DEVELOPMENT OF ASHGOURD [*Benincasa hispida* (Thunb.) Cogn.] AND PUMPKIN (*Cucurbita moschata* Poir.) BASED READY-TO-SERVE (RTS) BEVERAGE

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DECLARATION

I hereby declare that this thesis entitled "Development of Ashgourd [*Benincasa hispida* (Thunb.) *Cogn.*] and Pumpkin (*Cucurbita moschata* Poir.) based ready-to-serve (RTS) beverage" is a bonafide record of research work done by me during the course of research and that the thesis has not previously formed the basis for the award of any degree, diploma, associateship, fellowship or other similar title, of any other university or society.

Vellayani,
06-09-2007.

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CERTIFICATE

Certified that this thesis entitled "Development of Ashgourd [*Benincasa hispida* (Thunb.) Cogn.] and Pumpkin (*Cucurbita moschata* Poir.) based ready-to-serve (RTS) beverage" is a record of research work done independently by Ms. Sadaf Aleem (2005-16-107) under my guidance and supervision and that it has not previously formed the basis for the award of any degree, fellowship or associateship to her.

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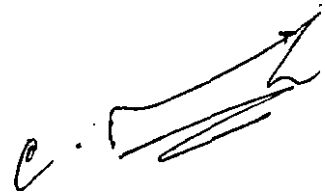

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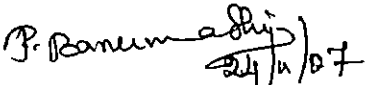
External Examiner: 

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Sadaf Aleem

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LIST OF ABBREVIATIONS

CD	-	Critical Difference
cm	-	Centimeter
et al.	-	And others
Fig.	-	Figure
FPO	-	Fruit Product Order
gm	-	Gram
g/l	-	Gram per litre
kg	-	kilogram
Min.	-	Minimum
Max.	-	Maximum
No.	-	Number
RTS	-	Ready-to-serve
SO_2	-	Sulphur dioxide
TSS	-	Total soluble solids
viz.	-	Namely
wt	-	Weight
ml	-	Milliliter
mg	-	milligram
ppm	-	Parts per million

LIST OF ABBREVIATIONS CONTINUED

µg	-	Micrograms
NIN	-	National Institute of Nutrition
A.O.A.C	-	Association of Official Analytical Chemists
^{0} Brix	-	Degree Brix
^{0}C	-	Degree Celsius
kg	-	Kilogram
%	-	Percentage
lbs	-	Pounds
Var.	-	Variety
cfu/ml	-	Colony forming unit per millilitre

Dedicated to

MY PARENTS

Introduction

INTRODUCTION

India with its wide range of soil and agro-climatic conditions, grows different kinds of horticultural crops, and is considered as one of the horticulturally rich countries of the world (Sharma, 2004). India has achieved self sufficiency and a good degree of stability in food production. But the post harvest losses due to the absence of adequate facilities for handling, transportation and storage can be considered as a social evil which eats up the growers margin and pushes up the consumer price (Kapoor and Kaur, 2004).

The country produces 50 million tonnes of fruits and 85 million tones of vegetables per year, but just 20 per cent of this goes for processing while over 25 per cent is spoiled due to improper handling and storage (CFTRI, 2002). Increased awareness about sound health and quality life and increased problem of nutritional insecurity, brought about a sudden shift from food grain production and consumption pattern to diversified and value added food production and consumption (Premnath et al., 2004).

With the overwhelming success of the green and white revolution, India is now ferverently poised for the food revolution that will ensure agricultural diversification and large investments in food processing. The food processing industry is witnessing a 20 per cent annual growth rate and, consequently the demand for processed foods and beverages in the country is constantly on the rise.

Food processing adds value, enhances shelf life and encourages crop diversification. Moreover, it is employment intensive and generates 1.8 direct employments per ten lakh rupee of investment and 6.4 employments indirectly (Awasthi et al., 2006).

Fruits and vegetables that are among the perishable commodities are important in human diet since they are the source of protective foods. They have become star nutrients as they contain antioxidants and various phytochemicals,

which help to protect the body against chronic diseases (Rajeshwari, 2003). Fruits and vegetables have also been coined as functional foods since they not only fulfill the physiological needs, but also have prophylactic effect. They are needed to be available throughout the year in fresh or processed form to meet one's requirement of vitamins and minerals.

Among the vegetables, the cucurbitaceous crops form one of the largest group in the vegetable kingdom with their adaptation in both temperate and tropical regions (Pitrat et al., 1999; Paris, 2001; Bisognin, 2002; Sanjur et al., 2002). The cucurbitacae consists of nearly 100 genera and over 750 species (Yamaguchi, 1983). Production of Ashgourd being 15326 tonnes and Pumpkin 532779 tonnes is abundantly available in India for consumers (Sidhu, 1998).

Efforts are required to process products from cucurbits as it has a limited shelf life under the prevailing temperature and humidity conditions. The demand for fruit juice and soft drinks is increasing day by day and consumption of synthetic soft drinks and carbonated beverages is also increasing especially among students and employed youths.

Considering the increasing demand and non-availability of cost effective vegetable juice, the present study entitled "Development of Ashgourd [*Benincasa hispida* (Thunb.)Cogn.] and Pumpkin (*Cucurbita moschata* Poir.) based Ready-To-Serve (RTS) beverages" is planned with the following objectives:

- To develop RTS beverages from Ashgourd and Pumpkin
- To ascertain their quality parameters.

Review of Literature

2. Review of Literature

The literature pertaining to the present investigation is reviewed under the following heads:-

2.1 Importance of fruits and vegetables

Our country has achieved self sufficiency and a good degree of stability of food production. This created an urgent need for providing health security to our population by supplying nutrition through balanced diet. Vegetables form one of the most important components of a balanced diet (Sidhu, 1998).

According to Ganry (2007), "Fruits and vegetables (F&V) are important components of a healthy diet, and their sufficient daily consumption could help prevent major diseases." WHO/FAO report addresses the need for increased fruit and vegetable consumption, particularly in developing countries where there is a dislocation between potential supply and the reality of daily diets.

Low fruit and vegetable intake was identified as an important risk factor for chronic diseases in the WHO World Health Report 2002. Overall, it is estimated that up to 2.7 million lives could potentially be saved each year if fruit

and vegetable consumption was sufficiently increased. A Joint FAO/WHO Expert Consultation recommended the intake of a minimum of 400 g of fruit and vegetable (F&V) per day (excluding potatoes and other starchy tubers) for the prevention of chronic diseases as well as for the prevention and alleviation of several micronutrient deficiencies, especially in developing countries (Keller and Tukuitonga, 2007).

India is the second largest producer of vegetables in the world next only to China. Presently the total vegetable production of India has already touched a level of 95 million metric tonnes (Singh et al., 2007a).

Prem Nath (2007) has opined that the increased production and consumption of horticultural crops particularly vegetables provide important nutrients and offer promise for the future as supplementary foods.

Vegetables product are regarded as a new generation of food products upgraded to substitute the traditional fried and sponge foods (USDA, 1998).

George (1994) stated that fruits are no longer a luxury since they belong to an important class of protective foods, which provide adequate vitamins and minerals needed for the maintenance of health.

Fruits and vegetables play a significant role in the human diet, through its supply of vitamins and minerals. They have become star nutrients as they contain antioxidants and various phytochemicals which help to protect the body against chronic diseases (Rajeshwari, 2003). Currently they are coined as functional foods since they not only fulfill the physiological needs but also have prophylactic effect (Kapoor and Kaur, 2004).

Dubey (1988) has opined that fruits and vegetables are known to provide the vigour and vitality. The chief energy constituent is carbohydrates. He further reported that fruits and vegetables contain the indigestible material called fibre, which adds bulk to stools and thus act as mild laxative.

Vaidehi (1994) is of the opinion that if we make use of tropical and under exploited fruits and vegetables, we may overcome the problem of deficiencies that are arising due to lack of certain vitamins and minerals.

Kapoor and Kaur (2004) reported that the underutilized fruit have an important role to play in satisfying the demand of nutritionally rich natural foods of high therapeutic value.

Among the vegetables, cucurbitaceous crops form one of the largest groups in the vegetable kingdom with their wide adaptation from arid to the humid tropic environments. Cucurbits may be considered as one of the largest botanical families of vegetable produced and consumed (Prem Nath, 2007).

2.1.1 Ashgourd – Origin, geographical distribution and production

Benincasa hispida – the winter melon has been reported to have grown as vegetable in China since 500 A.D. (Ng, 1993).

Ashgourd is reported to be introduced to India from Japan and Java by foreign navigators and missionaries (Peter, 1998). In India it is grown in Andhra Pradesh, Tamil Nadu, Karnataka, Maharashtra and Kerala.

Simmonds (1976) reported that Ashgourd is indigenous to Asian tropics. Ashgourd is probably a native of Malaysia. The cultivated forms may have originated in Southeastern Asia.

Benincasa hispida is also known as wax gourd, white pumpkin, Chinese squash, etc., (Sheshadri, 1993). The name wax gourd refers to the thick waxy cuticle that typically develops on mature fruits.

According to Chadha (2005), fruits become ready for harvesting 90-100 days after sowing when the ashy bloom slowly drops off. Fruits can be stored in a well ventilated room for 4-5 months.

The total production of Ashgourd is nearly 15326 tonnes (Sidhu, 1998). It is used mostly as vegetable, as confectionary and ayurvedic medicinal preparations but pulp could be used for preparing different products. (Indira and Peter, 1987).

Chung-May et al. (1987) found that major compounds identified in the gourds (Benincasa hispida, Cogn) were E-2-hexenal, n-hexanal and n-hexyl formate.

2.1.2 Pumpkin – Origin, geographical distribution and production

Pumpkin (*Cucurbita moschata* Poir.) is a hard shelled squash with bright orange, fine grained flesh and excellent nutritive properties (Wessel – Beaver and Varela, 1991)

According to Orzolek et al. (2000), Pumpkins originated in America. Fragments of stems, seeds and fruits have been identified and recovered from cliff dweller ruins in the Southwestern United States.

In another study done by Saade and Hernandez (1994), the oldest archaeological remain were found in Nortwestern Mexico and date from 4900 to 3500 B.C. Remains are also known in northern Belize, in Tikal, Gautemala (200 B.C to A.D 850) and in Huaca Preita, Peru (3000 B.C).

The geographical distributions of the known archaeological remains of *C. moschata* indicate that it has been cultivated for more than 5000 to 6000 years. In India it is grown mainly in Assam, West Bengal, Tamil Nadu, Karnataka, Madhya Pradesh, Uttar Pradesh, Orissa and Bihar (Chadha, 2005).

According to Sidhu (1998), the production of Pumpkins had already touched 532779 tonnes.

The fruits of *C. moschata* reach maturity 75 – 180 days after sowing depending upon variety and season. They can be stored for 2 -3 weeks at 15 - 20^0C as holding temperature at 75% relative humidity. Well mature Pumpkins can be stored for 4 – 6 months in a well ventilated room (Chadha, 2005).

2.1.3 Nutritional significance of Pumpkin and Ashgourd

According to Gwanama et al. (2002), tropical pumpkin (Cucurbita moschata) can be used to combat vitamin A deficiency and eye diseases.

In another study by Murkovic et al. (2002) different strains of Pumpkin were analyzed for their content of α – carotene, β – carotene and lutein which was found to be in the range of 0.06 to 17mg per 100gm of the fruit pulp.

According to Fokou et al. (2004) the seeds of *Cucurbita moschata* are rich in oil and protein content.

Cucurbits cultivated for seed consumption are reported to be rich in nutrients (Badifu, 1993; Schafferman et al., 1998; Mello et al., 2000, 2001).

According to Gonzalez et al. (2001), Cucurbita moschata is an important source of provitamin A, viz., β carotene.

Wills et al. (1984) has opined that Ashgourd contains 0.4 per cent protein, 1.96 per cent carbohydrate, 0.3 per cent minerals and traces of vitamin A, B and C per 100gm of edible portion. In addition the fruit also contains calcium, phosphorous, sodium, magnesium, iron, potassium, sulphur and starch in minute quantities (Nesamony, 1988).

2.1.3 Therapeutic value of Pumpkin and Ashgourd

In Ayurveda, Ashgourd fruit is considered best among climbers. The small fruited type referred to as 'Ney kumbalam' has wide demand for variety of ayurvedic preparations like 'kushmandasayanam' and 'kushmandasavam' (Devi Raveendran, 2003).

Ashgourd is considered good for people suffering from nervousness and debility (Saimbhi, 1993). Ripe fruits are useful for treating 'tridoshas', insanity, epilepsy and other nervous disorders (Sanyal, 1984).

Fruit paste can be used in case of cuts, burns and minor wounds (Mathewkutty, 1996). Tender stems are found good in liver troubles and muscular pain. Seed powder is antihelminthic (Agarwal, 1997).

In another study done by Chopra et al. (1996), the fruit is considered as a tonic, nutritive and diuretic. Decoction of fruit is laxative, styptic and given for respiratory troubles and internal hemorrhage (CSIR, 1986).

The alkaline fruit juice is useful to reduce hyperacidity (Santhakumar, 1991). Seeds are vermifuge and useful in difficult urination and bladder stones (Sivarajan and Balachandran, 1994). Fruit powder helps in increasing blood count and used in treating anaemia (Supreeja, 2002).

According to Ng (1993), cucurbits are well recognized source of secondary metabolites.

In another study *Benincasa hispida* is proven to be diuretic, laxative and aphrodisiac properties besides being effective in dermatological ailments, fever epilepsy, gonorrhea and intestinal worms (Chakravarty, 1990; Schultes, 1990; Nagao et al., 1991; Ng et al., 1991).

Cucurbita moschata is a diuretic and also effective in the treatment of ulcers, fever, jaundice, measles, smallpox and intestinal worms (Chakravarty, 1990; Schultes, 1990; Nagao et al., 1991; Ng et al., 1991).

The seed of *C. moschata* is a vermifuge and is rich in protein, fat and carbohydrate and is almost comparable with the nutrients in peanut but is low in fibre and ash (Saade and Hernandez, 1994; Loukou et al., 2007)

2.2 Processing of blended beverages

Food processing industry has been termed as 'sunrise industry' and several efforts have been made during the last few years to give a big thrust to this sector. Food processing adds value, enhances shelf life and encourages crop diversification (Awasthi et al., 2006).

India is among the world's major producers of food products and yet, India's share in International food trade is less than 2 per cent. Value addition to food by processing is poor. Fruits and vegetables available during specific season should be preserved so as to make it available in an acceptable form throughout the year. To avoid wastage during glut season, fruits have to be processed into juice, pulp, squash, jam and the like. Beverages are processed from single fruit or a combination of fruits.

Kaur and Khurdiya (1993) pointed out that fruit based beverages are becoming increasingly popular in the market with the growing consciousness of people regarding the nutritive value of fruits. The blends of fruit products could be an economic requisite to utilize profitably some fruit varieties for processing which may not have otherwise favourable characteristics and cost for product

preparation. Blending is also important to supplement appearance, nutrition and flavour and to develop new products.

