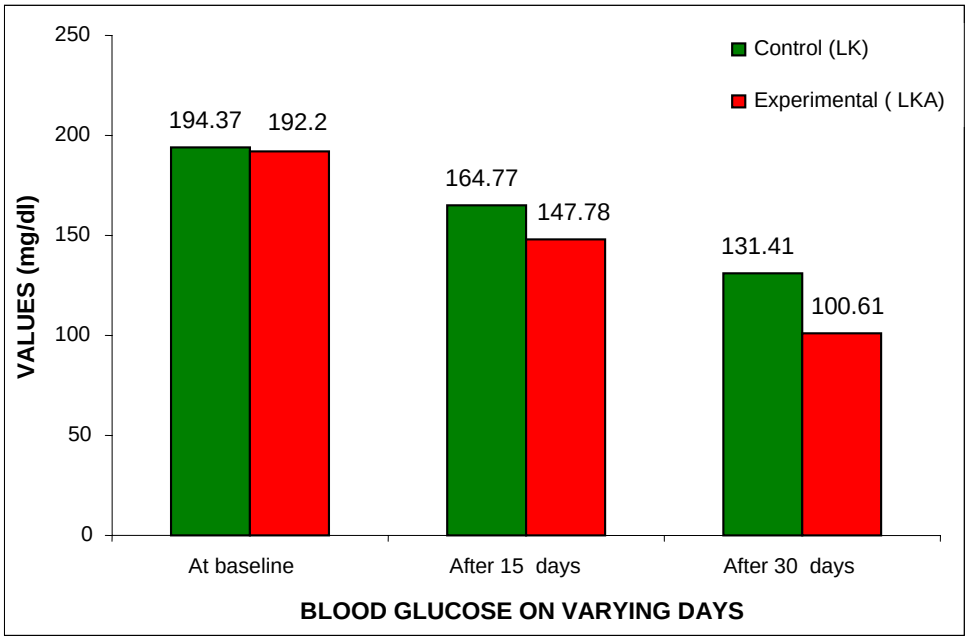


Fig. 4.8 Effect of LK and LKA juice blend on fasting blood sugar level of diabetic subjects

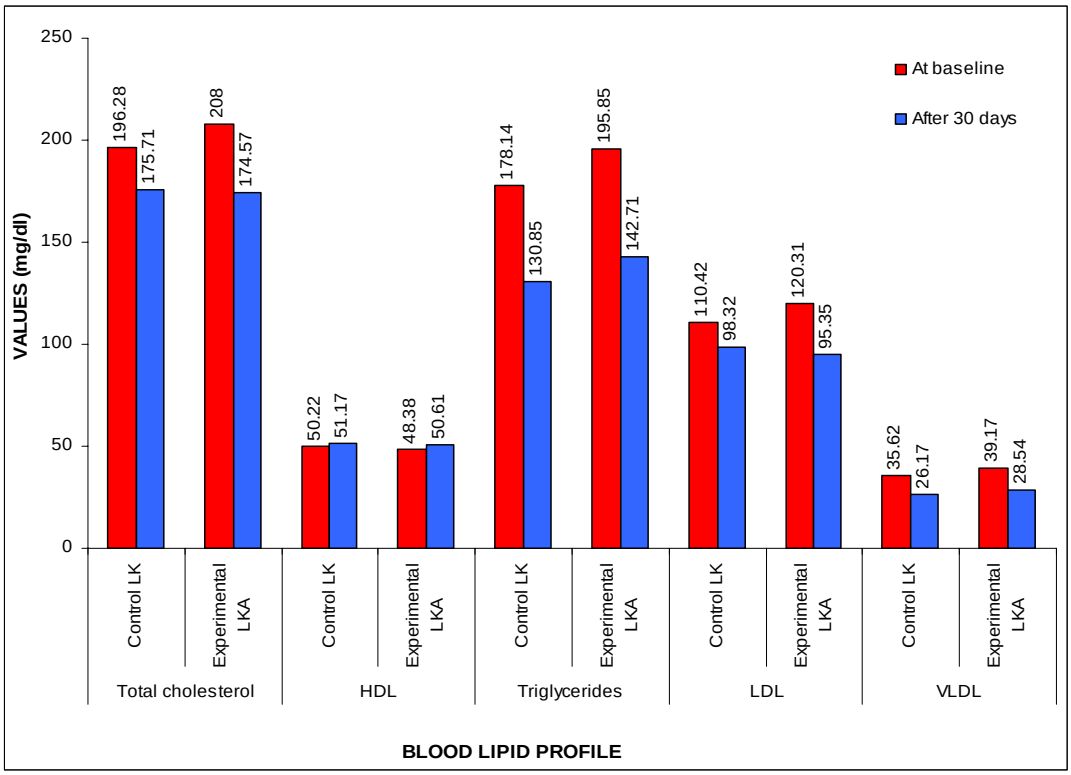


Fig. 4.9 Effect of LK and LKA juice blend on lipid profile of diabetic subjects

4.9.3.6 Effect of LK and LKA juice blends consumption on blood lipid profile

Data regarding effect of LK and LKA juice blends consumption on blood lipid profile of diabetic subjects is shown in Fig 4.8 and Appendix-X.

4.9.3.6.1 Total cholesterol level

Result showed significant reduction in total cholesterol level of both control (196.28 to 175.71) and experimental group (208 to 174.57) after consumption of LK and LKA juice respectively for 30 days. However percentage of total cholesterol reduction was found lower in control group (10.47per cent) than in experimental group (16.02 per cent).

4.9.3.6.2 HDL cholesterol

HDL cholesterol was found to increase non- significantly in control group (50.22 to 51.17) as well as in experimental group (48.38 to 50.61) after consumption of LK and LKA juice for 30 days respectively. However percentage of HDL cholesterol increment was found higher in experimental group (4.60 per cent) as compared to control group (1.89 per cent).

4.9.3.6.3 Triglycerides level

Result showed significant decrement in triglycerides level of both control (178.14 to 130.85) and experimental (195.85 to 142.71) group after consumption of LK and LKA juice respectively for 30 days. However the percentage of triglycerides level reduction was found higher in experimental group (27.13) than in control group (26.54).

4.9.3.6.4 LDL cholesterol

The LDL level of control group dropped significantly to 98.32 from 110.42 after consumption of LK juice blend for 30 days. Similar result was observed in

experimental group in which also LDL level decreased significantly to 95.35 from 120.31 after consumption of aloe vera incorporated LKA juice blend for 30 days. However the rate of reduction was found higher in experimental group i.e. 20.74 than in control group i.e. 10.95.

4.9.3.6.5 VLDL cholesterol

The VLDL level of both control (35.62 to 26.17) and experimental group (39.17 to 28.14) was found to decrease significantly after consumption of LK and LKA juice blend respectively for 30 days. However the percentage of VLDL reduction was found lower in control group i.e. 26.53 per cent as compared to experimental group i.e. 27.13 per cent.

4.9.3.6.6 TC/HDL ratio

The total cholesterol to HDL cholesterol ratio is a number that is helpful in predicting an individual's risk of developing atherosclerosis. The number is obtained by dividing the total cholesterol value by the value of the HDL cholesterol. High ratios indicate higher risks of heart attacks, low ratios indicate lower risk. In control group and experimental group TC/HDL ratio was found to decrease non- significantly after consumption of LK and LKA juice blend for 30 days. However the reduction was found more in experimental group i.e. 19.11 than in control group i.e. 15.36.

4.9.3.6.7 LDL/HDL ratio

The LDL/HDL ratio is more important ratio than total cholesterol/HDL because LDL is a measure of bad cholesterol and HDL is a measure of good cholesterol whereas the total cholesterol is the sum of HDL, LDL, and the VLDL. The LDL/HDL ratio of control group was to decrease non significantly while in

experimental group it was found to decrease significantly from 2.54 to 1.95 after consumption of LK and LKA juice respectively for 30 days. However the reduction was found higher in experimental group i.e. 24.19 than in control group i.e. 10.00.

Ahmed *et al.* (2001); Chaturvedi *et al.* (2004); Senanayake *et al.* (2004); Chaturvedi *et al.* (2005), Chen *et al.* (2005) and Kumar *et al.* (2010) reported decreases in triglycerides and LDL cholesterol and increases in HDL cholesterol due to bitter gourd consumption. Ghule *et al.* (2006), Deshpande *et al.* (2008). Mohale *et al.* (2008) and Saoji *et al.* (2009) showed improvement in lipid profile of diabetic subjects. Hart *et al.* (1989) and Arora *et al.* (2009) reported significant reduction in total cholesterol, triglycerides, LDL, VLDL and significant increment in HDL cholesterol after oral administration of 150 ml of aloe vera juice for 3 months to diabetic patients (Arora *et al.,* 2009). Various investigators also supported the anti-hyperlipidaemiac activity of aloe vera (Dixit and Joshi, 1983; Agarwal, 1985; Bunyapraphatsara *et al.,* 1996; Rajeskaran *et al.,* 2001 and Rajeskaran *et al.,* 2006).

4.10 Evaluation of therapeutic value of carrot-orange (CO) and carrot-orange- aloe vera (COA) juice blends in constipated patients

4.10.1 Medical history of constipated patients

4.10.1.1 Type of constipation

Data presented in Table 4.25 revealed that in both control and experimental group, 70 per cent of the subjects were found to have problem of constipation regularly while 30 per cent had irregular constipation and occasionally suffer from constipation (Fig. 4.25)

Table 4.25 Medical history of constipated subjects

Attributes	Control (n=10)	Experimental (n=10)
MEDICAL HISTORY		
Types of constipation		
Regular	7 (70)	7 (70)
Irregular	3 (30)	3 (30)
Duration		
0-10 yrs	5 (50)	6 (60)
11-21 yrs	2 (20)	3 (30)
22-32 yrs	2 (20)	-
33-43 yrs	-	-
44-54 yrs	1 (10)	1 (10)
Family history		
Yes	2 (20)	6 (60)
No	8 (80)	4 (40)
Any other problem		
Hypertension	2 (20)	1 (10)
Kidney problem	1 (10)	-
Eye	-	1 (10)
Any other	5 (50)	1 (10)
No	2 (20)	7 (70)
Associated complaints		
Flatulence + Indigestion	1 (10)	-
Indigestion	2 (20)	1 (10)
Flatulence + headache + felt heavy	1 (10)	-
Coated tongue + headache + felt heavy + indigestion	1 (10)	-
Felt heavy + lack of appetite	1 (10)	1 (10)
Flatulence + Indigestion + lack of appetite	2 (20)	-
Flatulence + coated tongue + felt heavy	1 (10)	-
Flatulence + felt heavy + lack of appetite	1 (10)	-
Flatulence + felt heavy	-	1 (10)
Coated tongue + lack of appetite	-	1 (10)
Headache + felt heavy	-	1 (10)
Flatulence+coated tongue+felt heavy + lack of appetite	-	1 (10)
	-	2 (20)
Flatulence + bad breath + indigestion	-	1 (10)
Headache + felt heavy + lack of appetite	-	1 (10)
Felt heavy + lack of appetite		
Elimination complaints		
Painful bowl movement + foul smelling stool	2 (20)	-
Painful bowl movement	2 (20)	4 (40)
Painful bowl movement+ alternating diarrhea and constipation	3 (30)	1 (10)
Foul smelling stool + alternating diarrhea and constipation	1 (10)	1 (10)
Mucous in stool + Painful bowl movement	2 (20)	1 (10)
Painful bowl movement+ alternating diarrhea and constipation + foul smelling stool	-	1 (10)
Alternating diarrhea and constipation	-	1 (10)
Mucous in stool + Alternating diarrhea and	-	1 (10)

constipation		
Feel the need to have bowl movement but not able to		
Yes	6 (60)	10 (100)
No	4 (40)	-
Strain during bowl movement		
Yes	3 (30)	10 (100)
No	7 (70)	-
Incomplete emptying sensation		
Yes	9 (90)	10 (100)
No	1 (10)	-
Frequency of passing stool		
Twice in morning	2 (20)	1 (10)
Thrice in morning	1 (10)	-
Once a day	4 (40)	5 (50)
Alternate day	3 (30)	4 (40)
Consistency of stool		
Soft	2 (20)	-
Hard	3 (30)	6 (60)
Thin	1 (10)	-
Lumpy	4 (40)	2 (20)
Hard + Lumpy	-	2 (20)
Use of laxatives to get relief from constipation		
Yes	10 (100)	10 (100)
No	-	-
Kinds of laxatives		
Drugs	1 (10)	2 (20)
Isabgol	5 (50)	1 (10)
Syrups	1 (10)	-
Churans	3 (30)	3 (30)
Isabgol + Churans	-	4 (40)
Frequency of taking laxatives		
Daily	4 (40)	8 (80)
Alternate day	3 (30)	1 (10)
Once a week	2 (20)	1 (10)
As per need	1 (10)	-

Values in parentheses indicate percent

4.10.1.2 Duration of constipation

Results depicted in Table 4.25 showed that in control group, 50 per cent of the subjects were suffering from constipation since last 10 years. Percentage of subjects suffering from constipation since 21 and 33 years was observed as 20 per cent for both the categories. Only 10 per cent of subjects suffered from constipation since 54 years. In experimental group, 60 per cent of the subjects suffered from constipation since 10 years. While 30 per cent of subjects had constipation since 21 years. Only 10 per cent of the subjects suffered from constipation since 54 years.

4.10.1.3 Family history of constipation

In control group 20 per cent of subjects had family history of constipation while 80 per cent had no such history. In experimental group 60 per cent of subjects had family history of constipation while 40 per cent showed no such history of constipation (Table 4.25).

4.10.1.4 Any other problem

Data shown in Table 4.25 exhibited that in control group 20 per cent of subjects were having problem of hypertension, 10 per cent having Kidney problem and 20 per cent had no problem while 50 per cent of subjects had other problems like hypothyroid, arthritis, low blood pressure and gall stones. In experimental group, subjects having hypertension, eye problem and other problem like backache were 10 per cent in each of the three categories while 70 per cent of the subjects showed no such problem.

4.10.1.5 Associated complaints

Hundred per cent of subjects in control group had following some or other associated complaints along with the problem of constipation (Table 4.25).

- Flatulence and indigestion-10 per cent of the subjects
- Indigestion-20 per cent of the subjects'
- Flatulence + Headache and felt heavy = 10 per cent of the subjects
- Coated tongue +headache + felt heavy +indigestion= 10 per cent of the subjects.
- Felt heavy + lack of appetite-10 per cent of the subjects
- Flatulence+ indigestion + lack of appetite =20 per cent of the subjects
- Flatulence + coated tongue + felt heavy=10 per cent of the subjects
- Flatulence+ felt heavy + lack of appetite = 10 per cent of the subjects
- In experimental group too, 100 per cent of subjects had following some or other associated complaints along with the problem of constipation.
- Indigestion-10 per cent of the subjects
- Felt heavy + lack of appetite – 10 per cent of the subjects
- Flatulence + felt heavy-10 per cent of the subjects
- Coated tongue + lack of appetite-10 per cent of the subjects
- Headache + felt heavy-10 per cent of the subjects.
- Flatulence+coated tongue+felt heavy+lack of apetite-10 per cent of the subjects
- Flatulence + bad breath + indigestion-20 per cent of the subjects
- Headache + felt heavy + lack of appetite-10 per cent of the subjects.
- Felt heavy + lack of appetite-10 per cent of the subjects.

4.10.1.6 Elimination complaints

Subjects of both control and experimental group reported elimination complaints associated with constipation. (Table 4.25). The control group had following elimination complaints.

- Painful bowl movement and foul smelling stool-20 per cent of subjects
- Painful bowl movement-20 per cent of subjects
- Painful bowl movement +alternating diarrhoea and constipation-30 per cent of the subjects.
- Fowl smelling stool + alternating diarrhoea and constipation-10 per cent of the subjects.
- Mucous in stool + painful bowl movement-20 per cent of the subjects.
- The experimental group showed the following elimination complaints:
- Painful bowl movement-40 per cent of the subjects
- Painful bowl movement + alternating diarrhoea and constipation-10 per cent of the subjects
- Foul smelling stool with alternating diarrhoea and constipation-10 per cent of the subjects
- Mucous in stool + Painful bowl movement- 10 per cent of the subjects
- Painful bowl movement+ alternating diarrhea and constipation + foul smelling stool -10 per cent of the subjects.
- Alternating diarrhoea and constipation – 10 per cent of the subjects
- Mucous in stool + alternating diarrhoea and constipation -10 per cent of subjects.

4.10.1.7 Feel the need to have bowl movement but not able to

Data pertaining in Table 4.25 reflected that in control group 60 per cent of the subjects felt the need to have bowl movement but not able to do while 40 per cent subjects reported no such problem while in experimental group 100 per cent subjects reported the problem associated with bowl movement.

4.10.1.8 Strain during bowl movement

The data depicted in Table 4.25 showed that 30 per cent subjects strained during bowl movement while 70 per cent did not strain during bowl movement in control group. In experimental group all the subject (100 per cent) strained during bowl movement.