According to Deka et al. (2002) in India among various fruit beverages, RTS beverages rank first with a production of 258.9 thousand tonnes followed by squash/ syrup, 74.20 thousand tonnes, fruit juice concentrate 8.55 thousand tonnes during the year 1996 – 1997.

Mall and Tandon (2007) prepared ready-to-serve (RTS) beverage by blending the pulp of guava fruit in different ratios with that of aonla to improve the flavour and acceptability of the beverages. The beverages having 10 per cent pulp, 12 or 14^0 Brix TSS and 0.22 per cent acidity were prepared, filled in pre-sterilized glass bottles, heat processed and stored up to three months under ambient conditions (18-35°C). Whey based papaya fruit juice blended RTS beverage was prepared as per FPO specification by blending papaya juice (10 per cent) with whey as reported by Kumar and Manimegalai (2005).

Zhukova and Zhukova (2002) developed beverages from milk whey and natural vegetable juices (carrot and beet juices, and syrup "Rubin"). Beverage was developed because of the high dietetic and therapeutic properties of whey and use in traditional and folk medicines for treatment and prevention of human diseases.

Studies on the processing techniques for *Sechium edule* juice and fermented beverage from Cucurbita moschata were carried out by Zhang et al. (2000). Results showed that juice had the delicate fragrance and colour of *Sechium edule*, and that the unfiltered beverage contains 20-30 per cent juice. The lactic acid fermented beverage from *C. moschata* was delicious, containing 12^0 Brix solids, 8.5 per cent sugar and 0.25 per cent acid.

Nath and Yadav (2002) prepared a blended beverage from kinnow mandarin juice and ginger. The juices were mixed at ratios of 0:30, 5:25, 10:20, 15:15, 20:10, 25:5 and 0:30, with final TSS and acidity of 40.0 and 40.5^0 Brix and 3.1 and 3.2 respectively.

RTS beverage was standardized by Narayana et al. (2002) from enzyme clarified juice. The clarified juice was used with different levels of TSS (15-19^0 Brix) and acidity (0.3-0.5 per cent) with added sugar, citric acid and water.

Jain and Khurdiya (2004) developed RTS beverages enriched with vitamin C by blending with Indian gooseberry juice. RTS beverage prepared by blending gooseberry juice and Pusa navrang grape juice in 20:80 ratio was found to be the best.

Deka et al. (2005) prepared mango – pineapple spiced RTS beverage by blending the juice in the ratio 85:15 respectively. The RTS had 10^0 Brix, 0.2 per cent acidity and 0.006 per cent cardamom spice drops.

Ramajayam et al. (2002) developed RTS beverage and squashes from Simarouba fruits. RTS juices prepared with 15 per cent juice, 20^0 Brix and squash prepared with 40 per cent juice, 45^0 Brix was more acceptable.

A refreshing drink from bitter gourd (*Momordica charantia* L) with sorbitol was prepared for diabetics. The calorie value of the developed beverage has been reduced by 80 per cent per serving at 100 per cent sweetness level of sorbitol (Barwal et al., 2005).

Inyang and Abah (1997) prepared blended juice with cashew apple and Sweet Orange juice in different proportions and the ratio of 60:40 was found to be highly acceptable in terms of flavour, after taste and overall acceptability. Sand pear juice was blended with apple juice, concentrated apple juice, apricot pulp and plum juices in different ratios of 90:10, 80:20, 70:30 and 60:40 and the sand pear juice and apricot pulp in 80:20 ratio was found to be acceptable (Attri et al., 1998).

Multi fruit RTS beverages were prepared by Sandhu and Sindhu (1992) and beverages prepared from Kinnow Mandarin, pear, mango and grapes in the ratio of 25:25:25:25 secured the highest organoleptic acceptability followed by pear and guava blend in the ratio of 75:25. Clarified Water Melon juice when blended with lime juice and pineapple juice also gave RTS beverage of acceptable quality.

The RTS beverages containing grape juice and mango pulp were evaluated for organoleptic qualities by Saxena et al. (1996) and were found to be acceptable to the taste panel. The blend containing juice or pulp in the ratio of 1:1 and Brix to acid ratio of 60:1 were found to be highly acceptable due to balanced taste and flavour.

Fruits of papaya were processed to prepare ready to serve beverage by Saravanan et al. (2004) using varying levels of pulp percentage (10, 14 and 18 per cent) with 13^0 Brix TSS and 0.3 per cent acidity as citric acid. RTS beverage with 18 per cent pulp, 13^0 Brix TSS and 0.3 per cent acidity was most highly ranked and thus preferred by the panelists.

Deka et al. (2004) developed lime-aonla spiced beverage prepared from desi variety of Aonla and ' kagzi lime'. Six per cent blended juices (95:05) were used for preparation of RTS beverages having 10^0 Brix, 0.3 per cent acidity and different aqueous spice extracts.

Vaidehi et al. (2003) developed blended juice with cashew apple and water melon in the preparation of 75:25, 50:50 and 25:75 and all the blends were found to be highly acceptable. Pomegranate and kokum juice when blended in the ratio of 80:20 gave the highest organoleptic score for colour, flavour, consistency and overall acceptability (Wasker, 2003).

Four different combinations of carrot juice with two levels each of beet root and black carrot juice were prepared by Dhaliwal and Hira (2001) and all four combinations were found to be highly acceptable. Studies by Kalra et al. (1991) revealed that 25-33 per cent papaya pulp could be incorporated with mango pulp without affecting the acceptability of mango beverages.

A non conventional carotene rich drink from mango was prepared by Kaur and Khurdiya (1993) by blending pineapple, orange and plum juices. Vaidya et al. (1998) evaluated mixed fruit juice beverages based on guava, pomegranate and ber juices in different proportions like 10:90, 20:80, 30:70, 40:60 and 50:50 for the preparation of RTS beverages and reported that guava and pomegranate juices in the ratio of 30:70 and guava – ber juice in the ratio of 40:60 were superior to others in terms of acceptability.

Tiwari (2000) prepared RTS beverages from guava – papaya blends having 15 per cent pulp, 14^0 Brix and 0.3 per cent acidity and guava – papaya blends in the ratio of 70:30 was found to be highly acceptable and observed a significant increase in the carotenoid content in the blended beverages.

Akinwale (2000) prepared acceptable and nutritious blended beverages with cashew apple juice and other tropical fruits like pineapple, orange, grape, mango and lemon.

The pomegranate juice blended with mango pulp for the preparation of ready to serve beverages was evaluated for sensory properties and found that beverages prepared by blending pomegranate and mango in the ratio of 60:40 was superior than the other combinations (Nakadi et al., 2001).

Deka et al. (2001) organoleptically evaluated arts beverage for the feasibility of blending of fruit juice or pulp of lime, aonla, grape, pineapple and mango in different proportions (5–90 per cent). Among the different combinations tried, lime – aonla in the ratio of 95:5 was found to be the best based on overall sensory score.

Toertia et al. (1992) analyzed the constituent of RTS beverage prepared by blending muskmelon and mango. The beverages contained 15^0 Brix TSS, 0.26 per cent acidity, 6.55 per cent reducing sugar, 12.80 per cent total sugars. Tripathi et al. (1992) standardized RTS beverages from a mixture of pineapple and guava juices in different proportions and the beverages prepared from pineapple and guava blends in the ratio of 90:10 had a TSS of 16^0 Brix and 0.2 per cent acidity and secured maximum scores with respect to overall quality parameters.

Srivastava (1998) prepared highly acceptable mango drink comprising of 50:50 combination of 'Dashehri' and 'Banganpalli' varieties with 15 per cent pulp, 14^0 Brix and 0.5 per cent acidity.

Saravanakumar and Manimeglai (2001) prepared acceptable RTS beverages by blending pear, pineapple and pomegranate juice in the ratio of 1:1:1 and pear and pineapple juice in the ratio of 1:1. The RTS contained 16^0 and 10^0 Brix TSS, 0.26 per cent and 0.20 per cent acidity, 3.95 and 3.85 pH, 4.074 and

4.24 per cent reducing sugars, 14.52 and 14.76 per cent total sugar and 2.38 and 2.60 mg ascorbic acid per 100ml respectively.

Singh et al. (2001) has formulated RTS beverages from jackfruit pulp with 10 per cent pulp content, 12^0 Brix TSS and 0.3 per cent acidity. Pandey and Singh (1999) developed recipes for commercial preparation of guava RTS beverage. The recipe containing 10 per cent pulp and 11^0 Brix TSS (total soluble solids) with 0.25 per cent acidity was found most ideal. The RTS beverage prepared from cv. Sardar (L-49) was better than that from cv. Allahabad Safeda, Apple Colour and Sangam.

2.3 Shelf stability of RTS beverages

2.3.1 Changes in Chemical Constituents during storage

In the RTS beverage prepared by Kumar and Manimeglai (2005) using whey and papaya fruit juice, during storage there was an increase in acidity and reducing sugar and a decrease in pH, total sugar and ascorbic acid but TSS did not change.

Kalra et al. (1991) did not observe any significant change in acidity and TSS during 12 months of storage in mango – papaya blended beverages at ambient temperature.

Kotecha and Kadam (2003) prepared RTS beverage, syrup and concentrate from tamarind. The products were stored at ambient (33.8+or-7.4 degrees C, RH 74.2+or-23.8 per cent) and low (7+or-2 degrees C, RH 90-95 per cent) temperatures for 180 days. Results showed that TSS, titrable acidity and total sugar content of RTS beverages stored at both temperatures increased, whereas ascorbic acid content decreased. A gradual increase in TSS, titrable acidity and total sugars, as well as a slight decrease in ascorbic acid content were observed for syrups stored at both temperatures. The rate of increase or decrease, however, was higher in syrup stored at ambient conditions. A gradual increase in TSS was observed in the juice concentrates stored at both temperatures. Titrable acidity and total sugar content also increased, while ascorbic acid content

decreased. The overall acceptability scores for the 3 types of products decreased during storage. The RTS beverage and juice concentrate stored at ambient conditions obtained lower scores compared to those stored at low temperature. Syrups stored at both ambient and low temperatures remained acceptable for 180 days.

Tripathi et al. (1992) noticed a decline in the acidity of pineapple – guava blended RTS beverages stored at ambient temperature for 3 months. There was an increase in the reducing sugar and total sugar contents of the beverages and no change in pH during 3 months of storage.

Barwal et al. (2005) observed an increase in the total soluble solids and reducing sugar while a decrease in the titratable acidity, total sugars and ascorbic acid in the dietetic bitter gourd RTS drink during a storage period of 6 months.

A decline in the ascorbic acid content and provitamin A content was noticed in the blended guava – carrot – bilimbi (50:50:25) RTS beverages during storage (Rosario, 1996). The author also observed an increased degradation of constituents when the RTS beverages were stored at higher temperature.

Prati et al. (2004) conducted the shelf-life study of a product developed with sugar cane juice, partially clarified-stabilized and passion fruit juice (5%). The blend was added with antioxidant, preservatives and thickener in pre-established concentration. After pasteurization, the product was refrigerated in polyethylene teraftalate (PET) bottles and refrigerated for one month. It was observed that ascorbic acid content was maintained at a good level until the end of storage, with a loss of only 20% in relation to the concentration added.

Freitas and Jackix (2004) conducted a study to develop a mixed nectar with carrot and orange, as well as fructooligosaccharides and citric pectin. The influence of the addition of these functional ingredients was evaluated by complete factorial design of their physicochemical characteristics and sensory acceptance. Addition of fructooligosaccharides and pectin enhanced the soluble rate and viscosity of the beverage. Fructooligosaccharides did not negatively affect the sensory properties of the drink, even at high concentration (15 per cent). Addition of citric pectin as soluble fibre at >1 per cent concentration led to

an increase in pH of the drink and the formulations with these concentrations did not reach good acceptance by the judges in the sensory evaluation.

Mokadi et al. (1984) observed rapid decrease in ascorbic acid content in blended fruit juices consisting of orange, banana and apple after three hours of incubation at ambient temperature.

Saravanan et al. (2004) noticed an increase in TSS, total sugar and reducing sugar and decreases in acidity, ascorbic acid, total carotenoids and non-reducing sugar during storage at 20-25 degrees C in papaya based RTS beverage. However, there was no change in Ca and P contents during storage up to 90 days.

Deka et al. (2005) in their mango – pineapple spiced RTS beverages stored in white and amber coloured bottles for 6 months under 3 different storage environment viz., ambient temperature (12.5-36 degrees C), cool chamber (10-29.6 degrees C) and low temperature (4+or-1 degrees C) showed a gradual decrease in sensory quality, acidity, ascorbic acid and tannins. Retention of ascorbic acid was more in beverages stored in amber coloured bottles under low temperature. An increasing trend was found in total soluble solids, reducing sugars, total sugars and NEB. The hunter colour values 'L and a' got decreased over 6 months. The major volatile flavouring compound found in mango-pineapple spiced beverage was Terpenyl acetate that got decreased during storage.

Krishnaveni et al. (2001) reported an increasing trend in the acidity and reducing sugar and decreasing trend in pH, total sugar, ascorbic acid and beta-carotene content, but TSS did not change during storage of jackfruit based RTS beverage. Retention of ascorbic acid and beta-carotene contents were much better in the samples stored in green coloured bottles.

In the enzyme clarified banana juice based RTS beverage developed by Narayana et al. (2002) results showed that the TSS recorded a slight decrease during storage up to 30 days in all the treatments, followed by an increase during subsequent storage up to 90 days. Reducing sugars drastically increased, total sugars slightly increased, while acidity and NEB decreased during storage.

Nascimento et al. (2003) studied the evaluation of thermal treatment on the quality and chemical composition of the beverage cajuina (clarified cashew juice). Results showed that the commercial cajuina beverage of Ceara State, Brazil presented great diversity in process standardization and vitamin C content, caused by inadequate thermal processing. The process is more efficient with a time period of 2 hours. Results indicate that a combination of the analyses of 5-HMF, furfural and ascorbic acid and the ratio of ascorbic acid/citric acid is an alternative method for the evaluation of cajuina quality.

Kotecha and Kadam (2003) observed that TSS, titratable acidity and total sugar content of tamarind based RTS beverages stored at both temperatures increased, whereas ascorbic acid content decreased. A gradual increase in TSS, titratable acidity and total sugars, as well as a slight decrease in ascorbic acid content were observed for syrups stored at both temperatures. The rate of increase or decrease, however, was higher in syrup stored at ambient conditions. A gradual increase in TSS was observed in the juice concentrates stored at both temperatures. Titratable acidity and total sugar content also increased, while ascorbic acid content decreased. The overall acceptability scores for the 3 types of products decreased during storage. The RTS beverage and juice concentrate stored at ambient conditions obtained lower scores compared to those stored at low temperature. Syrups stored at both ambient and low temperatures remained acceptable for 180 days.

Kannan and Thirumaran (2004) studied the storage life of jamun (*S. cumini*) fruit products like, ready-to-serve-beverage (RTS), squash, syrup and jam. Total soluble solids and reducing sugars increased whereas the total sugars and acidity decreased slightly. The total phenolics (tannins) decreased throughout the storage period. The anthocyanin rapidly degraded during 6 months of storage. The maximum retention of anthocyanin was in jam followed by syrup, squash and RTS beverage. The jamun products stored in colourless glass bottles were accepted even after 6 months of storage at ambient conditions.

Pandey (2004) observed that TSS content of guava (*Psidium guajava*) based RTS beverage and squash increased during storage, whereas TSS content

decreased in the case of cider. Acidity of RTS beverage and squash showed slight increases during storage, while acidity of cider decreased. Increase in browning and decrease in ascorbic acid content were observed during storage of the 3 guava beverages. Alcohol content of cider showed increasing trends up to 5 months of storage and then remained constant.

Jain et al. (1997) during storage of nectar and RTS of 6 early maturing mango cultivars (Amin, Bombay green, Dashehari, Kurukkan, Ranipasand and Sunderja) in the Chhattisgarh region of eastern Madhya Pradesh, found that the TSS, acidity and viscosity remained unchanged, but the ascorbic acid content was reduced, and reducing sugars increased. The quality of the mango RTS and nectar during storage remained acceptable for 3 and 4 months, respectively.

Dhaliwal and Hira (2001) did not observe any significant change in the acidity and total solids in carrot and beetroot blended beverages during storage. An increase in acidity and reducing sugar was observed in papaya – pineapple blended RTS beverage during 120 days of storage (Sindhumathi, 2002). The author also observed a decrease in the pH, ascorbic acid and β carotene contents of the beverages during storage.

An increase in the acidity from 1.1 – 1.32 per cent and reducing sugar from 33.3 – 43.4 per cent and a decrease in carotene content from 1476.3 – 1082.6 were observed in papaya – mango blended squash during storage period of six months (Manimegalai et al., 1994).

Sudhagar (2001) observed an increasing trend in acidity and total sugars and a decreasing trend in pH and reducing sugars in the pear squash and pear blended squash during storage of 180 days at room temperature. An increase in TSS and a decrease in acidity of the squash prepared by blending kinnow mandarin juice and ginger juice were observed with an increase in storage period at room temperature by Nath et al. (2005)

Joshi et al. (1993) observed a decreasing trend in the acidity of plum squash when spices were added to the beverage. The author also observed an increase in the ascorbic acid and sugar contents of the spiced plum beverages.

Deka (2000) found a decrease in the acidity of the spiced RTS beverages prepared from lime – aonla, mango – pineapple and guava – mango blends during six months of storage. The author also noticed highest brix / acid ratio in mango – pineapple – cardamom spiced beverages. An increasing trend in pH and tannin content was also observed in spiced beverages during storage.

Deka et al. (2004) studied the physico – chemical changes of lime – aonla spiced beverages during storage and found an increasing trend in TSS, reducing sugars and non enzymatic browning (NEB) and a gradual decrease in acidity, ascorbic acid and tannin content.

Srivastava (1998) reported a decline in the carotenoid content in mango RTS beverages prepared from 'Deshahri' and 'Banganpalli' varities after six months storage at ambient temperature. An increase in reducing sugars in guava – papaya blended RTS beverages during storage was reported by Tiwari (2000)

2.3.2 Changes in Organoleptic Qualities during storage

Singh et al. (2007b) standardized guava and pineapple juice blended RTS and nectar beverages. The RTS score prepared from 70% guava and 30% pineapple juice had highest acceptability with 82% score initially and 48% marks after four month of storage at ambient temperature. Similarly, nectar scored 80.2% marks initially but 56% marks after 4 months at ambient storage. Sudhagar (2001) observed a decrease in the scores for appearance, colour, flavour, taste and overall acceptability in pear and pineapple based squashes.

The papaya – mango blended squash prepared in the ratio of 50:50 was stored for six months at room temperature and observed a decrease in the overall acceptability score (Manimeglai et al., 1994). However Krishnaveni et al. (2001) observed that the sensory quality attributes of jackfruit based RTS beverages were found to be highly acceptable even after storing for 6 months at room temperature.

Likewise Bobby and Sri (2003) observed that orange and musambi squash formulated in different combinations were acceptable even after two months of storage.

Chakraborthy et al. (1993) reported that the watermelon RTS beverages prepared with or without blending with lime juice or pineapple juice had acceptable organoleptic quality and shelf life up to six months. The RTS beverages prepared from tamarind juice and blending with ginger, mint, cardamom, pepper and mixed spices were found to be highly acceptable even after storing for six months at room temperature (Manjula et al., 2003).

Daniel et al. (2003) did not observe any change in the sensory qualities during storage for the RTS beverages and squash prepared with palmyra fruit and roseapple. However a gradual decrease in overall acceptability scores were noticed during storage of 60 days by Sahu et al. (2005) in nutritionally rich and therapeutically valued whey based mango – lemongrass RTS beverages prepared with different concentrations of lemongrass distillate.

In a study conducted to develop a mango – milk beverage, Hassan and Ahmed (1998) found that even after 6 months of storage, the beverages were highly acceptable if stored at ambient temperature. Rabbani and Singh (1989) in their RTS beverages based on local sucking mango varieties found that they were less acceptable after 2 months of storage.

Deka et al. (2004) and Deka et al. (2005) observed a gradual decrease in the sensory qualities of lime – aonla and mango – pineapple spiced beverages respectively during storage. Pandey and Singh (1999) found that their guava based ready to serve beverage was acceptable up till four months of storage at ambient temperature.

Saravanakumar and Manimegalai (2001) studied the organoleptic characteristics of RTS beverages based on blended pear, pineapple and pomegranate juices and indicated a decreasing trend in the score for colour, flavour, taste and overall acceptability during storage.

2.3.3 Microbial changes

Kumar and Manimeglai (2005) found a slight increase in the microbial load of whey based papaya fruit juice blended RTS beverage, stored at refrigeration temperature after 3 months.

Prati et al. (2004) found that the beverage prepared by blending partially clarified stabilized sugar cane juice and natural passion fruit juice could be developed and commercialized up till 15 days under refrigeration because the conditions allowed the maintenance of microbiological and sensory qualities.

Narayana et al. (2002) detected no mould and bacterial growth up to 90 days of storage in enzyme clarified banana juice based ready to serve beverage. Same results were observed by Sindhumathi (2002) in papaya based blended RTS beverage up to 80 days of storage. However bacterial growth was observed in the RTS beverages during 100^{th} day which increased during 120^{th} day of storage.

Deka and Sethi (2001) could not notice any bacterial growth in the spiced RTS beverages during storage. However negligible growth of mould and yeast in drinks was observed in the spiced RTS beverages.

Attri et al. (1998) observed that blended juice prepared with sand pear, apple, apricot and plum could be stored at room temperature for six months without any spoilage.

Materials and Methods

3. MATERIALS AND METHODS

The present study entitled "Development of Ashgourd [*Benincasa hispida* (Thunb.) Cogn.] and Pumpkin (*Cucurbita moschata* Poir.) based Ready To Serve (RTS) beverage is aimed at developing RTS beverages utilizing the juice of Ashgourd and Pumpkin as the base material, mixing it with pineapple juice/ amla juice/ lime juice/ ginger extract and mint extract and sweetening it with sugar/ honey to introduce variety and to enhance the flavour and taste.

The beverages developed under the study were further evaluated for their physico-chemical properties, organoleptic qualities, shelf stability, consumer acceptability and economic viability. The methodology used for the study is presented under the following headings:-

3.1 Collection of fruits for the study

3.2 Preparation of fruit pulp and extraction of fruit juice

3.3 Standardization of RTS beverages

3.4 Quality Assessment

3.4.1 Physical Characterenistics of Fruits

3.4.2 Organoleptic evaluation of RTS beverages

3.4.2.1 Acceptability of RTS beverages

3.4.2.2 Selection of judges

3.4.2.3 Preparation of Score Card

3.4.2.4 Selection of best combinations

3.4.3 Chemical Constituents of Fruits and RTS beverages

3.4.4 Shelf stability of RTS beverages

3.4.5 Microbial examination of RTS beverages

3.5 Consumer acceptability study of the best selected RTS beverages

3.6 Cost benefit of the product

Statistical analysis

Plate 1. Ashgourd [Benincasa hispida (Thunb.)Cogn.]

Plate 2. Pumpkin (Cucurbita moschata Poir.)

3.1 Collection of fruits for the study

The fruits (Ashgourd and Pumpkin) were collected from Horticorp, Thiruvanathapuram. The fruits selected were fresh, firm and sound. Thirty to forty days mature, fresh Ashgourd with firm and sound flesh and fully matured ripe Pumpkin with orange-yellow flesh were purchased for the study (Plate 1 and Plate 2). Other fruit juices/extracts like pineapple, amla, lime and spices ginger and mint were also added which were purchased from Horticorp, Thiruvanathapuram. Horticorp is a government sales outlet counter of vegetables and fruits and gives freedom to select items.

3.2 Preparation of fruit pulp and extraction of fruit juice

Both Pumpkin and Ashgourd has thick skin and numerous seeds. The standard procedure suggested by CFTRI (1999) was followed for the extraction of juice from Ashgourd and Pumpkin.

The fruits were thoroughly washed, skin and seeds removed and then cut into small pieces. The pieces were ground to pulp using a mixer-grinder and the juice was extracted. The extracted juice was strained and used for preparation of RTS beverages.

Processing loss

Processing loss (PL) of the product was worked out using the formula:

$$PL = \frac{\text{Weight of food ingredients (Ap wt)} - \text{Weight of edible portion(Ep wt)}}{\text{Weight of food ingredients (Ap wt)}}$$

In the present study the modified formula given below was used to determine the processing loss that occurred while developing the product.

$$PL = \frac{\text{Weight of the whole fruit (Pumpkin/Ashgourd)} - \text{Quantity of juice obtained}}{\text{Weight of the whole fruit (Pumpkin/Ashgourd)}}$$

Yield ratio

To determine the Yield ratio from fruits (Pumpkin and Ashgourd), the following formula was used.

$$\text{Yield Ratio} = \frac{\text{Quantity of juice extracted from Pumpkin/Ashgourd}}{\text{Weight of edible portion of Pumpkin/Ashgourd}}$$

3.3 Standardization of RTS beverages

RTS beverage is a drink in which any base material such as fruit juice/ vegetable juice is considerably altered in composition with sugar and water during preparation so that no further dilution is necessary prior to serving and hence consumed in the Ready To Serve form (Deka, 2000). RTS beverages with different combinations were prepared keeping Pumpkin and Ashgourd juice as the base material and mixing each combination separately with pineapple juice/ amla juice/ lime juice/ ginger extract or mint extract. Sugar and honey were used in RTS beverages as sweetening agents. The combinations were prepared as per the FPO specifications as given in table 1.

Table 1. FPO specifications for RTS beverages (Source: FPO 1966)

S.No	Constituents	Quantity
1.	Min. fruit juice (per cent)	10
2.	Min. TSS(^{0} Brix)	10
3.	Max. Acidity (per cent)	0.3
4.	Max. preservative free SO_2(ppm)	70

The amount of citric acid and sugar/ honey to be added to prepare different combinations as per the FPO specifications was computed taking into account the acidity and TSS already present in the fruit juices.

In the preparation of different combinations of RTS, the ingredients used at different levels are detailed in table 2.

Table 2. Concentration of fruit juices in RTS beverages (in per cent)

	Base Material		Flavouring Agents				
Treatments	Ashgourd Juice (A)	Pumpkin Juice (P)	Pineapple Juice (a)	Amla Juice (b)	Lime Juice (c)	Ginger Extract (d)	Mint Extract (e)
T1	-	10	5	5	2.5	2.5	2.5
T2	-	20	5	5	2.5	2.5	2.5
T3	-	30	5	5	2.5	2.5	2.5
T4	-	40	5	5	2.5	2.5	2.5
T5	10	-	5	5	2.5	2.5	2.5
T6	20	-	5	5	2.5	2.5	2.5
T7	30	-	5	5	2.5	2.5	2.5
T8	40	-	5	5	2.5	2.5	2.5

(200 ml of RTS beverage was considered as 100 per cent)

In the preparation of RTS beverages, sugar syrup and honey syrup were prepared by mixing required quantity of honey/ sugar and citric acid in measured amount of boiled and cooled water. This was filtered and mixing it with Pumpkin juice/ Ashgourd juice according to their respective treatments. Other fruit juices or extracts were added as per their combinations. Finally the preservative was added.

The beverages were filled in sterilized glass bottles (200ml), leaving 2.5cm head space and were crown corked with sterilized metallic caps. The bottled beverages were then pasteurized at 72^0C for 15 minutes after which they were cooled to room temperature. The actual quantity of different ingredients used to prepare one litre of RTS beverages are furnished in table 3 and figure 1 depicts the flowchart showing the preparation of RTS beverages.