4.10.1.9 Incomplete emptying sensation

It is clear from Table 4.25 that in experimental group 100 per cent subjects had incomplete emptying sensation after bowl movement. In control group 90 per cent subjects had such problem while 10 per cent had no such incomplete emptying sensation.

4.10.1.10 Frequency of passing stool

Table 4.25 revealed that twenty per cent of the subjects in the control group had frequency of passing stool twice in a day especially in the morning while only 10 per cent passed stool thrice in morning. Percentage of subjects passing stool once a day and on alternate day was observed as 40 per cent and 30 per cent respectively. In experimental group, percentage of subjects passing stool twice in the morning was found as 10 per cent while 50 per cent and 40 per cent subjects used to pass stool once a day and alternate day respectively.

4.10.1.11 Consistency of stool

It is evident from Table 4.25 that in experimental group 60 per cent of subjects used to pass stool of hard consistency, 20 per cent of lumpy consistency while 20 per cent passed both hard and lumpy stool. In control group 40 per cent of subjects used to pass lumpy stool while soft and thin consistency stool was passed by 20 and 10 per cent subjects respectively. Percentage of subjects passing hard stool was found to be 30 per cent.

4.10.1.12 Types of laxatives tried to get relief

Data presented in Table 4.25 showed that all the subjects (100 per cent) in both control and experimental group tried different types of laxatives to get relief from constipation. In control group, 50 per cent of subjects tried *isabgols* while 30 per cent used *churans.* Subjects using drugs and syrups for getting relief from constipation were 10 per cent in both the categories. In experimental group, 40 per cent subjects tried both *isabgol and churans* for getting relief from constipation while 30 per cent used to consume *churans.* Subjects consuming drugs and *isabgols* for getting relief from constipation were 20 per cent and 10 per cent respectively.

4.10.1.13 Frequency of consuming laxatives

In control group 40 per cent of the subjects used to consume laxative daily while only 10 per cent consumed laxatives as per the need. Subjects consuming laxatives on alternate day and once a week were observed as 30 per cent and 20 per cent respectively. In experimental group 80 per cent of subjects consumed laxatives daily while subjects consuming laxative once a week and on alternate day were 10 per cent for both the categories (Table 4.25).

From the medical history of the subjects it can be said that the problem of constipation was regular in large number of subjects with associated and elimination complaints. The frequency of passing stool in control group (40 per cent) was once in a day. Most of the subjects in experimental group (60 per cent) had hard consistency of stool while in control group there were 30 per cent of subjects who passed hard consistency stool. Croffie (2006) and Thomson *et al.* (1991) defined constipation by a variety of symptoms including need for excessive

straining, hard stool, unsuccessful defecation abdominal discomfort and a sense of incomplete bowel evacuation. It is accompanied by headache, coated tongue foul breath and lack of appetite.

4.10.1.14 Intake of nutrient per day by constipated subjects

Data presented in Table 4.26 revealed that fat intake of control group (42.63 g/day) is slightly higher than experimental group (41.68 g/day). The carbohydrate, protein, energy and fiber consumption by control group were 348.67 g/day, 104.33 g/day, 2195.67 kcal/day, 22.58 g/day while by experimental group were 369.54 g/day, 107.59 g/day, 2283.64 kcal/day, 23.86 g/day. Intake of carbohydrate, protein, energy and fiber was higher in experimental than control group.

4.10.2 Anthropometric measurement of constipated subjects at baseline

4.10.2.1 Baseline Body Mass index (BMI)

Body mass index is a sex independent method used for determining overweight and obesity in adults. Body mass index is a calculation that divides a persons weight in kilogram by height in meters squared (BMI = kg/m^2). Weight and height of all subjects in both control and experimental group were taken and their body mass index was calculated (Appendix-XI).

Fig 4.9 showed that according to Body Mass Index categorization (WHO, 2004), in control group 40 per cent of subjects were in pre-obese category white only 20 per cent were having normal BMI. Thirty per cent and 10 per cent subjects were under class-1 and class-2 category of obesity respectively. In experimental group 60 per cent of subjects were in pre-obese category while 30 per cent were in class 1 category of obesity. Only 10 per cent of subjects were having normal body mass index.

Table 4.26 Intake of nutrients per day by constipated subjects

Group	Control	Experimental
Carbohydrate (g)	348.67±28.73	369.54±46.92
Protein (g)	104.33±2.50	107.59±3.12
Fat (g)	42.63±3.24	41.68±3.57
Energy (kcal)	2195.67±134.68	2283.64±149.55
Fibre (g)	22.58±1.57	23.86±1.43

Table 4.27 Baseline waist to hip ratio (WHR) of constipated subjects

Waist to hip ratio Standards	Control group		Experimental group	
	Male	Female	Male	Female
0.80-< 0.80	-	-	-	2 (20)
> 0.80	5 (50)	5 (50)	-	5 (50)
1.0	-	-	-	-
> 1.0	-	-	3 (30)	-

* Values in parentheses indicate percent

4.10.2.2 Waist to hip circumference ratio (WHR)

The waist to hip circumference ratio is a simple method for describing the distribution of both subcutaneous and inter abdominal adipose tissue (Gibson, 1990). Waist circumference and hip circumference of all subjects in control and experimental groups were taken and their waist to hip ratio was calculated (Table 4.27).

Data showed that in control group all females (50 per cent) had WHR greater than standard value of 0.80 and were at the risk of cardiovascular complications while all males (50 per cent) had waist to hip ratio less than standard value of 1.0.

In case of experimental group all males i.e. 30 per cent has waist to hip ratio greater than standard value of 1.0 and out of 70 per cent female only 20 per cent had normal waist to hip ratio remaining 60 per cent females had waist to hip ratio greater than 0.80. Data showed that subjects having waist to hip ratio greater than standard value were more at the risk of diabetes and cardiovascular complications.

4.10.3 Experimental study for health benefits of carrot orange (CO)aloe vera incorporated carrot orange juice blend (COA).

Total twenty constipated subjects were selected and were divided equally into two group-control group (n=10) and experimental group (n=10). Prior to experiment, all the subjects were asked to follow their normal daily routine and to avoid fasting during experimental period i.e. 30 days. The control group was provided 150 ml of carrot orange (CO) juice blend while experimental group was provided 150 ml of aloe vera incorporated carrot orange aloe vera (COA) juice blend for 30 days. Subjects were asked to consume juices just like any other drink.

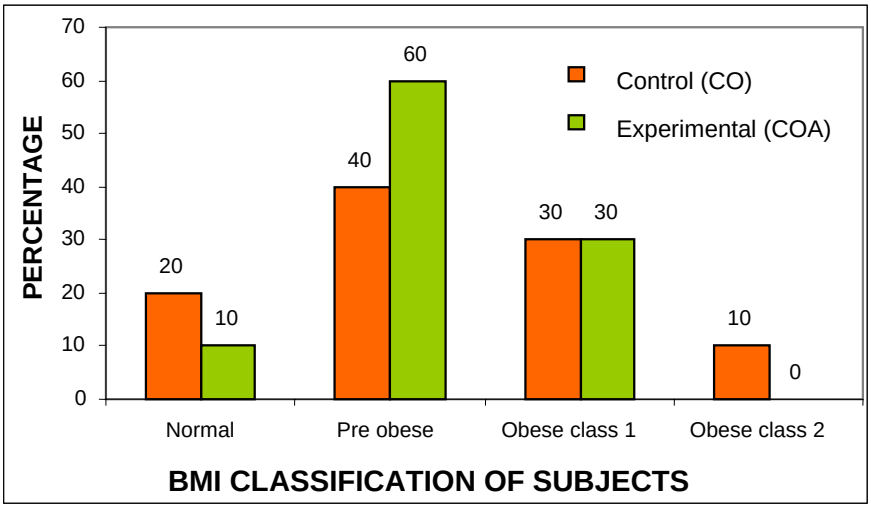


Fig. 4.10 Baseline Body Mass Index (BMI) of constipated subjects

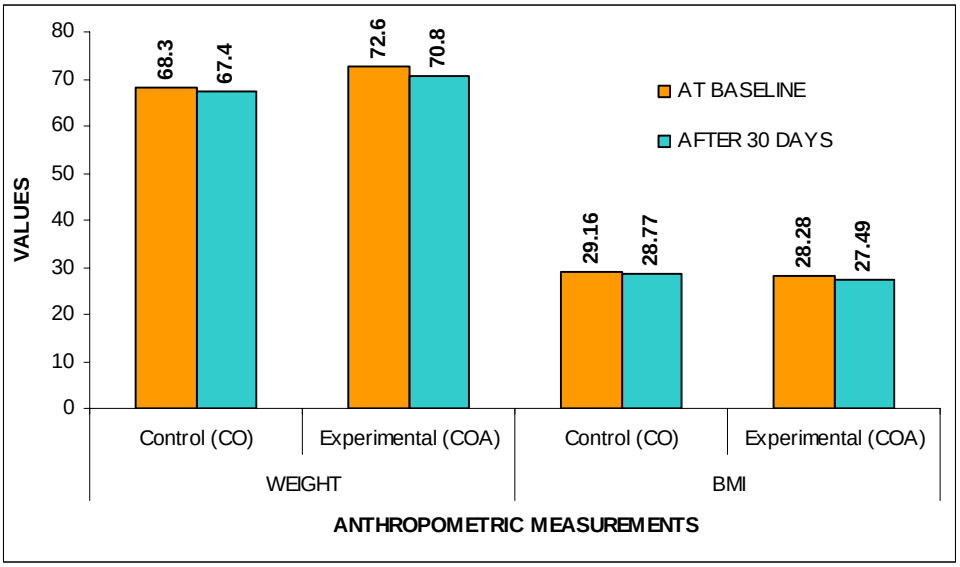


Fig 4.11 Effect of CO juice and COA juice blend on weight and BMI of constipated subjects

4.10.3.1 Effect of CO juice and COA juice blends on alleviation of sign and symptoms of constipation

The effect of test juice blends consumption on the reduction of signs and symptoms of constipation was evaluated by post survey proforma (Appendix V). The post survey proforma was filled up weekly for total 30 days. The information was collected on following parameters to see the effect of test juice blends. The results are presented in Table 4.28 (a) and Table 4.28 (b) on the basis of information obtained from the post survey proforma.

4.10.3.1.1 Found health drink

Data revealed that in the first week 90 per cent of subjects in control group found CO juice blend ineffective while 60 per cent of experimental group found COA juice blend satisfactory. During second week 60 per cent control group found drink ineffective while 80 per cent expressed its effectiveness. In third and fourth week 10 per cent and 30 per cent control found it effective respectively while 90 per cent of subjects in experimental group each found it effective in each third and fourth week. Thus at the end of study period aloe vera incorporated COA juice blend was found to be more effective than CO juice (Table 4.28 a).

4.10.3.1.2 Get relief

The CO juice blend did not provide any relief to 90 per cent and 70 per cent subjects during first and second week of study respectively whereas 50 per cent of subjects in experimental group got slight relief in first week and 70 per cent got gross relief in the second week. Only 10per cent and 50per cent of subjects in control group got slight relief a during third and fourth week respectively while subjects in the experimental group got gross relief during third (80per cent) and fourth (90per cent) week (Table 4.28 a).

Table 4.28 (a) Effect of carrot – Orange (CO) juice and Carrot-Orange-Aloe vera (COA) juice blends on alleviating sign and symptoms of constipated subjects

Attributes	1st week		2nd week		3rd week		4th week	
	C	E	C	E	C	E	C	E
Found health drink								
Satisfactory	1 (10)	6 (60)	3 (30)	1 (10)	8 (80)	1 (10	7 (70)	1 (1)
Effective	-	3 (30)	1 (10)	8 (80)	1 (10)	9 (90)	3 (30)	9 (90)
Ineffective	9 (90)	1 (10)	6 (60)	1 (10)	1 (10)	-	-	-
Get relief								
Grossly	-	2 (20)	1(10)	7 (70)	1 (10)	8 (80)	5 (50)	9 (90)
Slightly	1 (10)	5 (50)	3 (30)	2 (20)	6 (60)	1 (10)	5 (50)	1 (10)
No	9 (90)	3 (30)	7 (70)	1 (10)	3 (30)	1 (10)	-	-
Feel the need for bowl movement but not able to								
Grossly	8 (80)	2 (20)	7 (70)	1 (10)	2 (20)	-	-	-
Slightly	1 (10)	5 50)	1 (10)	2 (20)	5 (50)	3 (30)	2 (20)	1 (10)
No	1 (10)	3 30)	2 (20)	7 (70)	3 (30)	7 (70)	8 (80)	9 (90)
Strained during bowl movement								
Grossly	9 (90)	3 (30	7 (70)	1 (10)	1 (10)	-	-	-
Slightly	1 (10)	4 (40)	2 (20)	2 (20)	7 (70)	1 (10)	6 (60)	-
No	-	3 (30)	1 (10)	7 (70)	2 (20)	9 (90)	4 (40)	10 (100)
Incomplete emptying sensation felt								
Grossly	9 (90)	1 (10)	8 (80)	-	3 (30)	-	-	-
Slightly	1 (10)	4 (40)	1 (10)	3 (30)	6 (60)	1 (10)	5 (50)	1 (10)
No	-	5 (50)	1 (10)	7 (70)	1 (10)	9 (90)	5 (50)	9 (90)
Frequency of passing stool reduced								
Grossly	-	3 (30)	1 (10)	7 (70)	1 (10)	9 (90)	4 (40)	9 (90)
Slightly	1 (10)	4 (40)	2 (20)	3 (30)	7 (70)	1 (10)	6 (60)	1 (10)
No	9 (90)	3 (30)	7 (70)	-	2 (20)	-	-	-
laxative consumption reduced								
Grossly	-	1 (10)	1 (10)	7 (70)	1 (10)	9 (90)	4 (40)	9 (90)
Slightly	1 (10)	7 (70)	-	3 (30)	6 (60)	1 (10)	5 (50)	1 (10)
No	9 (90)	2 (20)	9 (90)	-	3 (30)	-	1 (10)	-

Values in parentheses indicate percent

4.10.3.1.3 Felt the need for bowl movement but not able to

Table 4.28 (a) showed that 80 per cent of control subjects and 20 per cent of experimental group subjects grossly felt the need for bowl movement but not able to during first week of study. The percentage decreased during the second week of study as 70 per cent of control group and 10 per cent of experimental group grossly felt the need for bowl movement but not able to do. During third week 50 per cent of control group subjects and 30per cent of experimental group subjects slightly felt the need for bowl movement but not able to do. In the last week high percentage of both control and experimental group i.e. 80 per cent and 90 per cent respectively did not feel the need for bowl movement and got marked relief.

4.10.3.1.4 Strained during bowl movement

During first week, 90per cent of control subjects and 30per cent of experimental subjects grossly strained during bowl movement. In the next week the percentage decreased to 70per cent and 10per cent in control and experimental group respectively. The control group was on higher side of problem. During third week 70per cent of control and 10per cent of experimental subjects slightly strained during bowl movement. In fourth week only 40per cent of control group subjects did not feel to strain during bowl movement while all subjects (100per cent) in experimental group did not strain during bowl movement (Table 4.28 a).

4.10.3.1.5 Incomplete emptying sensation felt

Ninety per cent of subjects in the control group and 10per cent in the experimental group grossly felt incomplete emptying sensation during first week of study. The percentage reduced in second week where 80per cent of control

group subjects grossly felt while no one in experimental group grossly felt incomplete emptying sensation in second week. In third week 60 per cent of control group subjects and 10 per cent of experimental group slightly felt incomplete emptying sensation. At the end of study period 50 per cent of control and 90per cent of experimental subjects did not feel incomplete emptying sensation after bowl movement. So it is seen that COA juice blend was more effective in providing relief from incomplete emptying sensation after the bowl movement (Table 4.28 a).

4.10.3.1.6 Reducing frequency of passing stool

It is evident from Table 4.28 (a) the frequency of passing stool did not reduce in 90per cent of control group subjects and 30per cent of experimental subjects in first week of study. 20per cent of control subjects and 30per cent of experimental subjects showed slight reduction in frequency of passing stool in second week. In third and fourth week 10per cent and 40per cent of control subjects showed gross reduction in the frequency of passing stool respectively. While in experimental group 90per cent of subjects showed gross reduction in the frequency of passing stool in both third and fourth week.