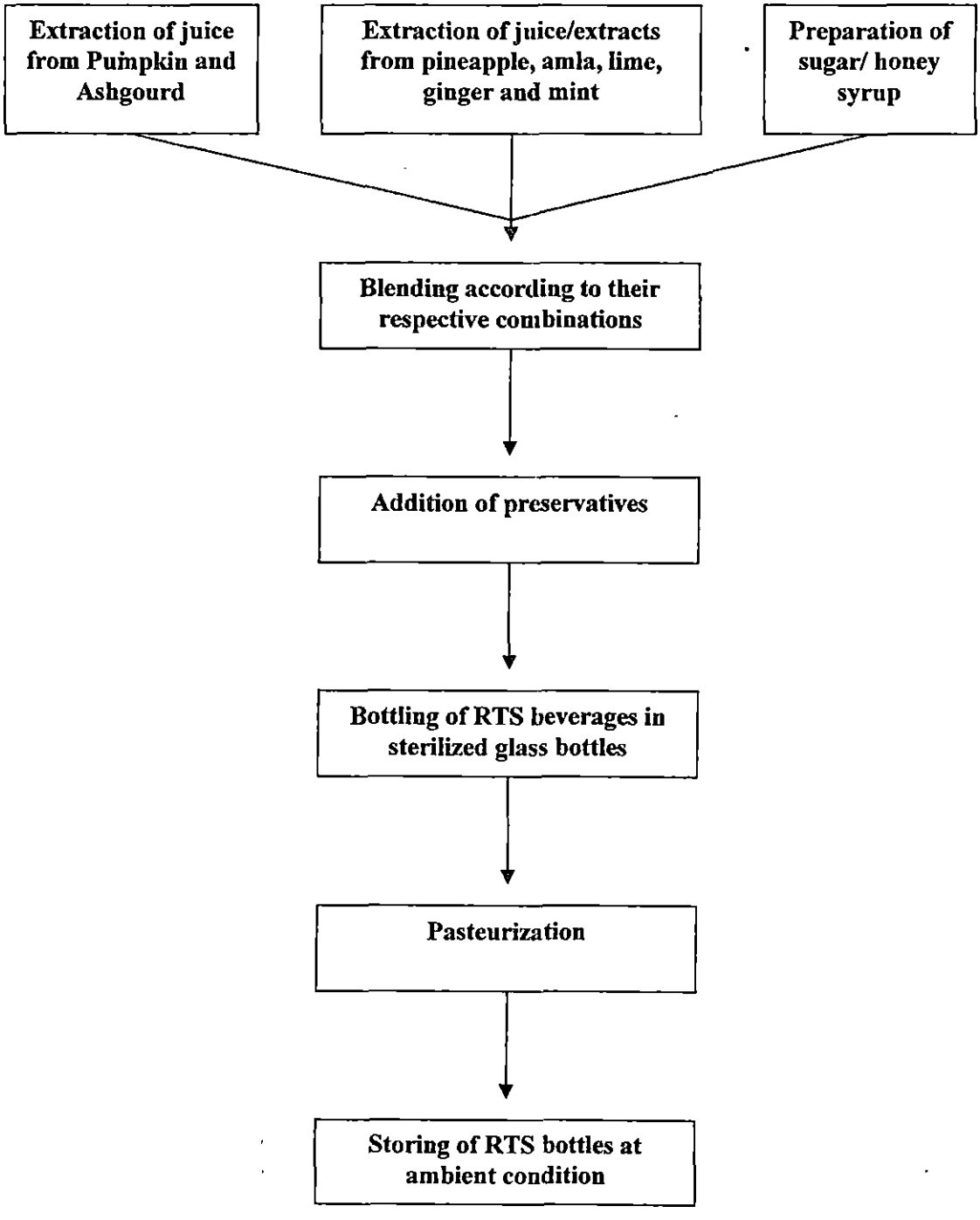
Table 3. Ingredients in One litre of RTS beverage

	Pumpkin				Ashgourd			
Ingredients	**T1**	**T2**	**T3**	**T4**	**T5**	**T6**	**T7**	**T8**
Base material								
Pumpkin juice(ml)	100	200	300	400	-	-	-	-
Ashgourd juice(ml)	-	-	-	-	100	200	300	400
Pineapple juice/ Amla juice (ml)	50	50	50	50	50	50	50	50
Lime juice/ Ginger extract (ml)	25	25	25	25	25	25	25	25
Sweetening agent								
*Sugar syrup (ml)	850 (190)	750 (167)	650 (145)	550 (123)	850 (190)	750 (167)	650 (145)	550 (123)
Honey syrup (ml)	567 (283)	500 (250)	433 (217)	367 (183)	567 (283)	500 (250)	433 (217)	367 (183)
Citric acid (gm)**	3	3	3	3	3	3	3	3
SO_2 (ppm)	70	70	70	70	70	70	70	70

* Figures in parenthesis denotes the quantity of sugar used in grams

** Not added in combinations containing lime juice

Fig 1. Flow chart showing preparation of RTS beverages from Pumpkin and Ashgourd



3.4 Quality assessment

Chemical qualities of the fruits Pumpkin and Ashgourd were assessed, followed by organoleptic evaluation of the standardized RTS beverages. Shelf stability of the stored RTS beverages were also assessed by evaluating the changes in the beverages organoleptically, chemically and microbiologically.

3.4.1 Physical characteristics of fruits

Physical characteristics like weight of the fruit, peel weight, seed weight, weight of edible portion, pulp weight, total juice content were recorded. The colour of the fruit pulp was also observed and recorded.

3.4.2 Organoleptic evaluation

3.4.2.1 Acceptability of RTS beverages

Sensory quality evaluation plays an important role in acceptability study of a new product. In order to select best combinations of the developed RTS beverages, organoleptic evaluation was conducted using score card by a panel of judges.

3.4.2.2 Selection of judges

A panel of 15 judges was selected using simple triangle test at laboratory level. The judges selected were in the age group of 18-35 years as suggested by Jellinek (1985).

3.4.2.3 Preparation of score card

The score card used for the evaluation of RTS beverages is given in appendix 1. The quality attributes viz. appearance, colour, flavour, taste and overall acceptability were evaluated.

3.4.2.4 Selection of best combinations of RTS beverages

RTS beverages were standardized from Pumpkin and Ashgourd separately. Preliminary trials were carried out with different concentrations (10 per cent to 60 per cent) of Ashgourd juice and Pumpkin juice and mixing it with pineapple juice/ amla juice/ lime juice/ ginger extract/ mint extract to formulate RTS beverages of good consumer acceptance.

Initially 120 RTS beverage combinations were prepared, sixty from each Ashgourd and Pumpkin, using five fruit juice/spice extracts (pineapple juice/ amla juice/ lime juice/ ginger extract/ mint extract) and two sweetening agents (sugar/ honey) in all the six treatments (10 per cent to 60 per cent).

Evaluation of these 120 RTS beverages revealed that RTS containing 10 per cent to 40 per cent juice concentration were more acceptable than those containing 50 per cent and 60 per cent juice. Hence, for further study, 80 combinations of RTS beverages were standardized and organoleptically evaluated and scored. Details of mean scores assigned to the different combinations is given in appendix II. Based on the overall mean scores 14 combinations having the highest scores were further identified. Hedonic scoring test was conducted by 10 judges on these selected 14 combinations so as to select 10 best combinations, 5 each from Pumpkin and Ashgourd for detailed study. One beverage from each Pumpkin and Ashgourd which maintained highest organoleptic score throughout the storage period and showed less changes chemically and microbiologically was selected for consumer acceptability study viz., Pumpkin based RTS (T1PbS), mixed with amla juice and sweetening it with sugar and Ashgourd based RTS (T1AcH) mixed with ginger extract and honey.

For ease of presentation, abbreviations were used for the 10 best selected combinations of RTS beverages which are detailed below:

T_2PaH – 20 per cent Pumpkin juice (T_2P) mixed with pineapple juice (a) and sweetened with honey (H).

T_1PcH – 10 per cent Pumpkin juice (T_1P) mixed with ginger extract (c) and sweetened with honey (H).

T_1PbS – 10 per cent Pumpkin juice (T_1P) mixed with amla juice (b) and sweetened with sugar (S).

T_3PcS – 30 per cent Pumpkin juice (T_3P) mixed with ginger extract (c) and sweetened with sugar (S).

T_1PdS – 10 per cent Pumpkin juice (T_1P) mixed with lime juice (d) and sweetened with sugar (S).

T_1AaH – 10 per cent Ashgourd juice (T_1A) mixed with pineapple juice (a) and sweetened with honey (H).

T_1AcH – 10 per cent Ashgourd juice (T_1A) mixed with ginger extract (c) and sweetened with honey (H).

T_1AbS – 10 per cent Ashgourd juice (T_1A) mixed with amla juice (b) and sweetened with sugar (S).

T_2AcS – 20 per cent Ashgourd juice (T_2A) mixed with ginger extract (c) and sweetened with sugar (S).

T_2AdS – 20 per cent Ashgourd juice (T_2A) mixed with lime juice (d) and sweetened with sugar (S).

3.4.3 Chemical constituents of fruits and RTS beverages

Chemical components of the fruit Pumpkin and Ashgourd and ten selected combinations of RTS beverages were analyzed using the standard methods given in table 4.

Table 4. Methods followed for the analysis of chemical constituents in fruits and RTS beverages

No	Parameters	Methods followed
1.	Total sugar (per cent)	Ranganna (1986)
2.	Reducing sugar (per cent)	Ranganna (1986)
3.	Total soluble solids (^{0} Brix)	Refractometer (Lal et al., 1998)
4.	β - Carotene (μg)	NIN (1991)
5.	Vitamin C (mg)	Ranganna (1986)
6.	Acidity (per cent)	Ranganna (1986)
7.	Moisture (per cent)	Ranganna (1986)
8.	Fibre (per cent)	A.O.A.C (1980)
9.	Total Ash(mg)	NIN (1991)
10.	Sodium(mg)	Thimmaiah (2004)
11.	Potassium(mg)	Thimmaiah (2004)

3.4.4 Shelf stability of RTS beverages

The selected ten best combinations of RTS, five from each Pumpkin and Ashgourd were prepared, preservative(KMS) was added and filled in clean, sterilized

and dried bottles of 200ml capacity leaving 2.5cm head space and crown corked with sterilized metallic caps. The bottles were pasteurized at 72^0 C for 15 minutes. The bottles were cooled and kept at ambient condition for storage study. The score card used for storage study and the mean scores obtained are presented in appendix III and IV respectively.

3.4.5 Microbial examination of RTS beverages

The microbial load including bacteria, fungi and yeast were estimated initially as well as finally after storage using serial dilution technique as suggested by Agarwal and Hasija (1986). The media used were nutrient agar, Martin's media and yeast extract mannitol agar (Appendix V). Ten selected best combinations of RTS beverages kept for shelf stability study were estimated for the growth of fungi, bacteria and yeast at the end of storage period. The procedure adopted for serial dilution was as follows – 1ml from each of the sample was taken in conical flask containing 99ml sterile water, making the dilution of 10^{-2}. From this 1ml of the dilution was further transferred into test tubes containing 9ml of sterile water so that the dilution becomes 10^{-3}. Likewise further dilutions of 10^{-4}, 10^{-5} and 10^{-6} were made.

In order to assess the number of fungi and yeast 1ml of 10^{-4} dilution was transferred into sterile petridishes and 10-15ml of each Martin's media and yeast extract mannitol agar were poured respectively.

For determining bacterial colonies, 1ml from 10^{-6} dilution was pipetted into sterile petriplates and nutrient agar media was added to it.

Three replications were done for each sample. The petriplates were then kept at room temperature for incubation. On the third day, bacterial population appeared which were visible as minute slimy colonies. Fungal growth appeared on the fifth day after incubation. Yeast colonies were not seen in any of the petriplates. The

colonies were then recorded from each of the replications of fungi, bacteria and yeast.

3.5 Consumer acceptability study of the best selected RTS beverages

Based on the quality assessment (chemical constituents, microbial load and shelf stability), the best combination of RTS containing Pumpkin and Ashgourd juice were selected and consumer acceptability study was conducted. Two selected RTS combinations each from Pumpkin and Ashgourd were assessed by 30 volunteers for three consecutive days for their preference and acceptability.

3.6 Cost benefit of the product

Cost benefit analysis was carried out based on the input cost i.e., cost of different ingredients used for the preparation of RTS beverages, cost of glass bottles used as packaging material and output cost (the total of input cost and added 10 per cent as overhead charges, fuel and labour charges).

Statistical analysis

The data collected were analyzed by applying the technique of analysis of variance for Completely Randomized Block Design (CRD) and test for proportion (Z test) following Panse and Sukhtame (1985).

Results

4. Results

Results of the present investigation entitled "Development of Ashgourd [*Benincasa hispida* (Thunb.) Cogn.] and Pumpkin (*Cucurbita moschata* Poir.) based Ready-To-Serve (RTS) beverage" are presented under the following heads:-

4.1 Assessment of physical characteristics of collected fruits.
4.2 Preparation of fruit pulp and extraction of fruit juices.
4.3 Standardization of RTS beverages.
4.4 Quality assessment
4.4.1 Assessment of chemical constituents in fruit
4.4.2 Assessment of chemical constituents in RTS beverages
4.4.3 Organoleptic evaluation of RTS beverages
4.5 Shelf stability of RTS beverages
4.5.1 Changes in organoleptic qualities of stored RTS beverages
4.5.2 Changes in chemical constituent of stored RTS beverages
4.5.3 Microbial analysis of stored RTS beverages
4.6 Comparison of the constituents of best selected RTS beverage with FPO specification
4.7 Consumer acceptability study
4.8 Cost benefit analysis of the product

4.1 Assessment of physical characteristics of collected fruits

Physical characteristics like total weight of the fruit, peel weight, seed weight, and weight of edible portion of collected Ashgourd and Pumpkin fruits were assessed in order to study the characteristics of the fruits for RTS beverage development. The physical characteristics are detailed in table 5.

Thirty to forty days mature Ashgourd and Pumpkin fruits were selected. Ashgourd with light green skin colour and waxy coating was purchased while

Pumpkin with light orange to light brown colour skin was purposively purchased for the preparation of RTS beverages.

Table 5. Physical characteristics of fruit Pumpkin and Ashgourd

Physical Characteristics	Ashgourd	Pumpkin
Average weight of the fruit (kg)	5.5	4.6
Average peel weight (kg)	1.375	2.070
Average seed weight (g)	2.5	3.2
Average edible portion weight (kg)	4.12	2.53

The mean weight of the Ashgourd purchased for the study was observed to be 5.5 kg. The mean weight of Pumpkin procured for the study was found to be 4.6 kg.

Peel weight (constituted of skin and core) was recorded after washing the fruits thoroughly and removing the peel carefully. The total weight of peel was noted to be 1.375 kg and 2.070 kg for Ashgourd and Pumpkin respectively.

Portion of the fruit left after removing peel and seeds, forms to be the edible portion of a fruit. The weight of the edible portion was observed to be 4.12 kg for Ashgourd and 2.53 kg for Pumpkin.

The seeds of Ashgourd fruits were white-cream and elliptical in shape while that of Pumpkin fruit were ovate/elliptical having a yellowish-white surface with shallow grooves. The weight of seeds was recorded after washing the seeds thoroughly and drying them at room temperature. The mean weight as recorded was found to be 2.5g and 3.2g for Ashgourd and Pumpkin respectively.

4.2 Preparation of fruit pulp and extraction of fruit juice

The colour of the pulp of Ashgourd fruit was noted to be white with a greenish tinge. The flesh of Pumpkin was observed to be deep yellow to orange in colour. The quantity of fruit pulp obtained from the ground edible portion was recorded as 4.12 kg for Ashgourd and 2.53 kg for Pumpkin.

The cut fruit pieces (exclusive of skin and seeds) were ground to pulp and the juice was extracted by straining the pulp and was recorded to be 3.910 litres and 2.248 litres for Ashgourd and Pumpkin respectively. Fruit juice/extract from pineapple, amla, lime, ginger and mint were also used to enhance the flavour of the RTS beverages. Fruit juices and extracts were initially prepared and kept aside before constituting RTS beverages.

Pineapple with mature and juicy flesh was chosen. After removing the skin, eyes and core it was cut into small cubes and then pulped in a mixer-grinder. Juice was strained and used as flavouring agent.

Large variety juicy Amla were chosen for juice extraction. It was thoroughly washed, cut into small pieces and seeds were removed. It was then ground to pulp and strained to obtain juice. Lime juice was obtained by thoroughly washing the lime, cutting it into halves and squeezing out the juice using lime squeezer.

Ginger was thoroughly washed, peeled and cut into small pieces. It was ground to paste and the juice was strained. Mint juice was extracted by grinding the mint leaves to a paste and straining the paste to obtain juice.

4.3 Standardization and selection of best combination of RTS beverages

Standardization and product development play a key role in the growth of food industries. According to Poduval (2002) one of the most important purposes of standardization is to facilitate the movement of materials and products through all stages of production, in any industrial activity starting from the raw material

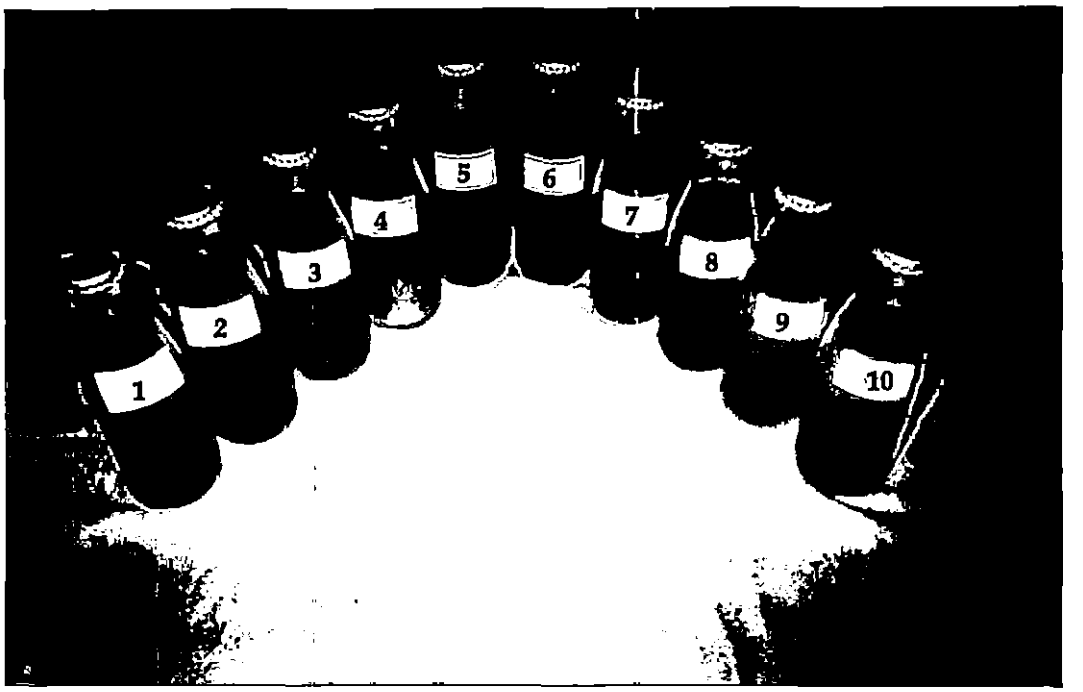


Plate 3. Ten best selected RTS combinations

1. T2PaH, 2. T1PcH, 3. T1PbS, 4. T3PcS, 5. T1PdS
6. T1AaH, 7. T1AcH, 8. T1AbS, 9. T2AcS, 10. T2AdS

to the finished product, then to the dealers and finally to the retailers and consumers.

RTS beverages were standardized using Pumpkin and Ashgourd juice as detailed in 3.3 and 3.4.2.4 of chapter Materials and Methods. These selected ten combinations were then assessed for further study.

Hedonic scoring is used to measure the degree of pleasurable and unpleasurable experience of the food product on a scale of 9 points from "like extremely" to "dislike extremely" (Kalia and Sood, 2000). Hedonic scoring for preference study was then conducted on these selected 14 combinations.

Results depicted in table 6 reveals that five combinations from each Pumpkin and Ashgourd based beverages were selected according to their percent scores, which are marked in bold alphabets. The numbers in the parenthesis indicate the number of judges whereas numbers outside parenthesis are the total scores given by those judges. Five combinations selected from Pumpkin based RTS beverages were (T_2PaH) mixed with pineapple juice and honey, (T_1PcH) mixed with ginger extract and honey, (T_1PbS) mixed with amla juice and sweetened with sugar, (T_3PcS) mixed with ginger extract and sweetened with sugar and (T_1PdS) mixed with lime juice and sweetened with sugar. Five combinations selected from Ashgourd based beverages were (T_1AaH) mixed with pineapple juice and honey, (T_1AcH) mixed with ginger extract and honey, (T_1AbS) mixed with amla juice and sweetened with sugar, (T_2AcS) mixed with ginger extract and sweetened with sugar and (T_2AdS) mixed with lime juice and sweetened with sugar. The highest percent score among Pumpkin based beverages (85 per cent) was achieved by (T_1PbS). Among Ashgourd based beverages, the highest percent score (77 Per cent) was recorded for (T_1AcH). These selected combinations were further studied in-depth for their chemical constituents as well as nutritional quality, microbial load and shelf stability. Plate 3 shows the selected 10 combinations of RTS beverages.

Table 6. Hedonic scoring for the preference of RTS beverages

Rating Scale	Scores	Scores for Pumpkin based combinations								Scores for Ashgourd based combinations					
		T_2PaH	T_1PbH	T_1PbS	T_1PcH	T_3PcS	T_1PdS	T_1PeH	T_1PeS	T_1AaH	T_1AbS	T_1AcH	T_2AcS	T_2AdS	T_1AeS
Like extremely	9														
Like very much	8	24 (3)		56 (7)	8 (1)	24 (3)	16 (2)				24 (3)	56 (5)			
Like moderately	7	21 (3)	14 (2)	21 (3)	28 (4)	21 (3)	42 (6)	7 (1)		28 (4)	28 (4)	14 (2)	35 (5)		7 (1)
Like slightly	6	12 (2)	36 (6)		24 (4)	12 (2)	12 (2)	42 (7)	18 (3)	36 (6)	12 (2)	6 (1)	12 (2)	36 (6)	12 (2)
Neither like nor dislike	5	5 (1)	10 (2)			10 (2)		10 (2)	25 (5)			10 (2)	15 (3)	20 (4)	25 (5)
Dislike slightly	4	4 (1)			4 (1)						4 (1)				8 (2)
Dislike moderately	3														
Dislike very much	2								4 (2)						
Dislike extremely	1														
TOTAL	90	**66**	60	**77**	**64**	**67**	**70**	59	47	**64**	**68**	**70**	**62**	**56**	52
Mean preference score		**0.73**	0.66	**0.85**	**0.71**	**0.74**	**0.77**	0.65	0.52	**0.71**	**0.75**	**0.77**	**0.68**	**0.62**	0.57
Percent Score		**73**	66	**85**	**71**	**74**	**77**	65	52	**71**	**75**	**77**	**68**	**62**	57

(Figures within parenthesis denotes the number of judges); n = Number of judges = 10

P = Pumpkin; A = Ashgourd; S = Sugar; H= Honey; a = Pineapple juice; b = Amla juice; c = Ginger extract; d = Lime juice; e = Mint extract.

T1 = Treatment(10% juice)

T2 = Treatment(20% juice)

T3 = Treatment(30% juice)

T4 = Treatment(40% juice)

4.4 Quality assessment

Quality is a very important parameter for judging the edible nature of any food product (Sharma, 2006). It is the ultimate criterion for the desirability of a food product. Among the various factors that influence the quality of a product, sensory attributes followed by chemical constituents are the major factors that determine the quality of a food product either before development or after the development of any food product. The results of the chemical and nutritional constituents of fruits and RTS beverages followed by organoleptic qualities of RTS beverages are detailed under quality assessment

4.4.1 Assessment of chemical constituents of fruits (Pumpkin and Ashgourd)

According to Potter (1986), the knowledge of the constituents of foods and their properties is the basis of understanding the quality of products. Various chemical constituents viz., moisture, acidity, TSS, total sugars, reducing sugars, fibre, total ash, β-carotene, vitamin C, sodium and potassium were analyzed in the fruits. The results are presented in table 7.

Table 7 Chemical constituents of Ashgourd and Pumpkin (per 100g of edible portion)

Chemical constituents	Ashgourd	Pumpkin
Moisture (per cent)	95.0	88.2
Acidity (per cent)	0.14	0.12
TSS (^{0} Brix)	2	9
Total sugar (per cent)	1.3	5.2
Reducing sugar (per cent)	0.6	3.7
Total Fibre (g)	1.7	0.8
Total ash (g)	0.9	0.4
β carotene (µg/100g)	-	10710
Vitamin C(mg/100g)	9.5	3.98
Sodium (mg/100g)	2	3.6
Potassium (mg/100g)	250	139

The moisture content of Ashgourd was found to be 95.0 per cent. In Pumpkin it was found to be 88.2 per cent.

Acidity was not much in both the fruits. Ashgourd recorded 0.14 per cent and Pumpkin 0.12 per cent. TSS content of Ashgourd was 2^0 Brix and Pumpkin 9^0 Brix.

Total sugar content as found in the fruit Ashgourd and Pumpkin was 1.3 per cent and 5.2 per cent respectively. While reducing sugar was found to be 0.6 per cent in Ashgourd and 3.7 per cent in Pumpkin.

Fibre content of both the fruits was low, in Ashgourd it was found to be 1.7g/100g and in Pumpkin 0.8g/100g. Total Ash content was recorded to be 0.9g/100g in Ashgourd and 0.4g/100g in Pumpkin.

Nutritional characteristics were assessed in both the fruits viz., Ashgourd and Pumpkin. β carotene content in Ashgourd was nil, while Pumpkin contains one of the richest supplies of bio-available carotenoids known to man, the value recorded was 10710µg/100g. Vitamin C content was observed to be 9.5mg/100g in Ashgourd and 3.98mg/100g in Pumpkin.

Sodium content in both the fruits was observed to be low with Ashgourd containing 2 mg/100g and Pumpkin 3.6mg/100g. Potassium content as recorded was higher in Ashgourd 250mg/100g than Pumpkin with 139mg/100g.

4.4.2 Assessment of Chemical constituents in RTS beverages

Table 8 gives the details of the chemical constituents recorded in the RTS beverages.

Reducing Sugar

Results indicated that maximum content of reducing sugars was recorded for T1PcH (6.87 per cent) combination of Pumpkin juice, ginger extract and honey. This value was closely followed by T2PaH (6.03 per cent), which had

Table 8. Chemical constituents of RTS beverages

	Pumpkin based RTS beverages					Ashgourd based RTS beverages				
Chemical constituents	**T_2PaH**	**T_1PcH**	**T_1PbS**	**T_3PcS**	**T_1PdS**	**T_1AaH**	**T_1AcH**	**T_1AbS**	**T_2AcS**	**T_2AdS**
Reducing sugar (%)	6.03	6.87	4.78	4.78	4.54	5.54	5.49	2.40	2.46	2.42
Total sugar (%)	13.94	13.02	12.09	11.42	12.47	12.46	12.03	12.10	11.02	11.03
TSS (^{0} Brix)	20	21	18	16	18	21	21	18	15	15
Acidity (%)	0.12	0.17	0.18	0.12	0.18	0.12	0.13	0.19	0.12	0.19
β carotene (µg/100ml)	2090	1010	1010	3010	1050	170	08	0	10	0
Vitamin C (mg/100ml)	2.66	1.88	47.54	1.76	3.54	3.62	2.81	52.77	2.69	4.67
Sodium (mg/100ml)	2.32	1.97	2.11	1.68	2.97	0.29	0.10	0.23	0.19	0.87
Potassium (mg/100ml)	98	86	101	82	122	165	105	143	123	189

P = Pumpkin; A = Ashgourd; S = Sugar; H= Honey; a = Pineapple juice; b = Amla juice; c = Ginger extract; d = Lime juice; e = Mint extract; T1 = Treatment (10% juice); T2 = Treatment (20% juice); T3 = Treatment (30% juice); T4 = Treatment (40% juice).

Pumpkin juice, pineapple juice and honey. The lowest value recorded (2.40 per cent) was for T1AbS combination of Ashgourd juice, lemon juice and sugar.

Pumpkin based RTS beverages had higher reducing sugar than Ashgourd based RTS beverages and also honey sweetened beverages in both Pumpkin RTS and Ashgourd RTS showed higher percentage of reducing sugar per cent than sugar sweetened beverages.

Total Sugar

Total sugar content was found to be highest in T2PaH (13.94 per cent) combination of Pumpkin juice, pineapple juice and honey. The second highest value (13.02 per cent) was recorded for T1PcH beverage, combination of Pumpkin juice, ginger extract and honey. The lowest values were observed to be 11.02 per cent and 11.03 per cent, both for Ashgourd RTS, T2AcS combination of Ashgourd juice, ginger extract and sugar and T2AdS, Ashgourd based beverage mixed with lime juice and sugar respectively.

Results indicated that Pumpkin based RTS beverages had higher total sugar content than Ashgourd based RTS beverages.

Total Soluble Solids

The TSS contents of RTS beverages as revealed from the table 8 was found to be within the range of 15-21^0 Brix. The highest value 21^0 Brix was recorded for two of Ashgourd based beverages sweetened with honey, T1AaH mixed with pineapple juice and T1AcH mixed with ginger extract and one Pumpkin RTS T1PcH mixed with ginger extract and honey. The lowest value 15^0 Brix were also recorded for two of Ashgourd based beverages sweetened with sugar, T2AcS mixed with ginger extract and T1AbS mixed with lime juice.

The highest TSS value of 20^0 Brix among Pumpkin RTS was recorded for T2PaH and T1AcH mixed with pineapple juice and ginger extract respectively and sweetened with honey.

Acidity

The acidity per cent in RTS beverages was found to be in the range of 0.12-0.19 per cent. The highest value 0.19 per cent being noted for two Ashgourd RTS beverages sweetened with sugar, T1AbS and T2AdS mixed with amla juice and limejuice respectively. Second highest value 0.18 per cent was observed in two of Pumpkin RTS beverages sweetened with sugar, T1PbS and T1PdS mixed with amla juice and limejuice respectively. The lowest value 0.12 per cent was recorded for two of Pumpkin RTS, T2PaH and T3PcS and two of Ashgourd based RTS beverages, T1AaH and T2AcS. In which T2PaH and T1AaH were mixed with pineapple juice and honey while T3PcS and T2AcS mixed with ginger extract and sweetened with sugar.

β Carotene

Pumpkin is one of the richest source of β carotene, on the other hand Ashgourd has no β carotene in it. However, since different juices (pineapple, lime, amla and ginger extract) and honey used in the formulation of RTS beverages, β carotene was also assessed in Ashgourd based RTS beverages also. The highest values were noted for Pumpkin RTS and the values for Ashgourd RTS were almost negligible except in T1AaH (170µg/100ml) mixed with pineapple juice and honey. Among Pumpkin RTS, T3PcS combination of ginger extract and sugar recorded the highest value (3010µg/100ml), followed by T2PaH (2090µg/100ml) combination of pineapple juice and honey.