4.10.3.1.7 Reduction in laxative consumption

Ninety per cent of control subjects in first and second week of study did not reduce the consumption of laxatives. However during third week 60per cent of control subjects slightly reduced the consumption of laxatives. The percentage of control subjects who grossly reduced the consumption of laxatives increased to 40per cent. In comparison to control group. 70per cent of experimental subjects slightly reduced the consumption of laxatives in first week of study. The

Table 4.28 (b) Effect of carrot – Orange (CO) juice and Carrot-Orange-Aloe vera (COA) juice blends on alleviating sign and symptoms of constipated subjects

Attributes	1st week		2nd week		3rd week		4th week	
	C	E	C	E	C	E	C	E
Consistency of stool								
Soft	-	2 (20)	1 (10)	4 (40)	1 (10)	7 (70)	5 (50)	10(100)
Hard	9(90)	1 (10)	9 (90)	-	2 (20)	-	-	-
Thin	-	3 (30)	-	2 (20)	1 (10)	2 (20)	1 (10)	-
Lumpy	1(10)	4 (40)	-	4 (40)	6 (60)	1 (10)	4 (40)	-
Bowl habit								
Regular	1(10)	7 (70)	2 (20)	10(100)	2 (20)	10(100)	4 (40)	10(100)
Irregular	9(90)	3 (30)	8 (80)	-	8 (80)	-	6 (60)	-
Elimination complaints								
Painful bowl movement + foul smelling stool	1(10)	-	1 (10)	-	1 (10)	-	-	-
Mucous in stool	1(10)	-	1 (10)	-	-	-	-	-
Painful bowl movement	2(20)	1 (10)	2 (20)	-	5 (50)	-	4 (40)	-
Alternating diarrhea & constipation	1(10)	1 (10)	1 (10)	-	2 (20)	-	1 (10)	-
Alternating diarrhea & constipation + foul smelling stool	1(10)	2 (20)	1 (10)	-	-	-	-	-
Alternating diarrhea & constipation+Painful bowl movement	3(30)	-	3 (30)	-	-	-	-	-
Mucous in stool + Painful bowl movement	1(10)	-	1 (10)	-	-	-	-	-
Foul smelling stool	-	-	-	1 (10)	1 (10)	-	-	-
No complaints	-	6 (60)	-	9 (90)	1 (10)	10(100)	5 (50)	10 (100)

Table 4.28 (b) Contd…

Attributes	1st week		2nd week		3rd week		4th week	
	C	E	C	E	C	E	C	E
Associated complaints								
Flatulence	1(10)	1 (10)	-	1 (10)	1 (10)	-	1 (10)	-
Felt heavy	-	-	1 (10)	-	2 (20)	-	1 (10)	-
Indigestion	2(20)	1 (10)	2 (20)	-	2 (20)	-	2 (20)	-
Felt heavy + lack of appetite	1(10)	1 (10)	1 (10)	-	-	-	-	-
Coated tongue + headache + felt heavy	1(10)	-	1 (10)	-	-	-	-	-
Flatulence + Indigestion	2(20)	1 (10)	2 (20)	-	-	-	-	-
Flatulence + coated tongue + felt heavy	1(10)	-	1 (10)	-	-	-	-	-
Flatulence + felt heavy	1(10)	-	-	-	1 (10)	-	-	-
Flatulence + felt heavy + indigestion + lack of appetite	1(10)	-	-	-	-	-	-	-
Flatulence + felt heavy+ indigestion	-	-	1 (10)	-	-	-	-	-
Coated tongue	-	1 (10)	-	-	1 (10)	-	-	-
Flatulence + bad breath	-	1 (10)	-	-	-	-	-	-
Indigestion + lack of Appetite	-	1 (10)	-	-	-	-	-	-
Lack of appetite	-	-	-	2 (20)	-	-	-	-
No	-	3 (30)	1 (10)	7 (70)	3 (30)	10(100)	6 (60)	10(100)

Would like to continue drink on own		
	Control	Experimental
Yes	5 (50)	8 (80)
No	5 (50)	2 (20)

Values in parentheses indicate percent

percentage of subjects further reduced to 30per cent in second week of study. In third and fourth week of study 90per cent of subjects grossly reduced the consumption of laxatives. Thus COA juice was found to be more effective in reducing laxative consumption as compared to CO juice blend as the period of study progressed (Table 4.28 a).

4.10.3.1.8 Consistency of stool

Data presented in Table 4.28 (b) showed that in the first and second week of study 90per cent of control subjects passed hard stool while 40per cent of experimental subjects passed lumpy stool. In third week only 10per cent of control subjects and seventy per cent of experimental subjects passed stool of soft consistency. In fourth week all the subjects in experimental group (100per cent) passed soft stool while 50per cent of control group subjects passed stool of soft consistency.

4.10.3.1.9 Bowl habit

The bowl habit of 90 per cent of control subjects and 30per cent of experimental subjects were found to be irregular. The percentage of control subjects having irregular bowl habit reduced to 80 per cent in second week and remained constant in third week. However the percentage of control subjects having irregular bowl habit further reduced to 60 per cent in fourth week. On the other hand in case of experimental group, all the subjects had regular bowl habit from second week till the end of study period (Table 4.28 b).

4.10.3.1.10 Elimination complaints

Table 4.28 (b) revealed that in first and second week of study, all the subjects in control group showed one or more elimination complaints while only

60 per cent in experimental group showed no elimination complaints in first week. The percentage of subjects showing no complaints in experimental group further increased to 90per cent in second week. In third week, 50per cent of control group subjects had one or more elimination complaints while all the subjects in experimental group showed no elimination complaints in third and fourth week of study.

4.10.3.1.11 Associated complaints

Data given in Table 4.28 (b) showed that during first week of study only 30per cent of experimental subjects showed no associated complaints while all the subjects in control group (100per cent) showed the complaints. In second week more percentage of subjects showed no associated complaints. The percentage was found to be higher in experimental group than in control group (10per cent). In third and fourth week 30per cent and 60per cent subjects showed no associated complaints respectively while in experimental group all subjects (100per cent) showed no associated complaints in third and fourth week.

4.10.3.1.12 Would like to continue

In control group 50 per cent of subjects stated that they would like to continue while 50per cent did not while in experimental group 80per cent of subjects liked to continue juice blend on their own while 20per cent did not. The reasons for not continuing on their own were shortage of time; extraction of juice and then cleaning of equipment (a tedious job) and some subjects did not have juicer for extraction of juice. A few subjects who wanted to continue to continue the consumption of juices on their own even planted aloe vera plant in their gardens.

4.10.3.2 Effect of CO and COA juice blend consumption on anthropometric measurements

Data regarding effect of CO and COA juice blend consumption on anthropometric measurements is shown in Fig 4.10 and Appendix XII.

4.10.3.2.1 Total body weight.

Results (Fig 4.10) showed that mean body weight of subjects in both control and experimental group was found to be decreased significantly after 30 days of CO and COA juice consumption by control and experimental group respectively. However more pronounced reduction was seen in experimental group (2.47per cent) as compared to control group (1.31per cent). Rolls *et al.* (2004) concluded that fruits and vegetables consumption does play a role in weight management because of their high fiber content that decreases energy intake and promote satiety.

4.10.3.2.2 Body Mass Index (BMI).

Result showed (Fig 4.10) that with decrease in weight, the BMI of both control and experimental subjects decreased significantly after consuming CO and COA juice blend for a period of 30 days respectively. The rate of reduction was found more prominent in experimental group (2.70per cent) than in control group (1.33per cent) i.e. twice of control group.

4.10.3.2.3 Waist to hip ratio (WHR).

Fig 4.10 showed that although control group showed reduction in body weight no significant difference was observed in waist to hip ratio after consuming CO juice blend for 30 days. However, experimental group showed significant reduction in waist to hip ratio after consuming COA juice blend for 30 days.

4.11 Evaluation of therapeutic value of AG juice and AGA juice blend in hypertensive subjects

4.11.1 Medical history of hypertensive patients

4.11.1.1 Type of hypertension

All the subjects in control group i.e. 100 per cent had primary hypertension while in experimental group, 75 percent of subjects were found to have primary hypertension and 25 per cent had secondary hypertension which was developed during pregnancy and after an accident (Table 4.29)

4.11.1.2 Duration of hypertension

Result depicted in Table 4.29 showed that in control group, 50 percent of the subjects were suffering from hypertension since last 5 years. Percentage of subjects suffering from hypertension since 11 and 17 years was observed as 25 percent in each category. In experimental group, 74 percent of the subject suffered from hypertension since 5 years While 13 percent of subjects had hypertension since 11 years and more than 17 years in each category.

4.11.1.3 Family history of hypertension

In control group 25 percent of subjects had family history of hypertension while 75 percent had no such history. In experimental group 50 percent of subjects had family history of hypertension while remaining 50 percent showed no such history of hypertension (Table 4.29).

4.11.1.4 Frequency of checking blood pressure

Data presented in Table 4.29 showed that most of the subjects i.e. 63 per cent in experimental group used to check their blood sugar monthly while 25 percent and 12 per cent used to check blood sugar fortnightly and weekly

Table 4.29 Medical history of hypertensive subjects at baseline

Attributes	Control	Experimental
MEDICAL HISTORY		
Type of hypertension		
Primary	8 (100)	6 (75)
Secondary	-	2 (25)
Duration		
0-5 yrs	4 (50)	6 (74)
6-11 yrs	2 (25)	1 (13)
12-17 yrs	2 (25)	-
> 17 yrs	-	1 (13)
Family history		
Yes	2 (25)	4 (50)
No	6 (75)	4 (50)
Frequency of checking blood pressure		
Weekly	2 (25)	1 (12)
Fortnightly	1 (12)	2 (25)
Monthly	5 (63)	5 (63)
Type of treatment		
Drugs + diet	8 (100)	7 (87)
Diet alone	-	1 (13)
Complications from hypertension		
Other	-	1 (13)
No	8 (100)	7 (87)
Side effect of drugs		
Headache + joint/muscle pain+ ankle swelling	1 (13)	-
Weakness + joint/muscle pain	2 (24)	-
Headache + joint/muscle pain	1 (13)	-
joint/muscle pain	2 (24)	2 (24)
dizziness + joint/muscle pain+ ankle swelling	1 (13)	-
dizziness + joint/muscle pain	-	1 (13)
joint/muscle pain+ ankle swelling	-	1 (13)
none	1 (13)	4 (50)
Medication to control blood pressure		
Allopathy	7 (87)	7 (87)
Homeopathy	1 (13)	-
No	-	1 (13)

Table 4.29 Contd….

Attributes	Control	Experimental
Frequency of medication per day		
Once	4 (40)	4 (50)
Twice	3 (37)	2 (25)
>3	1 (13)	-
According to need	-	2 (25)
Frequency of reducing intake of medicines		
Yes	4 (50)	7 (87)
No	4 (50)	1 (13)
Intake of supplement		
vitamins/minerals	3 (38)	-
salt supplement	2 (24)	1 (13)
no	3 (38)	7 (87)
Intake of herbal medication to control blood pressure		
Yes	2 (25)	2 (25)
No	6 (75)	6 (75)
salt intake		
Restrict	8 (100)	8 (100)
Normal	-	-
Use of flavoring substance in food		
Yes	7 (87)	7 (87)
No	1 (13)	1 (13)
Consumption of processed products (pickles, sauce, ketchup)		
Yes	1 (13)	2 (25)
No	5 (62)	4 (50)
Sometimes	2 (25)	2 (25)

*Values in parentheses indicate percent

respectively whereas in control group 25 per cent and 12 per cent of subjects used to check their blood sugar weekly and fortnightly respectively whereas 63 per cent used to check monthly.

4.11.1.5 Type of treatment

It is exhibited from Table 4.29 that all the subjects i.e. 100 percent of the subjects used to take drugs to control blood pressure in control group. In case of experimental group 87 percent subjects used to take drug while 13 per cent followed low salt diet to control blood pressure.

4.11.1.6 Any other problem

Table 4.29 exhibits that in control group 100 percent of subjects had no complications from hypertension. In experimental group, subjects having hypertension and other problem like vertigo were 13 percent while 87 percent of the subject did not show any problem.

4.11.1.7 Side effect of drugs

It is evident from Table 4.29 that in control group, subjects having side effect of drugs were

- Headache + joint/muscle pain+ ankle swelling – 13 per cent
- Weakness + joint/muscle pain - 24 per cent
- Headache + joint/muscle pain- 13 per cent
- Joint/muscle pain - 24 per cent
- Dizziness + joint/muscle pain+ ankle swelling - 13 per cent
- None – 13 per cent

Experimental group also suffered from following side effect of medication used to control blood pressure

- Joint/muscle pain - 24 per cent
- Dizziness + joint/muscle pain- 13 per cent
- Joint/muscle pain+ ankle swelling- 13 per cent
- None – 50 per cent (Table 4.29)

4.11.1.8 Type of medication to control blood pressure

It is clear from Table 4.29 that 87 per cent of subjects in both control and experimental group used to take allopathy medicines while 13 per cent in control group used to take homeopathy medicines. 13 per cent in experimental group did not take any medicines to control blood pressure

4.11.1.9 Frequency of medication per day

In control group, 40 percent and 37 percent of the subjects used to consume medicines once a day and twice a day respectively while 13 per cent consumed medicines more than thrice a day which includes homeopathic medicines. In experimental group 50 and 25 percent of subjects consumed medicines daily once and twice a day respectively whereas 25 percent used to consume medicines according to need i.e. if their blood pressure was raised only then they took medicines (Table 4.29).

4.11.1.10 Frequency of reducing intake of medicines

It is seen from Table 4.29 that among medicine users, 50 percent subjects in control group and 87 percent in experimental group sometimes used to reduce intake of medicines if their blood pressure level remains in normal range while 50 per cent and 13 percent subjects in control group and experimental group did not reduce the frequency of intake of medicines respectively.

4.11.1.11 Intake of supplements

In control group 38 and 24 percent of the subjects used to consume vitamin- mineral supplements and salt supplement respectively while 38 percent did not. In experimental group only 13 percent of subjects consumed salt supplements while 87 percent did not (Table 4.29).

4.11.1.12 Intake of herbal medication to control blood sugar

In control and experimental group 25 of the subjects used to consume herbal medication to control blood pressure while 75 percent of subjects in control and experimental group did not consume any herbal medication (Table 4.29).

From the medical history of the subjects it can be said that large number of subjects were suffering from primary hypertension with few having family history. Most of the subjects in control group were on medication (100 percent) while some subjects were on diet restriction (13 percent) in experiment group. Most of the subjects in both control and experimental group used to check their blood pressure once in a month. Most of the subjects suffered from side effect of medicines so they used to reduce consumption of medicines if they feel that their B.P is getting normal. Only 25 percent subjects in both group used to take herbal medication to control their blood sugar.

4.11.1.13 Intake of nutrient per day by hypertensive subjects

Data presented in Table 4.30 revealed that fat and fiber intake of control group (52.22 and 25.84 g/day respectively) is slightly higher than experimental group (51.88 and 24.49 g/day respectively). The carbohydrate, protein and energy consumption by control group were 339.24 g/day, 74.61 g/day and 2125.38 kcal/day respectively while by experimental group were 245.48 g/day, 78.32 g/day, and 2161.49 kcal/day respectively. Intake of carbohydrate, protein, energy and fiber was higher in experimental than control group.

Table 4.30 Intake of nutrient per day by hypertensive patients

Group	Control (n=8)	Experimental (n=8)
Carbohydrate (g)	339.24±23.87	345.48±25.60
Protein (g)	74.61±4.32	78.32±3.87
Fat (g)	52.22±2.56	51.81±1.62
Energy (kcal)	2125.38±116.30	2161.49±121.05
Fiber (g)	25.84±1.73	24.49±1.09

Table 4.31 Waist to hip ratio classification of hypertensive subjects at baseline

Waist to hip ratio Standards	Control group (n=8)		Experimental group (n=8)	
	Male	Female	Male	Female
0.80	-	-	-	1 (13)
> 0.80	-	7 (87)	-	4 (50)
<1.0	1 (13)	-	1 (13)	-
> 1.0	-	-	2 (24)	-

Values in parentheses indicate percent

4.11.2 Anthropometry at baseline

4.11.2.1 Body Mass index (BMI)

Result (Fig 4.11) revealed that according to BMI categorization (WHO, 2004) in control group 12 per cent of subjects were in normal and obese class 3 category in each group while 38 per cent of subjects were each under pre obese and class-1 category of obesity for each group. In experimental group 50 per cent and 38 per cent of subjects were in pre obese and class 1 obese category of obesity while 13 per cent were in underweight category of BMI.

4.11.2.2 Waist to hip ratio

Waist circumference (inches) and hip circumference (inches) of all subjects in control and experimental group were taken and their waist to hip ratio was calculated

Result (Table 4.31) showed that in control group all females i.e. 87 per cent had WHR greater than standard value of 0.80 while 13 percent of males had WHR less than standard value of 1. In case of experimental group 13 per cent males had waist to hip ratio less than standard value of 1 while 24 per cent males had greater than 1. Among females only 13 per cent had normal waist to hip ratio (0.80) remaining 50 per cent females had waist to hip ratio greater than standard value of 0.80. Subjects having waist to hip ratio greater than standard value are more at the risk of hypertension and cardiovascular complications.

4.11.3 Experimental study for health benefits of *aonla* - ginger juice (CO) blend and aloe vera incorporated *aonla* - ginger juice blend (COA).

Total 16 hypertensive subjects were selected and were divided into two group-control group (n=8) and experimental group (n=8). Prior to experiment, all the subjects were asked to follow their normal daily routine and to avoid fasting

during experimental period i.e. 30 days. The control group was provided 150 ml of *aonla*-ginger juice blend (CO) while experimental group was provided 150 ml of aloe vera incorporated *aonla* ginger aloe vera juice blend (COA) for 30 days. Subjects were asked to consume juices just like any other drink.