Vitamin C

Fresh Ashgourd juice is a fair source of vitamin C and contains more of it than Pumpkin juice. Combinations of Pumpkin and Ashgourd mixed with amla juice T1PbS (47.54 mg/100ml) and T1AbS (52.77mg/100ml) showed the highest content of vitamin C followed by lime juice mixed combination of Pumpkin and Ashgourd T1PdS (3.54mg/100ml) and T2AdS (4.67mg/100ml). The lowest value was observed for T3PcS (1.76mg/100ml) combination of pumpkin juice, ginger extract and sugar.

Sodium

Sodium content of RTS beverages varied from 0.10-2.97mg/100ml. The highest value was recorded for T1PdS of Pumpkin RTS beverage mixed with lime juice and sugar whereas lowest value was found to be of T1AcH combination of Ashgourd juice, ginger extract and honey. Among Ashgourd RTS, the highest value (0.81mg/100ml) was recorded for T2AdS mixed lime juice and sweetened with sugar.

Pumpkin based RTS beverages were found to have higher sodium content than Ashgourd based RTS beverages.

Potassium

Ashgourd is a good source of potassium, more than Pumpkin. The highest values 189mg/100ml and 122mg/100ml were recorded for T2AdS and T1PdS combinations of Ashgourd and Pumpkin, mixed with lime juice and sweetened with sugar respectively. The lowest value (82mg/100ml) being recorded for Pumpkin based RTS beverage, T3PcS mixed with ginger extract and sweetened with sugar.

4.4.3 Assessment of Organoleptic Qualities of RTS beverages

Scientific methods of sensory analysis of food are becoming increasingly important in evaluating the acceptability of the food product. When the quality of food is assessed by means of human sensory organs, the evaluation is said to be sensory analysis (Sini, 2002).

The RTS beverages standardized under the present study were assessed organoleptically by a panel of 15 judges using a score card of four point scale.

Table 9 represents the mean scores for organoleptic assessment of the RTS beverages standardized from Ashgourd and Pumpkin.

4.4.3.1 Appearance of RTS beverages

The first impression of food is usually visual and major part of willingness to accept a food depends upon its appearance.

Table 9 Mean scores for organoleptic assessment of RTS beverages

Organoleptic attributes	Pumpkin based RTS beverage					Ashgourd based RTS beverages				
Combinations	T_2PaH	T_1PcH	T_1PbS	T_3PcS	T_1PdS	T_1AaH	T_1AcH	T_1AbS	T_2AcS	T_2AdS
Appearance	3.86	4.13	5.00	4.60	4.53	3.80	4.66	3.03	4.13	4.26
Colour	4.26	4.13	4.93	4.60	4.46	3.93	4.73	4.66	3.06	3.06
Flavour	4.13	4.20	4.73	3.86	4.86	3.80	4.33	3.40	4.03	3.60
Taste	4.96	4.26	5.00	4.13	4.00	3.66	4.00	3.00	3.13	3.06
Overall acceptability	4.30	4.16	4.91	4.30	4.46	3.80	4.43	3.52	3.58	3.49

P = Pumpkin; A = Ashgourd; S = Sugar; H= Honey; a = Pineapple juice; b = Amla juice; c = Ginger extract; d = Lime juice; e = Mint extract. T1 = Treatment (10% juice)
T2 = Treatment (20% juice)
T3 = Treatment (30% juice)
T4 = Treatment (40% juice)

The mean scores for appearance of the RTS beverages ranged from 3.03-5.00 out of a maximum score of 5. The highest score was assigned to Pumpkin based RTS beverage (T1PbS) mixed with amla juice and sugar as a sweetener. The lowest score was recorded for Ashgourd based RTS beverage (T1AbS) mixed with amla juice and sugar as a sweetener.

The highest mean scores among Ashgourd based RTS beverage, 4.66 was achieved by T1AcH mixed with ginger extract and honey, whereas among Pumpkin based RTS beverages, the highest score of 5.00 was recorded for (T1PbS), a combination containing amla juice and sugar.

4.4.3.2 Colour of RTS beverages

Colour, one of the important visual attributes has been used to judge the overall quality of foods for a very long time. If the colour is unattractive, a potential consumer may not be impressed by any other attributes.

The mean scores assigned for RTS beverages for their colour ranged from 3.06-4.93. The highest score was recorded for Pumpkin RTS (T1PbS) mixed with amla juice and sweetened with sugar. The lowest score was allotted to two of Ashgourd RTS, T1AcS and T1AbS mixed with ginger extract and amla juice and sweetened with sugar respectively.

The highest mean score among Ashgourd based RTS beverage 4.73 was observed for (T1AcH) mixed with ginger extract and honey. Among Pumpkin based RTS beverages the highest score of 4.93 was assigned to (T1PbS) mixed with amla juice and sweetened with sugar.

4.4.3.3 Flavour of RTS beverages

Odour preference is generalized by stimulation of the sensory cells by specific volatile compounds present in the food. Flavours of RTS beverages developed with Pumpkin were superior to those of Ashgourd.

From the mean scores obtained, the range of scores falls between 3.40-4.86. The highest score of 4.86 was recorded for Pumpkin based RTS beverage T1PdS mixed with lime juice and sweetened with sugar. A very close score of 4.73 was followed by T1PbS, pumpkin based beverage mixed with amla juice and sweetened with sugar. The lowest score 3.40 was recorded for Ashgourd based RTS beverage (T1AbS) mixed with amla juice and sweetened with sugar.

Among Ashgourd based RTS beverages the highest mean score of 4.33 was recorded for T1AcH mixed with ginger extract and sweetened with honey. The highest score 4.86 among Pumpkin based RTS beverage was scored by T1PdS as mentioned in the paragraph above.

4.3.4 Taste of RTS beverages

Sharma et al. (1995) stated that taste is the primary and most important quality among various attributes.

From the mean scores obtained the range of scores falls between 3.00-5.00. The highest score 5.00 was recorded for Pumpkin based RTS beverage T1PbS mixed with amla juice and sweetened with sugar. A mean score of 4.96 was again followed by Pumpkin based RTS beverage T2PaH combination of pineapple juice and honey. The lowest score 3.00 was recorded for Ashgourd based RTS beverage (T1AbS) mixed with amla juice and sweetened with sugar. The second lowest score and also a very close score of 3.06 was recorded for T2AdS combination of lime juice and sugar.

Among Ashgourd based RTS beverage the highest score of 4.00 was recorded for T1AcH combination of ginger extract and honey.

4.4.3.5 Overall acceptability of RTS beverages

Overall acceptability is the most important parameter to evaluate the acceptability of a product. It was calculated by taking the total of mean scores assigned by 15 judges for appearance, colour, flavour and taste.

Organoleptic evaluation of the RTS beverages indicated that overall acceptability scores ranged from 3.49-4.91 out of five. Amla juice mixed, Pumpkin based RTS beverage (T1PbS) was adjudged to be the best in overall acceptability while lime juice mixed Ashgourd based RTS beverage (T2AdS) was found to be the lowest in overall acceptability.

Among Pumpkin based RTS beverages the highest score 4.91 was noted for T1PbS combination as shown in table 9. Whereas in the case of Ashgourd the highest score of 4.43 was achieved by T1AcH mixed with ginger extract and sweetened with honey.

4.5. Shelf Stability of RTS beverages

Shelf life qualities are essential parameters to be assessed, since they determine the suitability of a particular ingredient for product development

Table 10 Influence of storage on the appearance of RTS beverages

Storage period	Total Mean score *		Combinations										Storage Mean
	Pumpkin	Ashgourd	T2PaH	T1PcH	T1PbS	T3PcS	T1PdS	T1AaH	T1AcH	T1AbS	T2AcS	T2AdS	
Day1	2.790	2.547	2.80	2.73	2.93	2.80	2.67	2.73	2.40	2.40	2.53	2.67	2.668
Day2	2.720	2.520	2.80	2.67	2.87	2.73	2.53	2.67	2.40	2.40	2.47	2.67	2.620
Day3	2.640	2.480	2.73	2.60	2.73	2.67	2.47	2.60	2.33	2.40	2.47	2.60	2.56
Day4	2.507	2.188	2.60	2.53	2.60	2.47	2.33	2.20	2.13	2.13	2.13	2.33	2.347
Day5	2.320	2.013	2.40	2.27	2.47	2.27	2.20	1.93	1.93	1.93	2.07	2.20	2.166
Day6	2.000	1.573	2.07	1.87	2.20	2.00	1.87	1.60	1.60	1.60	1.40	1.53	1.786
Day7	1.733	1.240	1.80	1.60	1.93	1.73	1.60	1.27	1.27	1.33	1.27	1.07	1.4865
Mean F/T	2.387	2.080	2.457	2.324	2.532	2.381	2.238	2.142	2.027	2.027	2.048	2.152	

CD For RTS from fruits (Pumpkin and Ashgourd) = 0.0777; * Total mean score for Pumpkin and Ashgourd based RTS beverages
CD for Combinations = 0.1229 n = number of judges = 15
CD Fruit X Combinations = 0.1738

(Livingstone et al. 1993). The stored RTS beverages were examined for organoleptic changes, chemical changes and increase in microbial load.

Selected ten combinations of Pumpkin and Ashgourd RTS beverages were prepared in lot, sealed in RTS bottles, pasteurized and stored at ambient condition to study the their shelf stability. Initially the beverages were analysed for microbial load and throughout the storage for change in chemical constituents. Each day the changes in sensory qualities were also studied. At the end of storage period RTS beverages were once again analyzed for change in microbial load.

4.5.1. Changes in the Organoleptic features of RTS beverages

Sensory evaluation of the food products plays an important role in determining the acceptability and shelf stability of products. According to Jellinek (1985) chemical indices of deterioration alone will not decide the quality changes and it should be correlated with sensory evaluation of stored products. Hence periodical evaluation of the products was carried out with respect to the sensory parameters using score card of three point scale, by the selected panel of 15 judges to understand the deteriorative changes occurring in the stored products. The RTS beverages were evaluated daily for appearance, colour, flavour and taste changes until they were not acceptable by judges. It was found that the beverages were acceptable till 7 days of storage period.

Appearance

Appearance is the criterion for the desirability of any food product. The appearance of the food product is contributed by surface characteristics viz., size, shape, colour, transparency, opaqueness, turbidity and dullness (Srilakshmi, 2003). The changes in the appearance of RTS beverages is represented in table 10.

Significant difference was observed in the appearance attribute of RTS beverages formulated from the fruits Pumpkin and Ashgourd. As inferred from the CD value (0.077), the appearance scores for Pumpkin based beverages were

Table 11 Influence of storage on the colour of RTS beverages

Storage period	Total mean scores*		Combinations										Storage Mean
	Pumpkin	Ashgourd	T2PaH	T1PcH	T1PbS	T3PcS	T1PdS	T1AaH	T1AcH	T1AbS	T2AcS	T2AdS	
Day1	2.640	2.293	2.67	2.53	2.93	2.53	2.53	2.33	2.27	2.27	2.40	2.20	2.466
Day2	2.588	2.240	2.67	2.47	2.80	2.47	2.53	2.27	2.20	2.20	2.33	2.20	2.414
Day3	2.520	2.160	2.60	2.40	2.73	2.40	2.47	2.20	2.13	2.07	2.27	2.13	2.340
Day4	2.413	2.080	2.47	2.33	2.60	2.33	2.33	2.13	2.07	2.00	2.13	2.07	2.246
Day5	2.213	1.853	2.27	2.20	2.40	2.07	2.13	1.87	1.87	1.80	1.87	1.87	2.033
Day6	1.960	1.533	2.07	1.80	2.13	1.87	1.93	1.53	1.73	1.53	1.47	1.40	1.746
Day7	1.667	1.213	1.733	1.60	1.80	1.60	1.60	1.27	1.33	1.27	1.13	1.07	1.440
Mean F/T	2.285	1.910	2.354	2.190	2.484	2.181	2.217	1.942	1.942	1.877	1.942	1.901	

CD For RTS from fruits (Pumpkin and Ashgourd) = 0.0792; *Total mean score for Pumpkin and Ashgourd based RTS beverages
CD for Combinations = 0.125 n = number of judges = 15
CD for Fruit X Combinations = 0.177

higher (2.387) than that of Ashgourd based beverages (2.080) even after a storage period of seven days. Initially the scores were (2.790) for Pumpkin based RTS beverages and 2.547 for Ashgourd based beverages.

Significant difference (CD 0.012) was also observed among the various standardized beverages from Pumpkin and Ashgourd. Among the formulated RTS beverages, the highest mean score of 2.532 was recorded for (T1PbS) Pumpkin based, amla juice and sugar mixed beverage. Followed by 2.457 score of (T2PaH) Pumpkin based, pineapple juice and honey mixed beverage. The highest mean score of 2.152 among Ashgourd based beverage was recorded for (T1AbS) lime juice and sugar mixed beverage, which was closely followed by the score of 2.142 recorded for (T1AaH) pineapple and honey mixed RTS beverage. The lowest mean score of 2.027 was recorded for two of Ashgourd based RTS beverages, (T1AcH) mixed with ginger extract and sweetened with honey and other (T1AbS) mixed with amla juice and sweetened with sugar.

Mean scores for appearance of all the beverages decreased gradually from 2.66 to 1.48 over a period of seven days.

Significant interaction was also observed between fruits and their respective combinations over a storage period of seven days (CD 0.173) indicating that as the storage period increased, the mean score decreased.

Colour

Colour of food serves as a useful criterion for measurement of its quality. In addition to giving pleasure, the colour of food is associated with other attributes, e.g., ripeness (red colour), sourness (green colour) etc. Table 11 represents the changes in the colour of RTS beverages.

Data on the colour of RTS beverages revealed that there is a significant difference (CD 0.079) in the RTS beverages developed from Pumpkin and Ashgourd. The total mean score for Pumpkin based RTS beverages over the storage period was found to be 2.285 and 1.910 for Ashgourd based RTS beverages. Thus revealing that in terms of colour, Pumpkin based RTS beverages were superior to Ashgourd RTS beverages throughout the storage period.