4.11.3.1 Effect of control and test juice blends on alleviating sign and symptoms of hypertension

The effect of control and test juice blends consumption on the reduction of sign and symptoms of hypertensive was evaluated by post survey proforma (Appendix VI) and also by analysis of biochemical parameters like blood sugar and lipid profile at baseline and after study period of 30 days. The post survey proforma was filled up weekly i.e. after seven days for total 30 days. The information was collected on following parameters to see the effect of test juice blends. The results are presented on the basis of information obtained from the post survey proforma.

4.11.3.1.1 Found health drink

Data expressed in Table 4.32 revealed that in the first week 100 per cent of control subjects found LK juice blend ineffective while only 62 per cent of experimental group found satisfactory. During second week 62 per cent control group found drink satisfactory while only 75 per cent in experimental group expressed LKA juice blend effective. In third 100 per cent and of control subjects found it satisfactory whereas 87 percent experimental subjects found it effective. In fourth week of study 25 of control and 87 per cent of experimental group found the respective drink effective. Thus at the end of study period aloe vera incorporated AGA juice was found to be more effective than AG juice.

Table 4.32 Effect of AG and AGA juice blends on hypertensive subjects during 30 days of experimental study

Attributes	1st week		2nd week		3rd week		4th week	
	C	E	C	E	C	E	C	E
Found health drink								
Satisfactory	-	5 (62)	5 (62)	2 (25)	8 (100)	1 (13)	6 (75)	1 (13)
Effective	-	3 (38)	-	6 (75)	-	7 (87)	2 (25)	7 (87)
Ineffective	8 (100)	-	3 (38)	-	-	-	-	-
Get relief from symptoms of hypertension								
Grossly	-	4 (50)	-	7 (87)	1 (13)	8 (100)	2 (25)	8 (100)
Slightly	1 (13)	4 50)	5 (62)	1 (13)	7 (87)	-	6 (75)	-
No	7 (87)	-	3 (38)	-	-	-	-	-
Reduce the frequency of taking medicines								
Yes	-	4 (50)	-	7 (87)	1 (13)	8 (100)	3 (38)	8 (100)
No	8 (100)	4 (50)	8 (100)	1 (13)	7 (87)	-	5 (62)	-
Blood pressure								
High	7 (87)	6 (75)	6 (75)	3 (38)	3 (38)	-	2 (25)	-
Normal	1 (13)	1 (25)	2 (25)	5 (62)	5 (62)	8(100)	6 (75)	8 (100)

	Control group	Experimental group
Other benefits		
Yes	6 (75)	7 (87)
No	2 (25)	1 (13)
Like to continue on own		
Yes	3 (38)	6 (75)
No	5 (62)	2 (25)

*Values in parentheses indicate percent

4.11.3.1.2 Get relief

It is evident from Table 4.32 that both AG and AGA juice blend provided slightly relief to 13 per cent of control subject and 50 per cent of experimental subjects in first week of study. In second week more subjects in control group (62 per cent) got slight relief while subjects in experimental group (87 per cent) got gross relief. Gross relief was further experienced by more subjects in the experimental group (100 percent) than in control group (13 per cent) in third week. In fourth week, percentage of experimental subjects getting gross relief was higher i.e. 100 percent as compared to control group i.e. 25 per cent. Thus it was observed that both AG and AGA juice blend provide relief from symptoms of hypertension but AGA juice blend was found more effective.

4.11.3.1.3 Reduction in medicines consumption

Data pertaining in Table 4.32 indicated that 100 per cent control and 50 per cent experimental subjects in first week of study did not reduce the consumption of medicines. However the percentage of subjects who did not reduce medication decreased in second week to 13 per cent in experimental group whereas none of the subject in control group reduced the consumption of medicines. In third week the 13 percent and 100 per cent of subjects reduced consumption of medicines in both control and experimental group respectively. In fourth week the percentage further increased in control group i.e. 38 per cent but percentage was found higher in experimental group i.e.100 per cent.

4.11.3.1.4 Effect of control and test juice on blood pressure

Table 4.32 showed that 87 per cent of control and 75 per cent of experimental subjects had higher blood pressure. The percentage reduced in both

control (75 per cent) and experimental (38) group in second week of study. 62 per cent of control subjects had normal blood pressure in third week which further increased to 75 per cent in fourth week. In case of experimental group, all the subjects i.e. 100 per cent had normal blood pressure in third and fourth week. So subjects consuming AGA juice got more benefit as compared to those consuming AG juice.

4.11.3.1.5 Other health benefits from consuming AG and AGA juice blends

Data presented in Table 4.32 indicated that 87 per cent subjects in experimental group and 75 per cent of subjects in control group also got other benefits from consuming AGA and AG juice blends respectively. These benefits include good digestion, no joint or muscular pain, feeling of freshness, weight reduction and did not catch cold.

4.11.3.1.6 Like to continue on own

Table 4.32 revealed that in control group 62 percent of subjects did not like to consume drink on own while 75 percent of experimental group would like to continue on own. The reason for not continuing drink on their own included lack of equipment, laborious process, lack of time especially those who are in service.

4.11.3.2 Effect of AG and AGA juice blend consumption on anthropometric measurements

Data regarding effect of AG and AGA juice blend consumption on anthropometric measurements is shown in Fig 4.12 and Appendix XII.

4.11.3.2.1 Total body weight

Data shown in Fig 4.12 and Appendix XII showed that consumption of AG juice blend by control group and consumption of AGA juice blend by

experimental group brought significant reduction in total body weight after 30 days but the reduction was found higher in experimental group (3.44 per cent) than in control group (2.72).

4.11.3.2.2 BMI

It is evident from Fig 4.12 that consumption of AGA juice blend by experimental group for 30 days brought significant reduction in BMI i.e. from 27.93 on 0 day to 26.85 after 30 days. Similarly consumption of AG juice blend for 30 days by control subjects also brought significant reduction in BMI i.e. from 30.34 on 0 day to 29.52 after 30 days but the percentage was found higher in experimental group (3.86 per cent) than in control group (2.37 per cent).

4.11.3.2.3 Waist to hip ratio (WHR)

Data presented in Table 4.31 showed that consumption of AG juice and AGA juice blend by control and experimental group respectively for 30 days brought significant reduction in WHR. However the reduction was observed higher in experimental group (4.49 per cent) than in control group (2.24 per cent).

4.11.3.3 Blood lipid profile

Data regarding effect of AG and AGA juice blends consumption on blood lipid profile of hypertensive subjects is shown in Fig 4.13 and Appendix-XII.

4.11.3.3.1 Total cholesterol level

Result (Fig 4.13) showed total cholesterol reduction in both control and experimental group but non significant reduction in total cholesterol level of control group was observed whereas experimental group showed significant reduction (219.11 to 191.78) after consumption of AG and AGA juice respectively for 30 days.

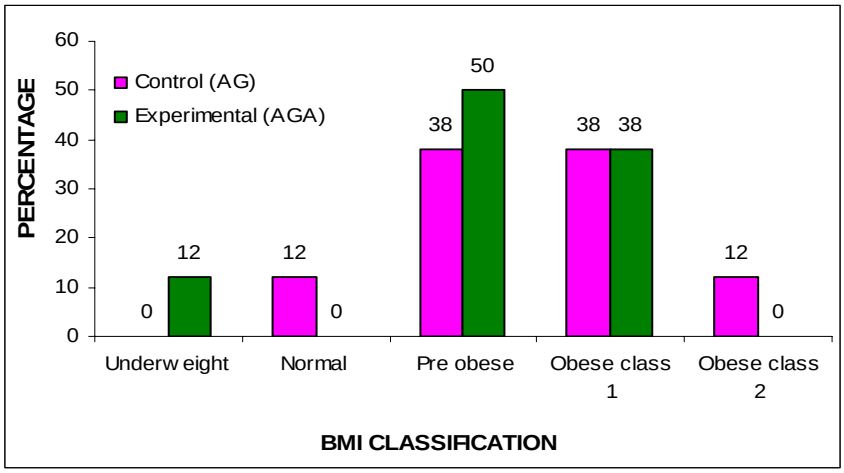


Fig 4.12 BMI classification of hypertensive subjects at baseline

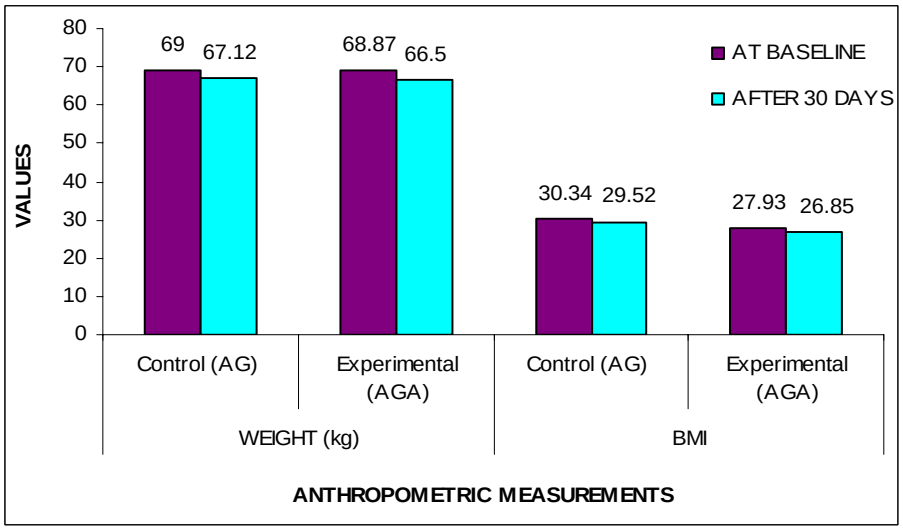


Fig 4.13 Effect of AG and AGA juice blend on weight and BMI of hypertensive subjects

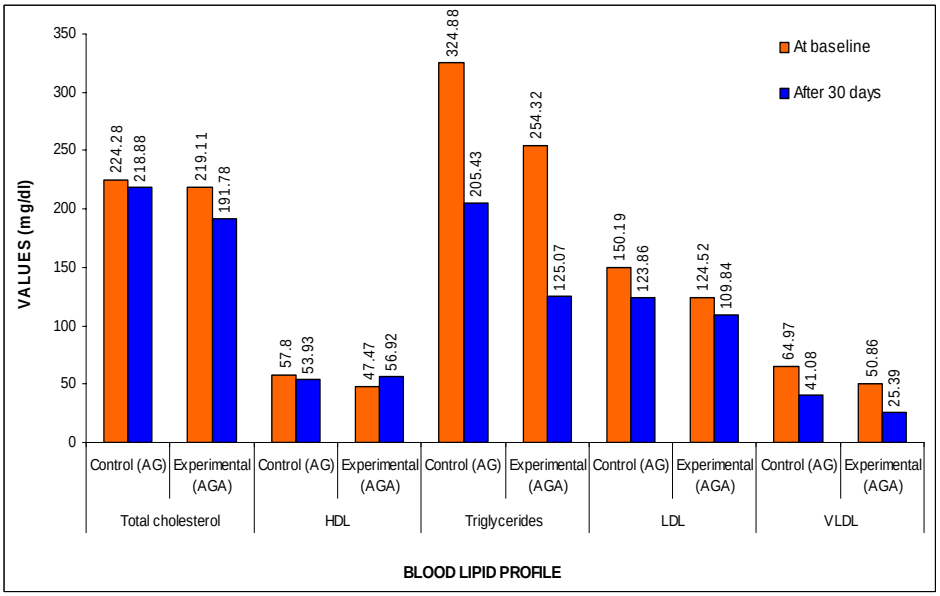


Fig 4.14 Effect of AG and AGA juice blend on lipid profile of hypertensive subjects

4.11.3.3.2 HDL cholesterol

It clear from Fig 4.13 that HDL cholesterol was found to decrease in control group (57.80 to 53.93) while increased in experimental group (47.47 to 56.92) after consumption of AG and AGA juice for 30 days respectively. However the result was found non significant in both cases.

4.11.3.3.3 Triglycerides

Data presented in Fig 4.13 showed significant decrement in triglycerides level of both control (324.88 to 205.43) and experimental (254.32 to 125.86) group after consumption of AG and AGA juice respectively for 30 days. However the percentage of triglycerides level reduction was found higher in experimental group (50.82) than in control group (36.76).

4.11.3.3.4 LDL cholesterol

The LDL level of control group dropped significantly to 123.86 from 150.19 after consumption of AG juice blend for 30 days. Similar result was observed in experimental group in which also LDL level decreased significantly to 109.84 from 124.52 after consumption of aloe vera incorporated AGA juice blend for 30 days. However the rate of reduction was found higher in control group i.e. 17.53 than in experimental group i.e. 11.97 (Fig 4.13).

4.11.3.3.5 VLDL cholesterol

Data expressed in Fig 4.13 indicate that VLDL level of both control (64.97 to 41.08) and experimental group (50.86 to 25.39) was found to decrease significantly after consumption of AG and AGA juice blend respectively for 30 days. However the percentage of VLDL reduction was found lower in control group i.e. 36.77 per cent as compared to experimental group i.e. 50.07 per cent.

4.11.3.3.6 TC/HDL ratio

The total cholesterol to HDL cholesterol ratio is a number that is helpful in predicting an individual's risk of developing atherosclerosis. The number is obtained by dividing the total cholesterol value by the value of the HDL cholesterol. High ratios indicate higher risks of heart attacks, low ratios indicate lower risk. In control group TC/HDL ratio was found to increase non-significantly and in experimental group TC/HDL ratio was found to decrease significantly (4.97 to 3.50) after consumption of AG and AGA juice blend for 30 days respectively (Fig 4.13).

4.11.3.3.7 LDL/HDL ratio

The LDL/HDL ratio is more important ratio than total cholesterol/HDL because LDL is a measure of bad cholesterol and HDL is a measure of good cholesterol whereas the total cholesterol is the sum of HDL, LDL, and the VLDL. The LDL/HDL ratio of control group was to decrease non significantly while in experimental group it was found to decrease significantly from 2.64 to 2.02 after consumption of AG and AGA juice respectively for 30 days (Fig 4.13).

Kamal and Akmeel (2009) also reported the similar result of giving *aonla* and ginger powder to hyperlipidaemia patients for 60 days. They showed significant reduction in the level of serum total cholesterol and serum triglycerides. This effect may be due to the presence of some chemical constituents in ginger which inhibit the absorption of dietary fat by inbibiting its hydrolysis, it also stimulate the activity of hepatic enzyme 7-alpha hydroxylase which in turn stimulate the excretion of cholesterol from the body (Scott, 2003). Flavonoids of *aonla* were found to decrease the activity of enzyme HMG- Co A

reductase and increase the degradation and elimination of cholesterol from the body (Han *et al.,* 2005 and Scott, 1982). The significant effect of control and experimental juice in decreasing the level of LDL and VLDL cholesterol was found to be in accordance with results of Kamal and Akmeel (2009) and most likely is attributed to serum total cholesterol and serum triglycerides lowering effect of juices. The effect of test juice in increasing the level of HDL cholesterol may be due to reduction in body weight and serum triglycerides both of which are inversely related to the level of HDL cholesterol in blood (Han *et al,*. 2005 and Tran and Welfman, 1985). The effect of juice in reducing the body weight was found to be in accordance with the study of Kamal and Akmeel (2009). This may most likely be due to the inhibitory action of ginger on absorption of dietary fat by inhibiting its hydrolysis and as a result may decrease the adipose tissue weight.

SUMMARY
AND
CONCLUSION

Chapter 5 SUMMARY AND CONCLUSION

Food and medicine have been the inseparable companions of humans from the very beginning of evolution. Population rise, inadequate supply of drug, prohibitive cost of treatments, side effects of several allopathic drugs and development of resistance to currently used drugs for infectious diseases have led to increased emphasis on the use of plant materials as a source of medicines for a wide variety of human ailments. Fruits and vegetables besides providing essential vitamins and minerals are also used in the treatment of many diseases of GIT, CVD and diabetes. On the other hand there are certain medicinal plants which can not be consumed alone and need to be mixed with other ingredients to make them acceptable and to get their benefits. Keeping this fact in view the present investigation entitled 'Assessment of therapeutic value of aloe vera *(Aloe barbadensis)* incorporated juices' was undertaken to explore the possibilities of utilization of various fruits and vegetables viz. lawki (bottle gourd), Karela (bitter gourd), carrot, orange, aonla, ginger and honey in the formulation of juice blends with the incorporation of aloe vera juice to improve health. Three juice blends having varying proportion of lawki-karela juice, carrot – orange juice and aonla-ginger juice were prepared and optimization was done in each juice blend category to select the best combination on the basis of organoleptic evaluation. Aloe vera juice was incorporated into the optimized juice blends and compared for sensory attributes with their corresponding juice blends having no aloe vera juice. Single strength juice of lawki, karela, carrot, orange, aonla, ginger, aloe vera juice and

honey as well as optimized juice blends (with and without aloe vera juice incorporation) were analyzed for physico-chemical, nutritional and mineral composition. Storage studies were conducted to assess the shelf life of optimized juice blends with and without aloe vera juice at ambient and refrigeration temperature for a period of 7 days. Experimental intervention studies were carried out to assess the therapeutic benefits of juice blends (with and without aloe vera juice). For this purpose, 150 ml of each juice blends having lawki – karela juice was allocated to diabetics, carrot-orange juice to constipated and aonla-ginger juice was allocated to hypertensive subjects for a period of 30 days. Reduction in signs and symptoms of problems were analyzed by post survey proforma and biochemical constituents and clinical signs were assessed during the study period (wherever necessary). Data were recorded and analyzed on 5 % level of significance. The salient research findings of present investigation are furnished as follow-

1. The per cent weight index of different fruits and vegetables viz. lawki, karela, carrot, orange, aonla, ginger and aloe vera juice ranged from 61.74 to 98.59 per cent. Aloe vera had lowest while karela had highest per cent weight index. Per cent waste index of various fruits- vegetables and aloe vera ranged from 1.24 to 37.80 per cent. Aloe vera had highest while karela had lowest per cent waste index. The per cent juice index of various fruits- vegetables and aloe vera ranged from 42.52 to 72.71 per cent. Aonla had highest while orange had lowest per cent juice index.
2. On the basis of sensory evaluation of juice blends having varying proportion of juice combinations, lawki- karela juice blend having lawki and karela juice in

the ratio of 120:30, carrot-orange juice blend having carrot and orange juice in the ratio of 100:50 and aonla –ginger juice blend having aonla and ginger juice in the ratio of 30:5 (with water: honey::100:15) were selected as best combinations.

3. Thirty ml juice from each of the three optimized juice blends viz. lawki- karela (LK) juice, carrot-orange (CO) juice and aonla –ginger (AG) juice blend was replaced by 30 ml of aloe vera juice for the preparation of lawki- karela- aloe vera (LKA) juice, carrot-orange- aloe vera (COA) juice and aonla –ginger- aloe vera (AGA) juice blends.
4. LK and LKA juice blends were rated as liked slightly by 37 and 36.86 per cent panelists respectively, CO and COA juice blends were rated as liked very much by 52.86 and 51.06 per cent panelists respectively while AG and AGA juice blends were rated as liked moderately by 48.4 and 47.53 per cent panelists respectively. The mean sensory scores for colour, appearance, flavour, taste, consistency and overall acceptability of LK juice, CO juice and AG juice blend showed no significant difference with LKA juice, COA juice and AGA juice blend respectively.
5. Analysis of single strength juice of lawki, karela, carrot, orange, aonla, ginger, aloe vera juice and honey showed highest moisture in aloe vera juice (99.34 per cent) and lowest in honey (19.68 per cent). Total solid and TSS was highest in honey i.e. 80.31 per cent and 80.53 ^{0} brix respectively and lowest in aloe vera juice i.e. 0.65 per cent and 0.50 ^{0} brix respectively. The pH of aonla juice (2.55) was lowest while of karela juice (7.32) highest. Aonla juice had highest

titrable acidity (2.34 per cent) while karela juice had lowest (0.085 per cent). The brix acid ratio of honey was highest (562.29) while aloe vera juice had lowest (4.44). Honey had highest reducing (67 per cent) and total sugar (69.45 per cent) while orange juice had highest non-reducing (4.25 per cent). Ginger juice had lowest non-reducing (0.091 per cent) and total sugar (0.30 per cent) while aloe vera juice had lowest reducing sugar (0.17 per cent). Aonla juice had highest (624.56 mg/100ml) while aloe vera juice (0.80 mg/100ml) had lowest ascorbic acid content. Free acidity, lactonic acid and total acidity of honey was 29.0, 15.5 and 44.33 meq/kg respectively. The beta carotene (mg/100ml) content of carrot and orange juice was 7.2 and 4.31. Aonla juice had lowest chlorophyll –a (0.48 mg/100ml), chlorophyll –b (0.24 mg/100ml) and total chlorophyll (0.73) content while karela juice highest chlorophyll–a (168.60 mg/100ml), chlorophyll–b (73.54 mg/100ml) and total chlorophyll (242.15 mg/100ml).

6. Large variation in mineral content was observed among all the single strength juices and honey samples. Calcium content was varied from 4.17 to 73.45 mg/100ml, sodium content was varied from 0.95 to 64.50 mg/100ml, potassium content was varied from 23.40 to 384.00 mg/100ml. Iron content was in the range of 0.197 to 1.288 mg/100ml, values of Mn and Zn was 0.058 to 0.777 and 0.039 to 0.848 mg/100ml respectively. Calcium, sodium, iron content was found to be maximum in carrot. Potassium, manganese and copper was highest in ginger juice zinc was highest in honey. Aloe vera juice contained minimum amount of potassium, copper, iron and iron.

7. Moisture, total solids, TSS, pH, reducing sugar, total sugar, ascorbic acid, chlorophyll-a, chlorophyll-b and total chlorophyll content of Lawki-Karela (LK) juice was seen significantly higher than Lawki-Karela – Aloe vera (LKA) juice blend. Carrot–orange juice (CO) blend had significantly higher moisture, total solids, TSS, pH, titrable acidity, reducing sugar, non-reducing sugar, total sugar and ascorbic acid content than and Carrot–orange-aloe vera juice (COA) juice blend. Moisture, total solids, TSS, titrable acidity, brix acid ratio, reducing sugar, non-reducing sugar, total sugar, ascorbic acid and chlorophyll-b content of aonla–ginger-aloe vera (AGA) juice blend was found significantly lower than aonla–ginger (AG) juice blend.
8. The sodium, potassium, manganese and calcium content of LKA juice blend was seen significantly higher than LK juice blend whereas copper, iron and zinc content of LK juice was significantly higher than LKA juice blend. Except for manganese, the calcium, copper, iron, zinc, sodium and potassium content of CO juice blend is significantly higher than the aloe vera incorporated COA juice blend. Calcium, manganese, zinc and sodium content of aloe vera incorporated AGA juice blend had significantly higher values than AG juice blend while copper, iron and potassium content of AGA juice blend were found to be significantly lower than AG juice blend.
9. Juice with and without aloe vera juice incorporation were stored at ambient and refrigeration temperature. During storage various physico-chemical and sensory attributes were monitored. Microbial growth was also enumerated in terms of total plate count (TPC), total coliform count (TCC) and yeast and mold count (YMC). Data was recorded on 0, 1st, 2nd, 3rd and 7th day of 7 days of storage.

I. TPC, TCC and YMC of LK juice, CO juice and AG juice blend was found higher than their corresponding aloe vera incorporated LKA juice blend, COA juice blend and AGA juice blend respectively. LK juice, CO juice and AG juice blend kept at ambient and refrigeration temperature had higher TPC, TCC and YMC than LKA juice, COA juice and AGA juice blend respectively during the entire storage period.

II. On the basis of microbial studies, the shelf life of LK juice and LKA juice blend was found one day at ambient temperature while 2 days at refrigeration temperature. At ambient temperature, the shelf life of CO juice and COA juice blend was 2 and 3 days while at refrigeration temperature, it was 3 days for both the juice blend. The shelf life of AG and AGA juice at refrigeration temperature was 3 and 7 days respectively while at ambient temperature it was 3 days for both the juice blends.

III. Colour, appearance, flavour, taste and overall acceptability scores of LK and LKA juice blend decreased during the storage period but more significantly in aloe vera incorporated LKA juice blend. The color, appearance, flavour, taste and overall acceptability scores of LK and LKA juice blends kept at ambient temperature and refrigeration temperature decreased significantly but more at ambient temperature. Similar trend was also seen in CO and COA juice blend and AG and AGA juice blend.

IV. As the storage days progressed, the total sugar content of both LK and LKA juice blends decreased significantly but the rate of reduction was found to be less in LKA juice blends. Total sugar content of LK juice at ambient

temperature is higher than LKA juice at same temperature. Similar trend was found in case of LK and LKA juice blends stored at refrigeration temperature. With increase in storage days, total sugar content of juice blends at ambient and refrigeration temperature decreased significantly however the rate of degradation of total sugar during storage was found more in juice blends stored at ambient temperature than at refrigeration temperature.

V. Similar trend was also seen in case of ascorbic acid content of LK and LKA juice blends, CO and COA juice blends and AG and AGA juice blend. The total chlorophyll content of LK - LKA juice and AG - AGA juice blend showed similar pattern of reduction. Beta carotene content of CO and COA juice blend also showed similar trend.

VI. With increase in storage period, total sugar content of CO and COA juice increased significantly but the rate of increment in total sugar content was found higher in CO than COA juice blend. With increase in storage days, the total sugar content of juice blends kept at both ambient and refrigeration temperature increased significantly, higher at ambient temperature than at refrigeration temperature. Total sugar content of CO juice blend stored at ambient temperature and refrigeration temperature had significantly higher total sugar than COA juice blend stored at ambient temperature and refrigeration temperature. Similar trend was shown by AG and AGA juice blends.

10. For the experimental study on the therapeutic value of aloe vera incorporated juices, 50 subjects were selected. Their general information

along with the information on work pattern and habits, physical fitness and diet history was collected. Out of those 50 subjects, 20 had chronic constipation, 14 had diabetes and remaining 16 had hypertension. Information on anthropometric measurements and medical history of all the subjects in each disease category was collected. Subjects in each disease category were divided equally in control and experimental group. Their 7 days dietary intake was determined by 24 hour dietary recall method and food frequency questionnaire

11. To study the effect of juice blends on diabetic subjects, 150 ml of each lawki-karela juice blend was given to control subjects (n=7) and lawki-karela-aloe vera juice blend was given to experimental subjects (n=7) daily for the period of 30 days. The effect of juice blends consumption on the reduction of signs and symptoms of diabetes was evaluated by a post survey proforma which was filled up weekly during the study period and by measuring biochemical parameters viz. blood glucose and lipid profile.

I. At the end of study period it was observed that both LK and LKA juice blend were effective; provide relief from symptoms of diabetes and brought reduction in intake of medicines but aloe vera incorporated LKA juice blend was found to be more prominent than LK juice blend.

II. Consumption of LK juice and LKA juice blend for 30 days brought reduction in total body weight and BMI of diabetics subjects but the reduction was found significant in case LKA juice blend.

III. Consumption of LK juice and LKA juice blend for 30 days brought significant reduction in blood glucose level of control and experimental diabetic subjects respectively but the percentage reduction was greater in case LKA juice blend.

IV. Significant reduction in total cholesterol, triglycerides and VLDL level of both control and experimental group after consumption of LK and LKA juice blend respectively for 30 days was seen. However the percentage reduction in these biochemical parameters was higher in experimental group who had consumed LKA juice blend. LDL level also decreased in both control and experimental group but more significantly in experimental group. HDL level increased non significantly in both group but per cent increment was greater in group who had consumed LKA juice blend.

12. To study the effect of juice blends on constipated subjects, 150 ml of carrot- orange juice blend was given to control subjects (n=10) and carrot-orange-aloe vera juice blend was given to experimental subjects (n=10) daily for the period of 30 days. The effect of juice blends consumption on the reduction of signs and symptoms of constipation was evaluated by a post survey proforma which was filled up weekly.

I. At the end of the study period, it was seen that the greater relief from signs and symptoms of constipation was higher in those group that consumed aloe vera incorporated COA juice blend than the group who consumed CO juice blend. They did not strain during bowl movement, did not feel incomplete emptying sensation and they also reduced laxative

consumption. The experimental result showed stool of soft consistency, regularity in bowl movement and greater improvement elimination and constipation associated complaints in experimental subjects.

II. Significant reduction in both total body weight and BMI of control and experimental group was seen after consumption of CO and COA juice blend respectively for 30 days. However the rate of reduction was found more prominent in COA group than in CO group.

13. To study the effect of juice blends on hypertensive subjects, 150 ml of aonla-ginger juice blend was given to control subjects (n=8) and aonla-ginger-aloe vera juice blend was given to experimental subjects (n=8) daily for the period of 30 days. The effect of juice blends consumption on the reduction of signs and symptoms of constipation was evaluated by a post survey proforma which was filled up weekly during the study period and by measuring blood pressure and biochemical parameters like blood lipid profile

I. Experimental result showed that both AG and AGA juice blend were effective in providing relief from symptoms of hypertension and brought reduction in intake of medicines but aloe vera incorporated AGA juice blend was found to be more prominent than AG juice blend.

II. Consumption of AG juice blend by control group and AGA juice blend by experimental group brought significant reduction in total body weight and BMI after 30 days but the per cent reduction was higher in experimental group than in control group.

III. Significant reduction in total cholesterol, triglycerides and VLDL level of both control and experimental group was observed after consumption of AG and AGA juice blend respectively in 30 days of study. However the percentage reduction in these biochemical parameters was higher in experimental group who had consumed AGA juice blend. LDL level also decreased in both control and experimental group but more significantly in control group. HDL level increased non significantly in experimental group while decreased non significantly in control group.

On the basis of above results it can be concluded that aloe vera juice can be effectively incorporated into the juice blends of carrot-orange, aonla-ginger and lawki- karela without affecting their sensory characteristics. However incorporation of aloe vera juice brought slight reduction in physico-chemical and nutritional composition of juice blends but its therapeutic role as a potent laxative, anti-hyperglycemic agent and anti-hyperlipidemic agent can not be ignored. Thus one must consume variety of fruits and vegetables as a part of a plant food based diet

Recommendations for further work

Since carrot, orange, aonla, ginger, lawki and karela are among the richest source of some nutrients and due to bitter taste and slimy nature of aloe vera juice, further work can be carried out on product development as well as on studying the clinical effect of aloe vera juice on various other medical problems. Some of the recommendations for further work are as follows-

- Different combinations of juices can be made by using these fruits and vegetables like carrot-aonla, carrot-ginger and aloe vera can be incorporated into it.

- Therapeutic role of juice blends can be done in other disease conditions like carrot-orange juice blend in CVD and anemia , aonla-ginger juice blend in GIT problems.
- Beside these fruits and vegetables aloe vera can also be incorporated into blends of other fruit and vegetable juices like pineapple, guava juice.
- Antioxidant activity of juice blends can be evaluated
- Since fresh juice are highly perishable food products so different preserving techniques can be tried to extend their shelf life without affecting their nutritional composition
- Natural taste enhancers like black pepper, coriander, mint and basil leaves can also be added into the juice blends.

These juice blends is a good source of minerals and vitamins and provides health benefit to consumer. This ready-to-drink, thirst quenching blended juice will satisfy the consumer demand for nutritious, health food.

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APPENDICES

Appendix I

Date:

Dear Evaluator,

You are requested to kindly evaluate the food product namely……

I. For preference by Hedonic Scale– Taste the following products to give preference by ticking one for each column. **

Hedonic scale	**Product Code**					
Like extremely						
Like very much						
Like moderately						
Like slightly						
Neither like nor dislike						
Dislike slightly						
Dislike moderately						
Dislike very much						
Dislike extremely						

II. Score card – Score the products for the given quality characteristics of the product that best describes your feeling about the coded sample. You are advised to use whole numbers and not giving scores in decimals.

Parameter → / **Product Code** ↓	**Color (10)**	**Appearance (10)**	**Flavor (10)**	**Taste (10)**	**Consistency (10)**	**Overall acceptability (10)**

Comments:

Signature

**Kindly rinse your mouth with water before you begin tasting and also between the samples.

Appendix II

DEPARTMENT OF FOODS AND NUTRITION
COLLEGE OF HOME SCIENCE

CONSENT LETTER

Dear Sir/Madam,

I am a student of Ph.D. 3rd year (Human Nutrition), under the guidance of Dr. Pratima Awasthi, Associate Professor, Department of Foods and Nutrition. The topic of my thesis is "ALOE VERA INCORPORATED HEALTH DRINKS AND THEIR THERAPEUTIC APPLICATION". Six juice combinations viz. Lawki juice+ Karela juice, Lawki juice+ Karela juice+Aloe Vera juice, Amla juice+ Ginger juice, Amla juice+ Ginger juice +Aloe Vera juice, Carrot juice+ Orange juice, Carrot juice+ Orange juice+Aloe Vera juice were prepared.

To study the health benefits of aloe vera incorporated juices to solve the problem of Diabetes, Constipation and Hypertension (high blood pressure) 60 volunteers (20 for each problem) in the age group of 35-60 years having one or more above stated problem are needed to conduct the trial. Juices will be provided to the subjects everyday or alternate day for a period of 30 days. Pre and post evaluation for sign and symptoms will be done through interview schedule and assessment of biochemical parameters in order to see reduction in parameters.

To carry out this study I need your cooperation. So, if you are willing to participate in this study kindly give your consent to me.