Table 12 Influence of storage on the flavour of RTS beverages

Storage Period	Total mean scores*		Combinations										Storage Mean
	Pumpkin	Ashgourd	T2PaH	T1PcH	T1PbS	T3PcS	T1PdS	T1AaH	T1AcH	T1AbS	T2AcS	T2AdS	
Day1	2.8	2.573	2.93	2.80	2.87	2.67	2.73	2.60	2.73	2.40	2.53	2.60	2.685
Day2	2.747	2.533	2.87	2.80	2.80	2.60	2.67	2.53	2.67	2.33	2.53	2.60	2.640
Day3	2.640	2.387	2.80	2.53	2.67	2.60	2.60	2.40	2.53	2.26	2.23	2.40	2.513
Day4	2.533	2.200	2.60	2.53	2.53	2.60	2.40	2.27	2.33	2.20	2.07	2.13	2.360
Day5	2.427	1.573	2.40	2.33	2.47	2.60	2.33	1.67	1.87	1.47	1.40	1.47	2.00
Day6	1.880	1.160	1.87	1.80	2.00	1.73	2.00	1.13	1.33	1.07	1.13	1.13	1.520
Day7	1.360	1.053	1.04	1.20	1.60	1.27	1.13	1.00	1.27	1.00	1.00	1.00	1.206
Mean F/T	2.341	1.925	2.410	2.284	2.42	2.295	2.265	1.942	2.104	1.818	1.841	1.904	

CD For RTS from fruits (Pumpkin and Ashgourd) = 0.0919; *Total mean score for Pumpkin and Ashgourd based RTS beverages
CD for Combinations = 0.145 n = number of judges = 15
CD for Fruit X Combinations = 0.205

Significant difference was also observed among the various standardized RTS beverages from Pumpkin and Ashgourd with respect to colour. The highest mean score of 2.484 was recorded for Pumpkin RTS T1PbS, mixed with amla juice and sweetened with sugar, closely followed by T1PaH, mixed with pineapple juice and honey. Lowest mean score for colour attribute (1.887) was recorded for T1AbS, Ashgourd based amla juice and sugar added beverage. Among Ashgourd based RTS beverages the highest mean score 1.942 was recorded for three of the beverages, T1AaH mixed with pineapple juice and honey, (T1AcH) mixed with ginger extract and honey and T1AcS mixed with ginger extract and sweetened with sugar. This indicates that there was no much difference in the scores for colour among Ashgourd based RTS beverages.

Analysis of data also revealed the interaction between fruits and their respective treatments (CD 0.177) indicating that the scores for Pumpkin based RTS beverages were more acceptable than Ashgourd based RTS beverages in terms of their colour attribute. The average mean score for all the treatments decreased from 2.466 to 1.440 over a period of seven days, indicating the deteriorative changes taking place in the colour of RTS beverages.

Flavour

The flavour of a food or beverage is not perceived in a single event, but rather as a series of events experienced as the food is consumed (Piggot and Schaschke, 2001). Flavour is the combination of taste and smell. Taste includes sweet, salty and sour characters in a product, while smell is identified as fragrant, acidic, burnt etc. The flavour changes of the developed RTS beverages were evaluated organoleptically and the details are given in table 12.

Analysis of the data revealed that there was a significant difference (CD 0.091) in the flavour attribute of the RTS beverages formulated from Pumpkin and Ashgourd. Mean score for Pumpkin based RTS beverages was higher 2.341 even after seven days of storage when compared with Ashgourd based RTS beverages with a score of 1.925. Significant difference was also observed (CD 0.145) between the combinations. The highest mean score of 2.420 was recorded

Table 13 Influence of storage on the taste of RTS beverages

Storage period	Total mean scores*		Combinations										Storage Mean
	Pumpkin	Ashgourd	T2PaH	T1PcH	T1PbS	T3PcS	T1PdS	T1AaH	T1AcH	T1AbS	T2AcS	T2AdS	
Day1	2.840	2.707	3.00	2.80	3.00	2.73	2.67	2.80	2.87	2.67	2.53	2.67	2.773
Day2	2.773	2.627	2.87	2.80	2.93	2.67	2.60	2.73	2.80	2.60	2.47	2.53	2.700
Day3	2.627	2.480	2.67	2.67	2.80	2.53	2.47	2.67	2.67	2.60	2.20	2.27	2.553
Day4	2.480	2.147	2.60	2.53	2.60	2.40	2.27	2.27	2.33	2.20	2.00	1.93	2.313
Day5	2.133	1.440	2.33	2.27	2.40	2.07	1.60	1.40	1.67	1.53	1.40	1.20	1.786
Day6	1.560	1.173	1.60	1.53	1.80	1.47	1.40	1.20	1.27	1.13	1.13	1.13	1.366
Day7	1.240	1.027	1.47	1.13	1.40	1.13	1.07	1.00	1.13	1.00	1.00	1.00	1.133
Mean F/T	2.236	1.943	2.362	2.247	2.418	2.142	2.011	2.01	2.105	1.961	1.818	1.818	

CD For RTS from fruits (Pumpkin and Ashgourd) = 0.115; * Total mean score for Pumpkin and Ashgourd based RTS beverages
CD For Combinations = 0.183 n = number of judges = 15
CD For Fruit X Combinations = 0.258

for Pumpkin based RTS beverage (T1PbS), mixed with amla juice and sweetened with sugar, closely followed by another Pumpkin RTS (T1PaH) mixed with pineapple juice and honey with a score of 2.410. The lowest mean score of 1.818 was recorded for Ashgourd RTS mixed with amla juice and and sweetened with sugar. The highest score of 2.104 among Ashgourd based RTS beverages was recorded for T1AcH, mixed with ginger extract and honey.

Interactions observed between fruits and their combinations, revealed that their was a significant difference (CD 0.205) between the combinations of Pumpkin and Ashgourd. Means scores for storage decreased gradually from 2.685 to 1.206.

Taste

Taste is a major attribute, which determines the acceptability of a food. It is not only a sensory response to soluble materials but also aesthetic appreciation of mouth (Wayre, 1994). The sensory quality evaluation of the RTS beverage for a storage period of seven days is detailed in table 13.

Analysis of the data shows that there is significant difference in the taste attribute of the RTS beverages developed Pumpkin and Ashgourd. As inferred from the CD value (0.115) the mean score for Pumpkin based RTS beverage (2.236) was higher than Ashgourd based RTS beverages with a score of 1.943. Initially also the mean score for Pumpkin based RTS beverages was higher 2.840 than Ashgourd based RTS beverages 2.707.

Significant difference (CD 0.183) was also seen among the various standardized beverages from Pumpkin and Ashgourd. Among the developed RTS beverages, the highest mean score of 2.418 was recorded for Pumpkin RTS (T1PbS), mixed with amla juice and sweetened with sugar, followed by another Pumpkin RTS (T1PcH), mixed with ginger extract and honey with a score of 2.362. The highest mean score 2.105 among Ashgourd based RTS beverage was recorded for (T1AcH) mixed with ginger extract and honey. This score was closely followed by (T1AaH) mixed with pineapple juice and honey with a score of 2.01. The lowest score of 1.818 was recorded for two of Ashgourd based

Table 14 Influence of storage on the overall acceptability of RTS beverages

Storage period	Total mean scores*		Combinations										Storage Mean
	Pumpkin	Ashgourd	T2PaH	T1PcH	T1PbS	T3PcS	T1PdS	T1AaH	T1AcH	T1AbS	T2AcS	T2AdS	
Day1	2.767	2.530	2.85	2.71	2.93	2.69	2.65	2.61	2.57	2.43	2.50	2.53	2.648
Day2	2.707	2.480	2.80	2.68	2.85	2.61	2.58	2.55	2.51	2.38	2.45	2.50	2.593
Day3	2.606	2.376	2.70	2.55	2.73	2.55	2.50	2.46	2.41	2.33	2.30	2.35	2.491
Day4	2.483	2.153	2.56	2.48	2.58	2.45	2.33	2.21	2.21	2.13	2.08	2.11	2.318
Day5	2.273	1.719	2.35	2.26	2.43	2.25	2.06	1.71	1.83	1.68	1.68	1.68	1.996
Day6	1.850	1.359	1.90	1.75	2.03	1.76	1.80	1.36	1.51	1.33	1.28	1.30	1.604
Day7	1.500	1.133	1.60	1.38	1.68	1.43	1.35	1.13	1.25	1.15	1.10	1.12	1.131
Mean F/T	2.312	1.964	2.39	2.25	2.46	2.24	2.18	2.04	2.41	1.91	1.91	1.94	

CD For RTS from fruits (Pumpkin and Ashgourd)= 0.071; * Total mean score for Pumpkin and Ashgourd based RTS beverages
CD For Combinations = 0.129 n = number of judges = 15
CD For Fruit X Combinations = 0.175

beverage (T1AcS) and (T1AdS) mixed with ginger extract and lime juice respectively and sweetened with sugar.

Mean scores for taste of the standardized beverages decreased slowly from 2.773 to 1.133 over a storage period of seven days. Significant interaction was observed between fruits and their combinations (CD 0.258) indicating that as the storage period increased the mean scores decreased. The scores for taste of Pumpkin based beverages were more stable than Ashgourd based beverages.

Overall acceptability

Overall acceptability is the most important parameter to evaluate the acceptability of the product. This is the mean of the sum total of scores of 15 judges for appearance, colour, flavour and taste. Table 14 depicts the mean scores for overall acceptability of RTS beverages over a period of seven days of storage.

Analysis of the data on the overall acceptability score of RTS beverages revealed that there is significant difference (CD 0.071) among the combinations of Pumpkin and Ashgourd. Mean scores at the end of the storage period for Pumpkin based RTS beverages (2.312) was greater than the mean scores of Ashgourd based RTS beverages (1.964). Initially also the mean scores (2.767) were higher for Pumpkin based beverages than Ashgourd based RTS beverages with a score of 2.530.

Significant difference (CD 0.129) was also recorded between each combination. The highest mean score 2.46 was recorded for Pumpkin based RTS beverage (T1PbS) mixed with amla juice and sweetened with sugar. A very close score of 2.39 was also observed for (T1PaH) mixed with pineapple juice and honey. The lowest overall acceptability score of 1.91 was recorded for two of Ashgourd based beverage (T1AcS) mixed with ginger extract and sweetened with sugar and (T1AbS) mixed with amla juice and sweetened with sugar. Overall mean scores were higher for Pumpkin based RTS beverages than Ashgourd beverages.

Mean score for storage decreased gradually from 2.648 to 1.131, which is an indicator of deteriorative changes taking place in the RTS beverages.

Significant interaction (CD 0.175) was observed between fruits and their respective combinations indicating that the combinations of Pumpkin were more acceptable in terms of appearance, colour, flavour and taste than Ashgourd based RTS beverages. Overall acceptability of the beverages decreased gradually over a storage period of seven days and the deteriorative changes in Ashgourd beverages were more pronounced than Pumpkin based beverages especially in terms of flavour.

4.5.2 Changes in chemical constituent of stored RTS beverages

RTS beverages when stored undergo changes with respect to chemical constituents, which will give an indication of the deteriorative changes occurring in the products. Shelf stability of the formulated beverages can thus be ascertained.

Acidity

Mehta et al. (2000) reported that acidity indicates flavour as well as wholesomeness of the product. Acidity is one of the prime chemical constituent which indicates the deteriorative changes in the product. Table 15 represents the changes in the acidity of RTS beverages over a storage period of seven days.

A significant difference (CD 0.0061) was observed in the acidity of RTS beverages stored for a period of 7 days. Total mean value of beverages was found to be 0.156 per cent, which increased to 0.188 per cent after 7 days. However the difference between initial readings and final readings of a particular combination was non significant.

Significant difference (CD 0.014) was also observed in the acidity between mean value of each combination. T1PcH, T1PbS, T1PdS, T1AcH, T1AbS and T2AdS beverage were found to be significantly different. While the acidity percent in T2PaH, T3PcS, T1AaH and T2AcS were on par with the CD value.

Table 15 Changes in Acidity (per cent) of the stored RTS beverages

Combinations	Storage Period		Combination Mean
	Initial Readings (Stage I)	Final Readings (Stage II)	
T2PaH	0.123	0.157	0.140
T1PcH	0.173	0.193	0.183
T1PbS	0.183	0.223	0.203
T3PcS	0.127	0.167	0.147
T1PdS	0.183	0.217	0.200
Average mean of Pumpkin based RTS beverages			0.174
T1AaH	0.127	0.167	0.147
T1AcH	0.137	0.167	0.152
T1AbS	0.193	0.220	0.207
T2AcS	0.127	0.147	0.137
T2AdS	0.190	0.223	0.207
Average mean of Ashgourd based RTS beverages			0.170
Stages Mean	0.156	0.188	

CD For stages = 0.006; CD for combination = 0.014;
CD for Combination x Stage = NS

Among the Pumpkin based beverages the combinations with the highest acidity percent (0.203) was noted for T1PbS mixed with amla juice and sweetened with sugar and for Ashgourd based beverages two combinations viz., T1AbS mixed with amla juice and sweetened with sugar and T2AdS mixed with lime juice and sweetened with sugar recorded (0.207 per cent). On the other hand the lowest acidity (0.137) per cent was noted for T2AcS mixed with ginger extract and sugar.

While considering all the ten combinations, the highest acidity was noted for Ashgourd based RTS beverages, T1AbS and T2AdS as mentioned above.

Total Soluble Solids

Table 16 represents the change in TSS of Ashgourd and Pumpkin based RTS beverages.

A significant difference (CD 0.411) was observed in the TSS of RTS beverages after a storage period of 7 days. The initial value for total mean of beverages was found to be 18.433^0 Brix which increased to 19.600^0 Brix as recorded on the final day of storage. However a non significant change was observed when comparing the initial readings with the final readings of a particular combination.

Table 16 Changes in TSS (^{0} Brix) of the stored RTS beverages

Combinations	Storage Period		Combination Mean
	Initial Readings (Stage I)	Final Readings (Stage II)	
T2PaH	19.667	21.667	20.667
T1PcH	20.333	22.333	21.333
T1PbS	18.667	18.667	18.667
T3PcS	16.333	17.333	16.833
T1PdS	18.333	20.333	19.333
Average mean of Pumpkin based RTS beverages			19.366
T1AaH	20.667	21.667	21.167
T1AcH	21.333	21.667	21.500
T1AbS	18.333	19.333	18.833
T2AcS	15.333	16.333	15.833
T2AdS	15.333	16.667	16.000
Average mean of Ashgourd based RTS beverages			18.666
Stages Mean	18.433	19.600	

CD For stages = 0.411; CD for combination x Stage = NS;
CD for Combination = 0.920

Significant difference (CD 0.920) was also observed in the TSS content between mean of each combination. Only the values of two Ashgourd based beverages T2AcS and T2AdS were on par with the CD value while all the other combinations showed a highly significant difference. The mean value of Ashgourd RTS (18.666^0 Brix) was recorded to be less than Pumpkin RTS (19.366^0 Brix) beverages.

The highest TSS (21.333^0 Brix) among Pumpkin RTS was noted for T1PcH beverage, mixed with ginger extract and honey and among Ashgourd RTS, T1AaH mixed with pineapple juice and honey was found to have highest TSS content (21.500^0 Brix). While the lowest TSS content was recorded for T3PcS (16.833^0 Brix) mixed with ginger extract and sweetened with sugar among Pumpkin beverages. Among Ashgourd RTS, the beverage with the lowest TSS content (15.333^0 Brix) was found to be T3AcS mixed with ginger extract and sweetened with sugar.

Total sugars

Table 17 represents the change in total sugar content of RTS beverages after storage period.

A highly significant difference (CD 0.7576) was observed between the mean score of both the stages (initial and final). The initial reading was found to be 12.15 per cent, which increased to 13.75 per cent after seven days of storage. Non significant change in total sugar was observed between the stages of each combination.