ADVISOR'S RECOMMENDATION

Vidya Kumari
I.D. No. 34020
Ph.D. Human Nutrition

HOD's RECOMMENDATION

CONSENT FORM

Type of problem: 1. Constipation 2. Hypertension 3. Diabetes

VOLUNTEER'S REMARK AND SIGNATURE

I am interested and agree to consume the products as per recommendation and shall help in pre and post data collection during the period of study

Signature:
Name:

Appendix III

GENERAL INFORMATION

Name– Age- Sex-
Occupation - Education status- Marital status-
Religion –

TYPE OF PROBLEM

Constipation - Diabetes - Hypertension -

WORK PATTERN AND HABITS

a) Life style: Sedentary- Moderate- Heavy-
b) Active working hours-
c) Do you smoke/chew tobacco? Daily / Occasionally / Rarely / No
d) Do you drink alcohol? Daily / Occasionally / Rarely / No

PHYSICAL FITNESS

a) Do you exercise? Yes- No-
b) Type of exercise: Walking- Brisk walking- Jogging-
Bicycling- Yoga- Gym- Any other-
c) Frequency of exercise: Daily- Alternate Day- Once a Week-
Whenever gets time-
d) Duration of exercise: <1/2 hour- 1/2 to 1 hour- 1 to 2 hour-
e) Hours of sleep/rest: <8 hours- 8 hours- >8hours-

DIET HISTORY

a) Food habits: Vegetarian- Non Vegetarian- Ovo Vegetarian-
b) No. of meals per day: 2- 3- 4- 5-
c) Normal menu pattern: Rice+Dal- Rice+Dal+Chapatti-
Rice+Dal+Chapatti+Vegetable- Dal+Chapatti+Vegetable-
Dal+ Chapatti- Chapatti+Vegetable- Any Other-
d) Do you eat salad with meal? Always / Occasionally / Rarely / Never
e) Do you eat snacks in between meals? Yes- No-
f) What type of?
g) Do you take tea/coffee? Yes- No-
h) How many times per day? once- twice- thrice- 4times- >4 times-
i) How much water do you drink daily? 1lit- 2lit- 3lit- 4lit-
j) Do you drink cold drinks? Always / Occasionally / Rarely / Never
k) Frequency of eating non-veg: Daily- Weekly- Fortnightly- Monthly-
l) Type of non-vegetarian item : Mutton / Chicken / Fish / Other
m) Frequency of eating vegetables per day: once- twice- thrice- 4times-
n) Type of vegetables preferred: Potatoes etc- Green Leafy Veg- Other-
o) Do you eat fruits? Daily / Occasionally / Rarely / No
p) How many servings?
q) In which form? Fruit juice (ready to take/freshly made) - Whole fruit-
r) Do you consume milk and / or curd? Yes (whole/skim/toned) No-
s) Do you take whole grain cereals and pulses? Yes- No-
t) Do you eat bread in breakfast? Daily / Occasionally / Rarely / No
u) Which type? White- Brown (Multi grain)-
v) Type of oil/fat used – desi ghee/ refined oil/ mustard oil/ hydrogenated fat (dalda)/ mixed
w) Do you consume refined/fast foods (made of Maida)/fried foods?
Yes (daily/occasionally/rarely) No

24-HOUR DIETARY RECALL FOR 7 DAYS

Meal time	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
Early morning							
Breakfast							
Lunch							
Tea time							
Dinner							
Bed time							
Any other							

Appendix IV

PART A - PRE- INTERVENTION QUESTIONNAIRE FOR DIABETICS

Name –

ANTHROPOMETRY

Height- Weight- BMI- Waist-to hip ratio-

MEDICAL HISTORY

a) Which type of diabetes do you have? Type I / Type II
b) Since how long?
c) Do you have family history of diabetes? Yes / No
d) Do you have any problem of heart / hypertension / kidney / eye / other / no?
e) Type of treatment advised: Diet- Indigenous Drugs- Insulin- Insulin+diet
   Oral Hypoglycemic Drugs (OHD) - OHD+diet-
f) How many times in a day do you take medicines/insulin?
g) Have you ever reduced the frequency of taking medicines?
h) Do you currently take vitamin/mineral supplement?
i) Do you currently take herbal medication to control blood sugar? If yes, please list.
j) How frequently do you check your blood sugar? Daily- Weekly-
   Fortnightly - Monthly-
k) Do you use artificial sweetener? Yes / No
l) Do you restrict salt intake? Yes / No-

PART B - POST- INTERVENTION QUESTIONNAIRE FOR DIABETICS

a) Name-
b) How did you find health drink?
   - 1st week – Satisfactory / Effective / Ineffective
   - 2nd week – Satisfactory / Effective / Ineffective
   - 3rd week – Satisfactory / Effective / Ineffective
   - 4th week – Satisfactory / Effective / Ineffective
c) How much relief did you get from the symptoms of diabetes after -
   - 1st week – Gross / Slight / No
   - 2nd week – Gross / Slight / No
   - 3rd week – Gross / Slight / No
   - 4th week – Gross / Slight / No
d) Did you reduce the frequency of taking medicines during the course of experiment?
   - 1st week – Yes / No
   - 2nd week – Yes / No
   - 3rd week – Yes / No
   - 4th week – Yes / No
e) Did you get any other benefit from this health drink? Yes / No
f) Would you like to continue this drink on your own? Yes / No

Appendix V

PART A - <u>PRE- INTERVENTION QUESTIONNAIRE FOR CONSTIPATED SUBJECTS</u>

Name –

ANTHROPOMETRY

Height- Weight- BMI- Waist-to hip ratio -

MEDICAL HISTORY

1) Which type of constipation do you have? Regular / Irregular
2) Since how long (duration)?
3) Do you have family history of constipation? Yes / No
4) Do you have any problem of heart/hypertension/kidney/eye?
5) Associated complaints:
6) Flatulence / Coated Tongue / Headache / Felt Heavy / Bad Breath / Indigestion / Lack of Appetite
7) Elimination complaints:
8) Blood in stool / Mucous in stool / Painful bowel movement / Alternating diarrhea and constipation / Foul smelling stool
9) Do you feel the need to have a bowel movement but not able to? Yes / No
10) Do you strain during a bowel movement? Yes / No
11) Do you feel incomplete emptying sensation after a bowel movement? Yes / No
12) How frequently do you pass stool? Twice in morning / Thrice in morning / Once a day / Alternate day / Twice a week/ Once a week
13) How is the consistency of stool passed? Soft / Hard / Thin / Lumpy
14) Have you tried any laxatives to get relief from constipation? Yes / No
15) What kind of laxatives? Drugs / Isabgol / Syrups / Churans
16) How frequently do you take laxatives? Daily / Alternate day / Once a week / As per need

PART B <u>POST- INTERVENTION QUESTIONNAIRE FOR CONSTIPATED SUBJECTS</u>

1) Name-
2) How did you find health drink? Satisfactory/Effective/Ineffective
3) After taking this health drink-
   a) How much relief did you get after-
      - 1st week- Gross improvement / Slight improvement/ No improvement
      - 2nd week- Gross improvement / Slight improvement/ No improvement
      - 3rd week – Gross improvement / Slight improvement/ No improvement
      - 4th week - Gross improvement / Slight improvement/ No improvement
   b) Do you feel the need to have a bowel movement but not able to after-
      - Ist week - Grossly / Slightly / No
      - IInd week- Grossly / Slightly / No
      - IIIrd week - Grossly / Slightly / No
      - IVth week - Grossly / Slightly / No
   c) Do you strain during a bowel movement after-
      - Ist week - Grossly / Slightly / No
      - IInd week- Grossly / Slightly / No
      - IIIrd week - Grossly / Slightly / No
      - IVth week - Grossly / Slightly / No

d) Do you feel incomplete emptying sensation after a bowel movement after-
   - Ist week - Grossly / Slightly / No
   - IInd week- Grossly / Slightly / No
   - IIIrd week - Grossly / Slightly / No
   - IVth week - Grossly / Slightly / No

e) How much the frequency of passing stool per day reduced after-
   - Ist week - Grossly / Slightly / No
   - IInd week- Grossly / Slightly / No
   - IIIrd week - Grossly / Slightly / No
   - IVth week - Grossly / Slightly / No

f) Did you reduce the consumption of laxative during the course of intervention, after
   - Ist week - Grossly / Slightly / No
   - IInd week- Grossly / Slightly / No
   - IIIrd week - Grossly / Slightly / No
   - IVth week - Grossly / Slightly / No

g) How is the consistency of stool passed after-
   - Ist week- Soft / Hard / Thin / Lumpy
   - IInd week- Soft / Hard / Thin / Lumpy
   - IIIrd week - Soft / Hard / Thin / Lumpy
   - IVth week - Soft / Hard / Thin / Lumpy

h) What is the effect of drink on bowel habit after-
   - Ist week- Regular / Irregular
   - IInd week- Regular / Irregular
   - IIIrd week - Regular / Irregular
   - IVth week - Regular / Irregular

4) What elimination complaints do you have after consuming juice blends for
   - Ist week - Blood in stool / Mucous in stool / painful bowel movement / Alternating diarrhea and constipation / foul smelling stool/ No
   - IInd week - Blood in stool / Mucous in stool / painful bowel movement / Alternating diarrhea and constipation / foul smelling stool / No
   - IIIrd week - Blood in stool / Mucous in stool / painful bowel movement / Alternating diarrhea and constipation / foul smelling stool / No
   - IVth week - Blood in stool / Mucous in stool / painful bowel movement / Alternating diarrhea and constipation / foul smelling stool / No

5) Do you still have any associated complaints after taking this drink for
   - Ist week: Flatulence / Coated Tongue / Headache / Felt Heavy / Bad Breath / Indigestion / Lack of Appetite / No
   - IInd week: Flatulence / Coated Tongue / Headache / Felt Heavy / Bad Breath / Indigestion / Lack of Appetite / No
   - IIIrd week: Flatulence / Coated Tongue / Headache / Felt Heavy / Bad Breath / Indigestion /Lack of Appetite / No
   - IVth week: Flatulence / Coated Tongue / Headache / Felt Heavy / Bad Breath / Indigestion / Lack of Appetite / No

6) Would you like to continue juice blend on your own? Yes / No

Appendix VI

PART A - <u>PRE- INTERVENTION QUESTIONNAIRE FOR HYPERTENSIVE SUBJECTS</u>

Name –

ANTHROPOMETRY

Height- Weight- BMI- Waist-to hip ratio -

MEDICAL HISTORY

a) What type of hypertension do you have? Primary / Secondary
b) Since how long?
c) Do you have family history of hypertension?
d) How frequently do you check your B.P.? daily/weekly/fortnightly/monthly
e) What type of treatment are you receiving? Drugs / Diet alone / Diet +Drugs
f) Do you have you any complications from hypertension? Yes / No
g) Do you suffer from any side effects of medicines you are taking to control B.P.? Headache / Weakness / Diarrhea / Fatigue / Dizziness / Fainting / Joint or Muscular Pain / Heart rhythm problem / Ankle swelling / None
h) What type medicines are you taking to control your B.P.? Allopathy / Homeopathy / No
i) How many times a day do you take medicines? Once / Twice / >3 times / As per cent need
j) Have you ever reduced the frequency of taking medicines? Yes / No
k) Do you currently take supplement? Vitamins / Minerals / Salt Supplement /No
l) Do you currently take herbal medication to control B.P.? Yes / No
m) Do you restrict salt intake? Yes / No
n) Do you use flavoring substance (coriander/garlic/mint/black pepper etc.) if salt intake is low? Yes / No
o) Do you consume processed items like Pickles / sauce / ketchup / processed cheese / butter (salted) / processed soups / No

PART B <u>POST- INTERVENTION QUESTIONNAIRE FOR HYPERTENSIVE SUBJECTS</u>

a) Name
b) How did you find health drink?
   - 1st week- Satisfactory / Effective / Ineffective
   - 2nd week- Satisfactory / Effective / Ineffective
   - 3rd week- Satisfactory / Effective / Ineffective
   - 4th week- Satisfactory / Effective / Ineffective
c) How much relief did you get after -
   - 1st week- Grossly / Slightly / No
   - 2nd week- Grossly / Slightly / No
   - 3rd week- Grossly / Slightly / No
   - 4th week- Grossly / Slightly / No
d) What was your blood pressure after
   - 1st week - High / Normal / Low
   - 2nd week - High / Normal / Low
   - 3rd week - High / Normal / Low
   - 4th week - High / Normal / Low

e) Did you reduce the frequency of taking medicines during the course of experiment?
    - 1st week – Yes / No
    - 2nd week - Yes / No
    - 3rd week - Yes / No
    - 4th week - Yes / No
f) Do you suffer from any side effects of medicines during the course of experiment?
    - 1st week – Headache / weakness / diarrhea / fatigue / dizziness / fainting / joint or muscular pain / heart rhythm problem / ankle swelling / other / none
    - 2nd week – Headache / weakness / diarrhea / fatigue / dizziness/fainting/ joint or muscular pain/ heart rhythm problem / ankle swelling / other / none
    - 3rd week- – Headache / weakness / diarrhea / fatigue / dizziness/fainting/joint or muscular pain/ heart rhythm problem / ankle swelling / other / none
    - 4th week- – Headache / weakness / diarrhea / fatigue / dizziness/fainting/joint or muscular pain/ heart rhythm problem / ankle swelling / other / none
g) Did you get any other benefit from this health drink?
h) Would you like to continue this drink on your own? Yes / No

Appendix VII

A. Organoleptic evaluation of Lawki-Karela (LK) juice and Lawki-Karela – Aloe vera (LKA) juice blend

Attributes	LK juice blend	LKA juice blend	S. Em	CD at 5%
Color	7.93 ± 0.25	7.93 ± 0.45	0.09	0.27
Appearance	7.86 ± 0.51	7.86 ± 0.35	0.11	0.33
Flavour	5.86 ± 1.06	6.40 ± 1.50	0.33	0.97
Taste	5.8 ± 1.14	6.66 ± 1.39	0.32	0.95
Consistency	7.13 ± 0.63	7.33 ± 0.61	0.16	0.47
Overall acceptability	6.20 ± 1.01	6.46 ± 1.40	0.31	0.91
Hedonic rating	37.0 % LS	36.86 % LS		

LK juice blend = Lawki juice : Karela juice :: 120 : 30
LKA juice blend = LK juice blend : Aloe vera juice :: 120:30
LS = Liked slightly

*Mean of score given by 15 panelists ± SD
Maximum scores = 10

B. Organoleptic evaluation of Carrot – Orange juice (CO) and Carrot Orange juice - Aloe vera juice (COA) blend

Attributes	CO juice blend	COA juice blend	S. Em	CD at 5%
Color	8.26 ± 0.59	8.20 ± 0.77	0.19	0.56
Appearance	8.20 ± 0.56	8.13 ± 0.63	0.15	0.44
Flavour	7.93 ± 0.88	7.53 ± 0.51	0.18	0.54
Taste	7.86 ± 0.63	7.46 ± 0.91	0.20	0.59
Consistency	7.86 ± 0.51	7.33 ± 0.89	0.18	0.54
Overall acceptability	8.13 ± 0.63	7.93 ± 0.70	0.17	0.50
Hedonic rating	52.86 % LVM	51.06 % LM		

CO juice blend = Carrot juice : Orange juice :: 100 : 50
COA juice blend = CO juice blend : Aloe vera juice :: 100:50
LVM = Liked very much

LM = Liked moderately
*Mean of score given by 15 panelists ± SD
Maximum scores = 10

C. Organoleptic evaluation of Aonla – Ginger juice (AG) and Aonla – Ginger - Aloe vera juice (AGA) blend

Attributes	AG juice blend	AGA juice blend	S. Em	CD at 5%
Color	8.06 ± 0.45	8.06 ± 0.25	0.09	0.27
Appearance	7.93 ± 0.45	7.93 ± 0.59	0.13	0.39
Flavour	7.80 ± 0.77	7.60 ± 0.63	0.18	0.52
Taste	7.80 ± 0.56	7.60 ± 0.73	0.16	0.48
Consistency	7.66 ± 0.61	7.33 ± 0.61	0.15	0.46
Overall acceptability	7.86 ± 0.74	7.60 ± 0.50	0.16	0.47
Hedonic rating	48.4 % LM	47.53 % LM		

AG juice blend = Aonla juice :Ginger juice : Honey : Water :: 30 : 5 : 15 : 100
AGA juice blend = AG juice blend : Aloe vera juice :: 100:50
LM = Liked moderately
*Mean of score given by 15 panelists ± SD
Maximum scores = 10

Appendix VIII

A. Physico-chemical characteristics of *Lawki-Karela* (LK) juice and *Lawki-Karela* – Aloe vera (LKA) juice blend

Parameters	LK Juice blend	LKA Juice blend	S. Em	CD at 5%
Moisture (%)	96.12 ± 0.11	96.76 ± 0.04	0.048	0.191*
Total solids (%)	3.87 ± 0.11	3.23 ± 0.04	0.051	0.199*
TSS (° brix)	3.76 ± 0.15	2.70 ± 0.2	0.102	0.401*
pH	5.55 ± 0.03	5.05 ± 0.03	0.018	0.073*
Titrable acid (%)	0.10 ± 0.03	0.064 ± 0.00	0.015	NS
Brix acid ratio	39.31 ± 17.4	42.18 ± 3.12	7.219	NS
Reducing sugars (%)	2.03 ± 0.01	1.66 ± 0.03	0.015	0.062*
Non -reducing sugars (%)	0.62 ± 0.03	0.66 ± 0.02	0.016	NS
Total sugar (%)	2.66 ± 0.03	2.34 ± 0.03	0.017	0.070*
Ascorbic acid (mg/100ml)	26.99 ± 1.07	20.16 ± 0.062	0.507	1.983*
Chlorophyll a (mg/100ml)	54.37 ± 0.15	36.65 ± 0.03	0.064	0.251*
Chlorophyll b (mg/100ml)	24.81 ± 0.06	19.56 ± 0.30	0.128	0.503*
Total chlorophyll (mg/100ml)	79.19 ± 0.12	56.22 ± 0.27	0.122	0.479*

* Significant at 5 %
** Mean of triplicate observation ± SD
LK juice blend = *Lawki* juice : *Karela* juice :: 120 : 30
LKA juice blend = LK juice blend : Aloe vera juice :: 120:30

B. Physico-chemical characteristics of Carrot – Orange juice (CO) and Carrot – Orange juice - Aloe vera juice (COA) blend

Parameters	CO Juice blend	COA Juice blend	S.Em	CD at 5%
Moisture (%)	89.97 ± 0.29	91.98 ± 0.20	0.147	0.577*
Total solids (%)	10.02 ± 0.29	8.01 ± 0.20	0.147	0.575*
TSS (° brix)	8.33 ± 0.35	7.43 ± 0.25	0.176	0.689*
pH	5.63 ± 0.06	5.62 ± 0.05	0.032	0.126*
Titrable acid (%)	0.45 ± 0.04	0.35 ± 0.03	0.023	0.093*
Brix acid ratio	18.24 ± 1.14	21.24 ± 2.24	1.029	NS
Reducing sugars (%)	3.44 ± 0.04	2.73 ± 0.02	0.021	0.082*
Non - reducing sugars (%)	3.25 ± 0.05	2.77 ± 0.05	0.031	0.121*
Total sugar (%)	6.76 ± 0.03	5.50 ± 0.02	0.029	0.080*
Ascorbic acid (mg/100ml)	10.11 ± 3.31	9.29 ± 0.47	1.360	NS
Beta carotene (mg/100ml)	7.58 ± 0.15	5.30 ± 0.081	4.260	NS

* Significant at 5 %
** Mean of triplicate observation ± SD
CO juice blend = Carrot juice : Orange juice :: 100 : 50
COA juice blend = CO juice blend : Aloe vera juice :: 100:50

C. Physico-chemical characteristics of *Aonla* – Ginger juice (AG) and *Aonla* – Ginger - Aloe vera juice (AGA) blend

Parameters	AG Juice blend	AGA Juice blend	S.Em	CD at 5%
Moisture (%)	83.87 ± 0.06	87.29 ± 0.81	0.332	1.298*
Total solids (%)	16.12 ± 0.06	12.72 ± 0.77	0.318	1.244*
TSS (° brix)	14.53 ± 0.30	12.56 ± 0.25	0.161	0.631*
pH	4.18 ± 0.04	4.25 ± 0.09	0.041	NS
Titrable acid (%)	0.26 ± 0.00	0.13 ± 0.00	0.005	0.021*
Brix acid ratio	56.76 ± 1.19	98.14 ± 2.01	0.957	3.742*
Reducing sugars (%)	8.14 ± 0.08	6.57 ± 0.06	0.042	0.165*
Non - reducing sugars (%)	2.36 ± 0.05	1.51 ± 0.04	0.028	0.111*
Total sugar (%)	10.50 ± 0.03	8.08 ± 0.02	0.015	0.058*
Ascorbic acid (mg/100ml)	125.18 ± 0.94	105.47 ± 0.88	0.530	2.074*
Chlorophyll- a (mg/100ml)	0.32 ± 0.05	0.26 ± 0.04	0.030	NS
Chlorophyll- b (mg/100ml)	0.24 ± 0.01	0.19 ± 0.009	0.007	0.028*
Total chlorophyll (mg/100ml)	0.57 ± 0.04	0.42 ± 0.14	0.047	NS

* Significant at 5 %
** Mean of triplicate observation ± SD
AG juice blend = Aonla juice :Ginger juice : Honey : Water :: 30 : 5 : 15 : 100
AGA juice blend = AG juice blend : Aloe vera juice :: 100:50

Appendix IX

General information of experimental subjects (n=50)

Attributes		**Attributes**	
GENERAL INFORMATION			
Age	**n=50**	**Sex**	**n=50**
40-45	14 (28)	Female	32 (64)
46-51	15 (30)	Male	18 (36)
52-57	19 (38)		
58-63	2 (4)		
Occupation		**Education**	
House wife	15 (30)	Illiterate	2 (4)
Service	33 (66)	Junior high school	2 (4)
Business	2 (4)	High school	12 (24)
Marital status		Intermediate	2 (4)
Married	42 (84)	Graduation	13 (36)
Unmarried	1 (2)	Post graduation	16 (32)
Widow	6 (12)	Ph. D.	3 (6)
Divorcee	1 (2)		
Type of problem		**Religion**	
Constipation	20 (40)	Hindu	36 (72)
Diabetes	14 (28)	Muslim	14 (28)
Hypertension	16 (32)		
WORK PATTERN AND HABITS			
Life style		**Active working hours**	
Sedentary	38 (76)	5-8 hours	23 (46)
Moderate	12 (24)	9-12 hours	23 (46)
		13-16 hours	3 (6)
		17-20 hours	1 (2)
Smoking / chewing tobacco		**Drinking**	
Daily	6 (12)	Occasionally	2 (4)
Occasionally	4 (8)	Rarely	4 (8)
Rarely	1 (2)	No	44 (88)
No	39 (78)		
PHYSICAL FITNESS			
Exercise / types of exercise		**Frequency of exercise**	
Walking	15 (30)	Daily	26 (70)
Yoga	14 (28)	Whenever get time	11 (30)
Walking + yoga	6 (12)		
Any other	2 (4)		
No	13 (26)		
Duration of exercise		**Hours of sleep / rest**	
Less than half an hour	20 (54)	Less than 8 hours	31 (62)
Half to one hour	14 (38)	8 hours	16 (32)
One to two hour	3 (8)	More than 8 hours	3 (6)

Appendix X

a) BMI classification of diabetic subjects at baseline

BMI classification	Control group (n=7)	Experimental group (n=7)
Underweight	1 (13)	-
Normal	2 (29)	2 (29)
Pre obese	2 (29)	2 (29)
Obese class 1	2 (29)	2 (29)
Obese class 2	-	1 (13)
* Values in parentheses indicate percent		

b) Effect of LK and LKA juice blend on weight, BMI and WHR of diabetic subjects

	Group **	Weight ± S.em	BMI ± S.em	Waist to hip ratio ± S.em
At baseline	Control	62.57 ± 5.50	25.76 ± 2.07	0.86 ± 0.01
	Experimental	72.28 ± 6.17	29.12 ± 2.27	0.88 ± 0.03
After 30 days	Control	61.71± 5.03	25.41 ± 1.88	0.85 ± 0.01
	Experimental	70.00 ± 5.61	28.17 ± 2.00	0.86 ± 0.02
Difference	Control	0.86 (1.37)	0.35 (1.35)	0.01 (1.16)
	Experimental	2.33 (3.22)	0.94 (3.22)	0.03 (3.40)
Calculated t- value	Control	NS	NS	NS
	Experimental	3.50 *	3.40*	NS
* significant at 5 % Tabulated t- value = 2.45		Values in parentheses indicate percent ** = control (n=7) and experimental (n=7)		

c) **Effect of LK and LKA juice blend on fasting blood sugar level of diabetic subjects**

	Group **	**Blood sugar**
At baseline (a)	Control	194.37 ± 37.55
	Experimental	192.20 ± 34.33
After 15 days	Control	164.77 ± 48.08
	Experimental	147.78 ± 26.06
After 30 days (b)	Control	131.41 ± 46.93
	Experimental	100.61 ± 18.91
S.em	Control	16.79
	Experimental	12.15
CD at 5 %	Control	49.90 *
	Experimental	36.63*
Difference (a-b)	Control	62.96 (32.39)
	Experimental	91.59 (47.65)

***** significant at 5%
** control (n=7) and experimental (n=7)
Values in parentheses indicate percent reduction

d) Effect of LK and LKA juice blend on lipid profile of diabetic subjects

Biochemical parameter	**Group ****	**At baseline**	**After 30 days**	**Difference (a-b)**	**Calculated t- value**
Total cholesterol	**Control**	196.28± 16.46	175.71 ± 13.25	20.57 (10.47)	2.66 *
	Experimental	208.00 ± 11.71	174.57 ± 6.33	33.43 (16.02)	2.50*
HDL	**Control**	50.22 ± 3.78	51.17 ± 2.99	-0.95 (-1.89)	-0.20
	Experimental	48.38 ± 5.03	50.61 ± 2.84	- 2.23 (-4.60)	-0.83
Triglycerides	**Control**	178.14 ± 21.92	130.85 ± 6.47	47.29 (26.54)	2.52*
	Experimental	195.85 ± 24.66	142.71 ± 11.62	53.14 (27.13)	3.37*
LDL	**Control**	110.42 ± 15.68	98.32 ± 12.83	12.10 (10.95)	1.58
	Experimental	120.31 ± 9.50	95.35 ± 6.60	24.96 (20.74)	2.99*
VLDL	**Control**	35.62 ± 4.38	26.17 ± 1.29	9.45 (26.53)	2.52*
	Experimental	39.17 ± 4.59	28.54 ± 2.32	10.63 (27.13)	3.37*
TC/HDL ratio	**Control**	3.90 ± 0.29	3.43 ± 0.35	0.47 (12.05)	1.96
	Experimental	4.29 ± 0.32	3.44 ± 0.33	0.85 (19.81)	1.56
LDL/HDL ratio	**Control**	2.20 ± 0.24	1.98 ± 0.29	0.22 (10.00)	1.20
	Experimental	2.48 ± 0.18	1.88 ± 0.23	0.60 (24.19)	4.93*

***** significant at 5 %
** control (n=7) and experimental (n=7)
Values in parentheses indicate percent
Tabulated t- value = 2.45

e) Anthropometric measurements of diabetics subjects at baseline and after 30 days of study period

Parameter	G	P	Subjects (n=7)							Mean
Height (mt)	C	-	1.55	1.55	2.56	1.50	1.52	1.60	1.57	
	E	-	1.55	1.50	1.55	1.70	1.57	1.52	1.55	
Weight (Kg)	C	B	75.00	50.00	65.00	56.00	60.00	87.00	45.00	**62.57**
		A	74.00	50.00	63.00	54.00	60.00	84.00	47.00	**61.71**
	E	B	58.00	50.00	82.00	85.00	86.00	73.00	70.00	**72.28**
		A	57.00	50.00	78.00	83.00	82.00	70.00	70.00	**70.00**
BMI kg/mt^2	C	B	31.25	20.83	25.39	24.88	25.86	33.98	18.14	**25.76**
		A	30.83	20.83	24.60	24.00	25.86	32.81	18.95	**25.41**
	E	B	24.16	20.83	34.16	29.41	34.67	31.46	29.16	**29.12**
		A	23.75	20.83	32.5	28.71	33.06	30.17	28.17	**28.17**
Waist (inch)	C	B	43.00	33.00	36.00	32.00	35.00	44.00	31.00	**36.28**
		A	42.00	33.00	35.00	31.00	35.00	43.00	30.00	**35.57**
	E	B	34.00	34.00	39.00	44.00	49.00	39.00	40.00	**39.85**
		A	34.00	34.00	37.00	42.00	45.00	37.00	38.00	**38.14**
Hip (inch)	C	B	47.00	40.00	42.00	37.00	41.00	52.00	34.00	**41.85**
		A	47.00	40.00	41.00	36.00	41.00	52.00	33.00	**41.42**
	E	B	40.00	40.00	46.00	43.00	51.00	47.00	45.00	**44.57**
		A	40.00	40.00	45.00	43.00	51.00	46.00	44.00	**44.14**
Waist to Hip ratio	C	B	0.91	0.82	0.85	0.86	0.85	0.84	0.91	**0.86**
		A	0.89	0.82	0.85	0.86	0.85	0.82	0.90	**0.85**
	E	B	0.85	0.85	0.84	1.02	0.96	0.82	0.88	**0.88**
		A	0.85	0.85	0.82	0.97	0.88	0.80	0.86	**0.86**

G = Group, C = Control group (n=7), E = Experimental group (n=7)
B = values at baseline, A = values after 30 days

f) Lipid profile of diabetics subjects at baseline and after 30 days of study period

Parameter	G	P	Subjects (n=7)							Mean
Total cholesterol (TC)	C	B	231.0	160.0	135.0	262.0	178.0	191.0	217.0	**196.28**
		A	215.0	158.0	114.0	201.0	176.0	161.0	205.0	**175.71**
	E	B	174.0	181.0	230.0	201.0	194.0	212.0	264.0	**208.00**
		A	163.0	158.0	194.0	177.0	184.0	193.0	153.0	**174.57**
HDL	C	B	52.5	38.0	57.4	61.7	37.3	45.7	59.0	**50.22**
		A	52.9	64.4	51.0	55.9	39.2	46.0	48.8	**51.17**
	E	B	33.8	49.9	45.6	47.0	37.5	49.7	75.2	**48.38**
		A	46.6	53.6	50.4	49.7	39.0	51.0	64.0	**50.61**
Triglycerides	C	B	127.0	241.0	102.0	146.0	231.0	239.0	161.0	**178.14**
		A	124.0	137.0	98.0	130.0	143.0	132.0	152.0	**130.85**
	E	B	227.0	163.0	273.0	217.0	151.0	242.0	98.0	**195.85**
		A	120.0	145.0	168.0	158.0	135.0	182.0	91.0	**142.71**
LDL	C	B	153.1	73.8	57.2	171.1	94.5	97.5	125.8	**110.42**
		A	137.0	66.2	43.4	119.1	108.2	88.6	125.8	**98.32**
	E	B	94.8	98.5	129.8	109.7	126.3	113.9	169.2	**120.31**
		A	92.4	75.4	110.0	95.7	118.0	105.2	70.8	**95.35**
VLDL	C	B	25.4	48.2	20.4	29.2	46.2	47.8	32.2	**35.62**
		A	24.8	27.4	19.6	26.0	28.6	26.4	30.4	**26.17**
	E	B	45.4	32.6	54.6	43.4	30.2	48.4	19.6	**39.17**
		A	24.0	29.0	33.6	31.6	27.0	36.4	18.2	**28.54**
TC to HDL ratio	C	B	4.4	4.21	2.35	4.25	4.77	4.18	3.68	**3.97**
		A	4.06	2.45	2.24	2.6	4.49	3.5	4.2	**3.36**
	E	B	5.15	3.63	5.04	4.2	2.76	4.27	3.51	**4.08**
		A	3.50	2.95	3.85	3.56	4.72	2.13	2.39	**3.30**
LDL to HDL ratio	C	B	2.92	1.94	1.00	2.77	2.53	2.13	2.13	**2.20**
		A	2.60	1.03	0.85	2.13	2.79	1.93	2.58	**1.98**
	E	B	2.80	1.97	2.85	2.29	3.37	2.29	2.25	**2.54**
		A	1.98	1.41	2.18	1.93	3.03	2.05	1.11	**1.95**

G = Group, C = Control group (n=7), E = Experimental group (n=7), B = values at baseline, A = values after 30 days

Appendix XI

A. **Baseline Body Mass Index (BMI) of constipated subjects**

BMI	**Control group**	**Experimental group**
Normal	2 (20)	1 (10)
Pre obese	4 (40)	6 (60)
Obese class 1	3 (30)	3 (30)
Obese class 2	1 (10)	-
* Values in parentheses indicate percent		

B. Effect of CO juice and COA juice blend on weight, BMI, and waist to hip ratio (WHR)

	Group *	**Weight ± S.em**	**BMI ± S.em**	**Waist to hip ratio ± S.em**
At baseline	Control	68.30 ± 2.65	29.16 ± 1.34	0.87 ± 0.007
	Experimental	72.60 ± 1.46	28.28 ± 0.75	0.94 ± 0.035
After 30 days	Control	67.40 ± 2.56	28.77 ± 1.28	0.87 ± 0.008
	Experimental	70.80 ± 1.41	27.49 ± 0.76	0.93 ± 0.035
difference	Control	0.90 (1.31)	0.39 (1.33)	0.00 (0 .0)
	experimental	1.80 (2.47)	0.79 (2.70)	0.01 (1.06)
Calculated t- value	Control	3.85 *	4.00*	NS
	experimental	5.51*	5.10*	5.99*
* significant at 5 % Tabulated t- value = 2.45		Values in parentheses indicate percent * = control (n=7) and experimental (n=7)		

C. Anthropometric measurements of constipated subjects at baseline and after 30 days of study period

Control group at baseline (n=10)						Control group after 30 days (n=10)				
Height (mt)	**Weight (Kg)**	**BMI kg/mt^2**	**Waist (inch)**	**Hip (inch)**	**Waist to hip ratio**	**Weight (Kg)**	**BMI kg/mt^2**	**Waist (inch)**	**Hip (inch)**	**Waist to Hip ratio**
1.58	69	27.71	39	45	0.86	68	27.30	38	44	0.86
1.61	57	22.00	35	39	0.89	57	22.00	34	38	0.89
1.25	58	37.17	36	42	0.85	57	36.53	35	42	0.85
1.58	83	33.33	40	47	0.85	81	32.53	40	46	0.85
1.58	62	24.89	34	38	0.89	61	24.49	34	38	0.89
1.55	65	26.97	36	42	0.85	64	26.55	36	42	0.85
1.58	76	30.52	36	41	0.87	76	30.52	35	41	0.87
1.50	66	29.33	34	39	0.87	65	28.88	33	37	0.87
1.58	76	30.52	34	38	0.89	74	29.71	34	38	0.89
1.56	71	29.21	39	42	0.92	71	29.21	38	41	0.92
Mean	68.30	29.16	36.30	41.30	0.87	67.40	28.77	35.70	40.70	0.87
Experimental group at baseline (n=10)						**Experimental group after 30 days (n=10)**				
Height (mt)	**Weight (Kg)**	**BMI kg/mt^2**	**Waist (inch)**	**Hip (inch)**	**Waist to Hip ratio**	**Weight (Kg)**	**BMI kg/mt^2**	**Waist (inch)**	**Hip (inch)**	**Waist to Hip ratio**
1.52	66	28.57	34	39	0.87	64	27.70	33	38	0.86
1.64	75	27.98	36	40	0.90	71	26.49	34	38	0.89
1.67	79	28.41	46	44	1.04	77	27.69	44	43	1.02
1.58	77	30.92	45	50	0.90	76	30.52	42	47	0.89
1.52	72	31.16	38	49	0.77	70	30.30	36	48	0.75
1.67	66	23.74	35	34	1.02	66	23.74	34	34	1.00
1.67	75	26.97	46	44	1.04	74	26.61	44	43	1.02
1.64	68	25.37	36	45	0.80	66	23.74	34	44	0.77
1.59	76	30.15	42	40	1.05	74	29.36	41	39	1.05
1.65	72	29.62	41	38	1.07	70	28.80	39	37	1.05
Mean	72.60	28.28	39.90	42.30	0.94	70.80	27.49	38.10	41.10	0.93

Appendix XII

A. **BMI classification of hypertensive subjects at baseline**

BMI classification	**Control group (n=8)**	**Experimental group (n=8)**
Underweight	-	1 (12)
Normal	1 (12)	-
Pre obese	3 (38)	4 (50)
Obese class 1	3 (38)	3 (38)
Obese class 3	1 (12)	-
* Values in parentheses indicate percent		

B. Effect of AG and AGA juice blend on weight, BMI and WHR of hypertensive subjects

	Group	**Weight ± S.em**	**BMI ± S.em**	**Waist to hip ratio ± S.em**
At baseline	Control	69.00 ± 2.74	30.34 ± 2.10	0.89 ± 0.01
	Experimental	68.87 ± 4.70	27.93 ± 1.67	0.93 ± 0.03
After 30 days	Control	67.12 ± 2.68	29.52 ± 2.05	0.87 ± 0.01
	Experimental	66.50 ± 4.39	26.85 ± 1.53	0.89 ± 0.02
difference	Control	1.88 (2.72)	0.72 (2.37)	0.02 (2.24)
	experimental	2.37 (3.44)	1.08 (3.86)	0.04 (4.49)
Calculated t- value	Control	15.00*	12.15*	7.63*
	experimental	5.65*	5.63*	3.71*
* significant at 5 % Tabulated t- value = 2.37		Values in parentheses indicate percent ** control (n=8) and experimental (n=8)		

C. Anthropometric measurements of hypertensive subjects at baseline and after 30 days of study period

Parameter	G	P	Subjects (n=7)								Mean
Height (mt)	C	-	1.60	1.50	1.55	1.60	1.55	1.50	1.52	1.32	
	E	-	1.55	1.50	1.57	1.50	1.55	1.55	1.65	1.70	
Weight (Kg)	C	B	71.00	68.00	62.00	62.00	82.00	59.00	74.00	74.00	69.00
		A	69.00	66.00	60.00	60.00	80.00	58.00	72.00	72.00	67.12
	E	B	77.00	61.00	74.00	72.00	64.00	42.00	75.00	86.00	68.87
		A	74.00	58.00	72.00	70.00	61.00	42.00	73.00	82.00	66.50
BMI kg/mt^2	C	B	27.73	30.22	25.83	24.21	34.16	26.22	31.89	42.52	30.34
		A	26.95	29.33	25.00	23.43	33.33	25.77	31.03	41.37	29.52
	E	B	32.08	27.11	30.83	32.00	26.60	17.50	27.57	29.75	27.93
		A	30.83	25.77	29.03	31.11	25.41	17.50	26.83	28.37	26.85
Waist (inch)	C	B	47.00	36.00	39.00	34.00	43.00	33.00	37.00	42.00	38.87
		A	46.00	34.00	38.00	33.00	41.00	32.00	36.00	40.00	37.50
	E	B	40.00	31.00	48.00	38.00	36.00	28.00	40.00	44.00	38.12
		A	37.00	29.00	46.00	37.00	34.00	28.00	37.00	42.00	36.25
Hip (inch)	C	B	50.00	39.00	45.00	40.00	47.00	39.00	39.00	46.00	43.12
		A	50.00	38.00	45.00	39.00	46.00	39.00	39.00	45.00	42.625
	E	B	39.00	34.00	51.00	45.00	41.00	35.00	38.00	33.00	39.50
		A	39.00	33.00	50.00	45.00	40.00	35.00	38.00	33.00	39.12
Waist to Hip ratio	C	B	0.96	0.92	0.86	0.85	0.91	0.84	0.94	0.91	0.89
		A	0.92	0.89	0.84	0.84	0.89	0.81	0.92	0.88	0.87
	E	B	1.02	0.91	0.94	0.84	0.87	0.80	1.05	1.02	0.93
		A	0.94	0.87	0.92	0.82	0.85	0.80	0.97	0.97	0.89

G = Group, C = Control group (n=7), E = Experimental group (n=7)
B = values at baseline, A = values after 30 days

D. Lipid profile of hypertensive subjects at baseline and after 30 days of study period

Parameter	G	P	Subjects (n=7)								Mean
Total cholesterol	C	B	264.00	251.90	329.00	197.00	172.40	245.00	144.00	191.00	**224.28**
		A	230.30	246.80	347.00	207.50	165.30	235.70	142.20	176.30	**218.88**
	E	B	211.00	245.00	196.00	257.00	210.50	225.30	189.10	219.00	**219.11**
		A	137.20	228.10	168.30	207.60	215.50	206.00	171.80	199.80	**191.78**
HDL	C	B	54.30	65.80	69.30	41.20	50.30	82.90	43.60	55.00	**57.80**
		A	52.00	61.40	48.10	40.80	46.60	82.20	43.80	56.60	**53.93**
	E	B	40.00	53.20	41.80	28.20	39.70	65.40	49.50	62.00	**47.47**
		A	42.20	55.10	47.30	45.40	79.30	80.90	42.80	62.40	**56.92**
Triglycerides	C	B	292.00	125.00	1450.00	228.00	120.10	201.00	103.00	80.00	**324.88**
		A	234.00	83.70	653.00	177.70	146.90	167.10	94.30	86.80	**205.43**
	E	B	355.00	228.00	142.00	706.00	163.30	116.50	161.80	162.00	**254.32**
		A	111.30	144.60	117.20	182.80	135.00	85.00	117.90	106.80	**125.07**
LDL	C	B	151.30	161.00	359.30	110.20	98.08	121.90	79.80	120.00	**150.19**
		A	131.50	168.66	168.30	131.16	89.32	120.08	79.54	102.34	**123.86**
	E	B	100.00	146.20	125.80	87.60	168.14	136.60	107.24	124.60	**124.52**
		A	72.74	144.08	97.56	125.64	109.20	108.10	105.42	116.04	**109.84**
VLDL	C	B	58.40	25.00	290.00	45.60	24.02	40.20	20.60	16.00	**64.97**
		A	46.80	16.74	130.60	35.54	29.38	33.42	18.86	17.36	**41.08**
	E	B	71.00	45.60	28.40	141.20	32.66	23.30	32.36	32.40	**50.86**
		A	22.26	28.92	23.44	36.56	27.00	17.00	26.58	21.36	**25.39**
TC to HDL Ratio	C	B	4.86	3.83	4.75	4.78	3.43	2.96	3.30	3.47	**3.92**
		A	4.43	4.02	7.21	5.09	3.55	2.87	3.25	3.11	**4.19**
	E	B	5.28	4.61	4.69	9.11	5.30	3.44	3.82	3.53	**4.97**
		A	3.25	4.14	3.56	4.57	2.72	2.55	4.01	3.20	**3.50**
LDL to HDL Ratio	C	B	2.79	2.45	5.14	2.67	1.95	1.47	1.83	2.18	**2.56**
		A	2.53	2.75	3.50	3.21	1.92	1.46	1.82	1.81	**2.37**
	E	B	2.50	2.75	3.01	3.11	3.48	2.09	2.17	2.01	**2.64**
		A	1.72	2.61	2.06	2.77	1.38	1.34	2.46	1.86	**2.02**

G = Group, C = Control group (n=7), E = Experimental group (n=7)
B = values at baseline, A = values after 30 days

E. Effect of AG and AGA juice blend on lipid profile of hypertensive subjects

Biochemical parameter	Group *	At baseline (a)	After 30 days (b)	Difference (a-b)	Calculated t- value
Total cholesterol	**Control**	224.28 ± 21.01	218.88 ± 22.48	5.40 (2.40)	0.97
	Experimental	219.11 ± 8.14	191.78 ± 10.63	27.33 (12.47)	3.22 *
HDL	**Control**	57.80 ± 4.96	53.93 ± 4.68	3.84 (6.64)	1.49
	Experimental	47.47 ± 4.41	56.92 ± 5.59	-9.45 (-19.90)	-1.84
Triglycerides	**Control**	324.88 ± 162.72	205.43 ± 66.55	119.45 (36.76)	2.42*
	Experimental	254.32 ± 69.67	125.07 ± 10.39	129.25 50.82)	2.79*
LDL	**Control**	150.19 ± 31.28	123.86 ± 11.74	26.33 (17.53)	2.49*
	Experimental	124.52 ± 9.24	109.84 ± 7.33	14.68 (11.97)	2.46*
VLDL	**Control**	64.97 ± 32.54	41.08 ± 13.31	23.89 (36.77)	2.42*
	Experimental	50.86 ± 13.93	25.39 ± 2.07	25.47 (50.07)	2.74*
TC/HDL ratio	**Control**	3.92 ± 0.26	4.19 ± 0.50	-0.27 (- 6.88)	- 0.82
	Experimental	4.97 ± 0.64	3.50 ± 0.24	1.47 (29.57)	2.71*
LDL/HDL ratio	**Control**	2.56 ± 0.40	2.37 ± 0.26	0.19 (7.42)	0.79
	Experimental	2.64 ± 0.18	2.02 ± 0.52	0.62 (23.48)	2.39*
* Control group (n=8) and Experimental group (n=8) **Tabulated t-value = 2.37			Values in parentheses represent percent reduction		

Vita

The, author, daughter of Mr. Manohar Singh and Mrs. Reema Singh was born on May 19th, in Jalandhar, Punjab. She passed her Secondary Education Examination and Intermediate Examination from Kendriya Vidyalaya No. 1, Jhansi (Uttar Pradesh). She obtained her B.Sc (Home Science) degree with second division from Mahila Vidyalaya Degree College, Lucknow in 1998 . She completed her M.Sc. (Foods and Nutrition) degree with first division from Maharani Laxmi Bai P. G. College, Bhopal (Madhya Pradesh) in 2001. She passed UGC-NET Exam and worked as lecturer in Lucknow. Thereafter she joined the college of Post Graduate Studies in G. B. Pant University of Agriculture and Technology in 2006 for her Doctor of Philosophy in Human nutrition.

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ABSTRACT

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Thesis title : "ASSESSMENT OF THERAPEUTIC VALUE OF ALOE VERA *(Aloe barbadensis)* INCORPORATED JUICES".

Precious fruits and vegetables viz. lawki (Bottle gourd), karela (Bitter gourd), carrot, orange, aonla, ginger and honey were used in the present study for the formulation of juice blends with the incorporation of aloe vera juice. The per cent weight index, per cent waste index and per cent juice index of different fruits and vegetables and aloe vera ranged from 61.74 to 98.59, 1.24 to 37.80 and 42.52 to 72.71 per cent respectively. On the basis of sensory evaluation of juice blends, lawki- karela (LK) juice blend having lawki and karela juice in the ratio of 120:30, carrot-orange (CO) juice blend having carrot and orange juice in the ratio of 100:50 and aonla –ginger (AG) juice blend having aonla and ginger juice in the ratio of 30:5 (with water: honey::100:15) were selected as best combinations. Thirty ml juice from each of the three optimized juice blends was replaced by 30 ml of aloe vera juice for the preparation of lawki karela - aloe vera (LKA) juice, carrot orange - aloe vera (COA) juice and aonla ginger- aloe vera (AGA) juice blends. The mean sensory scores for colour, appearance, flavour, taste, consistency and overall acceptability of LK juice, CO juice and AG juice blend showed no significant difference with LKA juice, COA juice and AGA juice blend respectively. Physico-chemical and nutritional evaluation of single strength juice of different fruits and vegetables, aloe vera and honey showed that moisture (%), total solid (%), TSS , pH, titrable acidity (%), brix acid ratio (^{0} brix), reducing sugar (%), total sugar (%), non-reducing sugar (%), ascorbic acid (mg/100ml), beta carotene (mg/100ml), chlorophyll –a (mg/100ml), chlorophyll –b (mg/100ml) and total chlorophyll(mg/100ml) ranged from 19.68- 99.34, 0.65 - 80.31, 0.50 - 80.53, 2.55 - 7.32, 0.085- 2.34, 4.44 - 562.29 , 0.17 – 67.00, 0.30 - 69.45, 0.091 - 4.25, 0.80 - 624.56, 4.31-7.2, 0.48-168.60, 0.24-73.54, 0.73-242.15 respectively whereas calcium, sodium, potassium, iron, manganese and zinc content ranged from 4.17-73.45, 0.95-64.50, 23.40-384.00, 0.197-1.288, 0.058-0.777 and 0.039-0.848 mg/100ml respectively. Moisture, total solids, TSS, pH, reducing sugar, total sugar, ascorbic acid, chlorophyll-a, chlorophyll-b and total chlorophyll content of LK, CO and AG juice blend was significantly higher than LKA, COA and AGA juice blend respectively. The Na, K, Mn and Ca content of LKA juice was significantly higher than LK juice blend. Except for Mn, the Ca, Cu, Fe, Zn, Na and K content of CO juice was significantly higher COA juice blend. Ca, Mn, Zn and Na content of AGA juice was significantly higher than AG juice blend. The shelf life of LK, LKA, CO, COA, AG and AGA juice blend at ambient temperature was 1, 1, 2, 3, 3 and 3 days respectively while at refrigeration temperature the shelf life was 2, 2, 3, 3, 3 and 7 days respectively. Sensory scores of LK, LKA, CO, COA, AG and AGA juice blend decreased during the storage period but more significantly in LKA, COA and AGA juice blend. Sensory scores of all juice blends kept at ambient temperature and refrigeration temperature decreased significantly but more at ambient temperature. The total sugar content LK & LKA juice blends decreased significantly but the rate of reduction was less in LKA juice blends while total sugar increased significantly in CO-COA and AG-AGA juice blend but the rate of increment was less in COA and AGA juice blend during storage period. The ascorbic acid, beta carotene and total chlorophyll content of all juice blends decreased significantly during storage period but rate of decrement was less in aloe vera incorporated juices and also in juices kept at refrigeration temperature. Consumption of LK & LKA juice blend for 30 days brought significant reduction in blood glucose, total cholesterol, triglycerides, LDL and VLDL level whereas HDL level increased non-significantly in control and experimental diabetic subjects respectively but the respective percentage reduction and increment was greater in group who had consumed LKA juice blend. Greater relief from signs and symptoms of constipation was higher in group that consumed COA juice blend than CO juice blend consumed group. Consumption of AG and AGA juice blend for 30 days by control and experimental hypertensive subjects respectively showed significant reduction in total cholesterol, triglycerides and VLDL level but percentage reduction was higher in group that consumed AGA juice blend. HDL level increased in experimental group while decreased in control group non-significantly. All the juice blends brought significant reduction in total body weight and BMI but reduction was higher in those groups that consumed aloe vera incorporated juice blend viz. LKA, COA and AGA. Thus it can be concluded that aloe vera juice can be effectively incorporated into the juice blends of carrot-orange, aonla-ginger and lawki- karela without affecting their sensory characteristics. However its incorporation brought slight reduction in physico-chemical and nutritional composition of juice blends but its therapeutic role as a potent laxative, anti-hyperglycemic agent and anti-hyperlipidemic agent can not be ignored.

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