The highest total sugar content when considering all the ten combinations was found to be (14.49 per cent) in T2PaH beverage mixed with pineapple juice and honey. While the lowest total sugar content (11.95 per cent) was noticed in T2AcS beverage mixed with ginger extract and sweetened with sugar. T2PaH was found to have highest total sugar content (14.49 per cent) among pumpkin RTS while among Ashgourd RTS it was T1AaH (13.16 percent) mixed with pineapple juice and honey.

Table 17 Changes in Total sugar (per cent) of the stored RTS beverages

Combinations	Storage Period		Combination Mean
	Initial Readings (Stage I)	Final Readings (Stage II)	
T2PaH	13.94	15.04	14.49
T1PcH	13.02	14.96	13.99
T1PbS	12.09	13.87	12.98
T3PcS	11.42	12.64	12.03
T1PdS	12.47	13.88	13.17
Average mean of Pumpkin based RTS beverages			13.33
T1AaH	12.46	13.86	13.16
T1AcH	12.03	13.66	12.84
T1AbS	12.10	13.82	12.96
T2AcS	11.02	12.88	11.95
T2AdS	11.03	12.92	11.97
Average mean of Ashgourd based RTS beverages			12.57
Stages Mean	12.15	13.75	

CD for stages = 0.7565; CD for combination = NS;
CD for combination x Stages = NS

Non significant difference was also found between mean value of each combination. All the treatments were recorded to be on par with the CD value. Average mean value of Pumpkin combinations (13.16 per cent) was recorded to be higher than that of Ashgourd beverages (12.57 per cent).

Reducing Sugar

Table 18 represents the change in reducing sugar content of RTS beverages after a storage period of 7 days.

Table 18 Changes in Reducing sugar (per cent) of the stored RTS beverages

Combinations	Storage Period		Combination Mean
	Initial Readings (Stage I)	Final Readings (Stage II)	
T2PaH	6.03	7.23	6.63
T1PcH	6.87	7.84	7.35
T1PbS	4.78	5.24	5.01
T3PcS	4.78	5.15	4.96
T1PdS	4.54	5.60	5.07
Average mean of Pumpkin based RTS beverages			5.80
T1AaH	5.54	6.56	6.05
T1AcH	5.39	6.73	6.06
T1AbS	2.40	3.98	3.20
T2AcS	2.46	4.01	3.23
T2AdS	2.42	4.05	3.23
Average mean of Ashgourd based RTS beverages			4.35
Stages Mean	4.52	5.63	5.07

CD For stages = NS; CD for combination = 0.917;
CD for Combination x Stage = NS

Non significant difference was observed in the reducing sugar content of RTS beverages stored for a period of 7 days. Initially in the first stage the mean value was found to be 4.52 per cent, which increased to 5.63 per cent in the second stage after storage period. The difference between initial readings and final readings of a particular combination also showed a non significant difference.

However significant difference (CD 0.917) was also observed in the reducing sugar content between mean score of each combination of a particular stage. All the beverages were found to be on par with the CD value.

Among the Pumpkin based beverages the combination with the highest reducing sugar percent (7.35 per cent) was noted for T1PcH mixed with ginger extract and honey and for Ashgourd based beverages T1AcH mixed with ginger extract and honey recorded higher reducing sugar percent (6.06 per cent) which was closely followed by T1AaH combination (6.05 per cent). On the other hand the lowest reducing sugar when considering all the ten combinations was found to be (3.20 per cent) noted for T1AbS mixed with amla juice and sugar.

4.5.3 Assessment of microbial growth in the stored RTS beverages

Microbial population in the processed foods is an important factor, which determines the quality and safety of the products. Microbial analysis of stored RTS beverages was done in order to ascertain the shelf stability of the product. RTS beverages were assessed initially for the microbial load and they were stored at ambient condition. At the end of storage period they were once again assessed for the change in microbial load. They were analyzed for viz., bacteria, fungi and yeast. The media used for the determination of bacteria, fungi and yeast were nutrient agar, Martin's media and mannitol-yeast extract media respectively. This was done by serial dilution technique as suggested by Agarwal and Hasija (1986). Table 19 gives an account of total bacterial count in different combinations after storage period.

The results obtained from initial assessment of RTS beverages showed nil to very low count of microbes in it. The final results after storage from plate count technique revealed the presence of bacteria and fungi in all the samples analyzed. Bacterial colonies as well as their growth were more when compared with fungi and yeast. Growth of yeast cell was not observed. The highest number of bacteria colonies (7) was observed in (T1PdS) beverage with pumpkin juice limejuice and sugar. The lowest number of colonies(2) was recorded for T1PbS beverage of pumpkin juice mixed with amla juice and sweetened with sugar. The colonies identified were slimy and cream to deep yellow in colour.

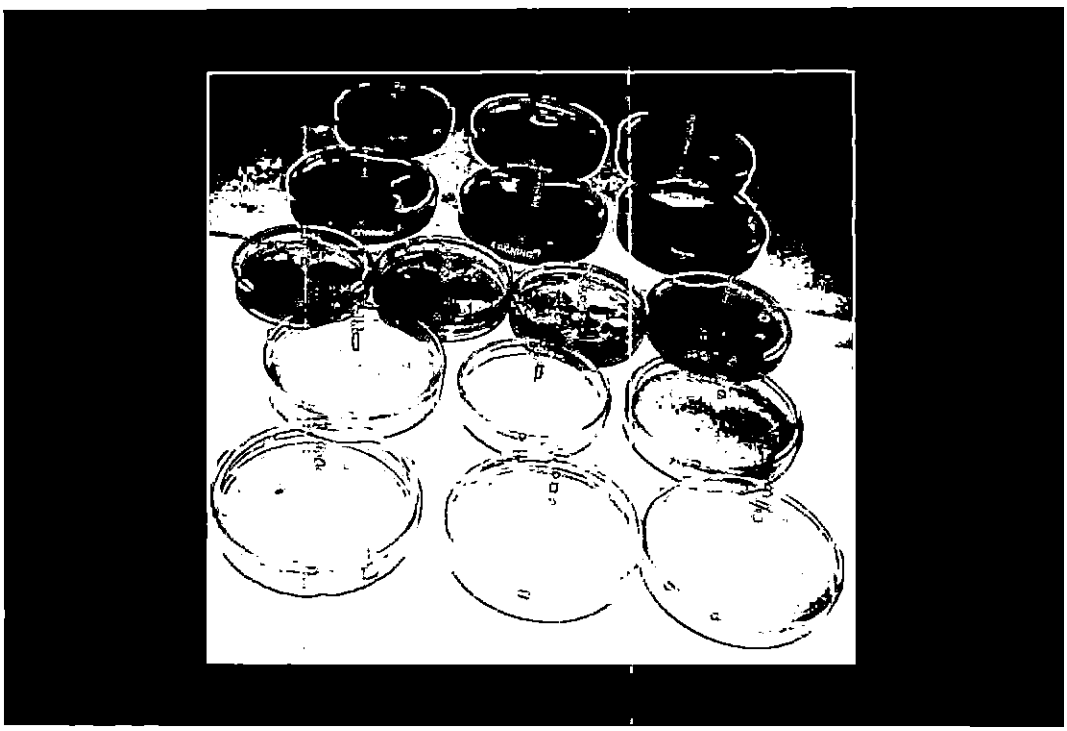


Plate 4. Bacterial & Fungal growth after storage period

Table 19 Microbial growth analysis in stored RTS beverages after 7 days of storage period

RTS beverages	No. of colonies	
	Bacteria	Fungi
T_2PaH	4	5
T_1PcH	4	4
T_1PbS	2	2
T_3PcS	5	2
T_1PdS	7	2
T_1AaH	4	3
T_1AcH	3	3
T_1AbS	4	4
T_2AcS	6	3
T_2AdS	6	3

Fungal growth was less when compared to bacterial growth. T2PaH combination of pumpkin juice, pineapple juice and honey showed the highest (5) number of fungal colonies. However least (2) number of colonies were observed in three Pumpkin based combinations viz., T1PbS combination mixed with amla juice and sweetened with sugar; T3PcS mixed with ginger extract and sweetened with sugar and T1PdS mixed with lime juice and sweetened with sugar. The fungal colonies identified were of Aspergillus, Mucor and Penicillium. Yeast colonies were not observed in any of the RTS beverage samples. Plate 4 shows the growth of fungal and bacterial colonies.

The results of microbial analysis revealed that among pumpkin based RTS beverages, T1PbS combination was least affected by microbial attack and T1AcH among Ashgourd based beverages. It was noted that microbial count of RTS beverages stored at ambient condition for 7 days was very low.

4.6 Comparison of the constituents of best selected RTS beverage with FPO specification

The FPO standards are mainly concerned with the standards required for maintaining the quality of fruits and vegetables and products manufactured from them (Kalia and Sood, 2000). Comparison of the best selected combination from Pumpkin and Ashgourd with FPO specifications is detailed in table 20.

Table 20 Comparison of the constituents of best selected RTS beverages with FPO specification

Constituents	FPO Standards	Developed RTS beverages	
		Pumpkin (T1PbS)	Ashgourd (T1AcH)
Min. Fruit juice (per cent)	10	10	10
Min. TSS (^{0} Brix)	10	18	18
Max. Acidity (per cent)	0.3	0.18	0.19
Max. Free SO_2 (ppm)	70	70	70

The finally selected RTS beverage combinations from Pumpkin T1PbS and Ashgourd T1AcH were found to meet the minimum requirements for fruit juice and total soluble solids and within the maximum requirement for acidity and free SO_2 as prescribed by FPO.

Comparison of the selected RTS beverage with FPO specifications indicated that the formulations were properly adjusted for its essential contents to meet the recommended standards. Hence the RTS beverages standardized from Pumpkin juice and Ashgourd juice were found to be in conformity with the prescribed FPO standards.

4.7 Consumer acceptance and preference for RTS beverages

Consumer's today are more conscious of a large range of food products available in the market to choose from. New foods/ Novel foods are rapidly increasing in number in the markets. Consumer acceptance of a new product is based largely on its convenience, appearance, sensory values, economic value and health benefits. Hence, the consumer acceptance and preference for the best selected RTS beverages developed from Ashgourd juice and Pumpkin juice was conducted. One beverage from each Pumpkin and Ashgourd which maintained highest organoleptic score throughout the storage period and showed less changes chemically and microbiologically was selected for the study viz., Pumpkin based RTS (T1PbS), mixed with amla juice and sweetened with sugar and Ashgourd based RTS (T1AcH) mixed with ginger extract and honey.

The subjects selected for the study were inmates of the ladies hostel, College of Agriculture, Vellayani, Thiruvananthapuram who were in the age group of 21-27 years. The respondents were purposely selected and the study was conducted on three consecutive days. Freshly prepared RTS was distributed among consumers along with the schedule to record their acceptance. The results of the study is consolidated and presented in table 21 while the result with statistical analysis is revealed in table 22.

The results revealed that there is a significant difference (Z 2.685) in the proportion of the subjects consuming full bottle (200ml) of RTS beverage of T1PbS and T1PcH combinations. Eighty per cent of the respondents consumed full bottle of T1PbS whereas only 55.58 per cent could consume full bottle of T1AcH beverage. A highly significant difference (Z 4.365) in the proportion of subjects was also found between the two beverages for the after taste sensation. After consuming (T1PbS) Pumpkin based RTS beverage 14.44 per cent of the respondents complained of an after taste. On the other hand, a higher percentage of 62.22 subjects complained of an after taste after drinking Ashgourd based beverage (T1AcH). Refreshing effect was felt by 87.88 per cent of the respondents after consuming T1PbS beverage whereas only 53.33 per cent of the respondents reported this effect after consumption of T1AcH beverage, showing

Table 21 Consumer acceptability of best selected Pumpkin and Ashgourd based RTS beverages

S.No	Criteria	Pumpkin based RTS beverage (T_1PbS)		Ashgourd based RTS beverage (T_1AcH)	
		No. of subjects	Percent	No. of subjects	Percent
1.	Quantity consumed :				
	Full bottle (200ml)	72	80%	50	55.55%
	Three fourth bottle (175ml)	10	11.11%	5	5.55%
	Half bottle (100ml)	8	8.88%	35	38.88%
2.	Feeling of after taste:				
	Yes	13	14.44%	56	62.22%
	No	77	85.55%	34	37.77%
3.	Immediate effect:				
	Refreshing effect	79	87.88%	48	53.33%
	No effect	11	12.22%	42	46.66%
4.	Effect on next day :				
	No effect	90	100%	90	100%
	Discomfort	-	-	-	-
	Allergy	-	-	-	-
5.	Overall acceptability scores:				
	91-100	56	62.22%	-	-
	81-90	24	26.66%	7	7.77%
	71-80	8	8.88%	48	53.33%
	Below 71	2	2.22%	35	38.88%

(Results collected from 30 Respondents for 3 consecutive days)

Table 22 Consumer acceptability of best selected Pumpkin and Ashgourd based RTS beverages (Consolidated table with statistical analysis)

S.No	Criteria	T1PbS	T1AcH	Z - Test
		Proportion of subjects	Proportion of subjects	
1.	Quantity consumed :			
	Full bottle (200ml)	0.8	0.5775	2.658
	Three fourth bottle (175ml)	0.11	0.055	4.365
	Half bottle (100ml)	0.088	0.388	5.00
2.	Feeling of after taste:			
	Yes	0.144	0.622	6.69
	No	0.855	0.377	6.638
3.	Immediate effect:			
	Refreshing effect	0.877	0.533	5.134
	No effect	0.122	0.466	5.134
4.	Effect on next day :			
	No effect	1	1	1
	Discomfort	-	-	-
	Allergy	-	-	-
5.	Overall acceptability scores:			
	91-100	0.622	-	-
	81-90	0.266	0.077	60.96
	71-80	0.088	0.533	6.544
	Below 71	0.022	0.388	6.203

(Results collected from 30 respondents for 3 consecutive days)
Values for Z test < table value (1.96) are NS

a significant difference (Z 5.134) in the refreshing effect felt by the respondents after consuming T1PbS and T1AcH beverages.

There was no side effect, discomfort or allergy reported, even after consuming the beverages by the respondents for three consecutive days. An overall acceptability score of 91 and above was awarded by 62.22 per cent of the

respondents for T1PbS beverage, while low scores were awarded (<81) for (T1AcH) Ashgourd based beverage. Only 2.22 per cent of the respondents gave a score below 71 to T1PbS beverage. But for T1AcH beverage, 38.88 per cent of the respondents gave a score below 71 out of 100.

Thus from the results it can be revealed that a higher proportion of respondents accepted as well as preferred the T1PbS (Pumpkin based RTS beverage) than T1AcH (Ashgourd based RTS beverage).

4.8 Cost benefit analysis of the product

The factors that determine the cost of the finished product is the turnover of the finished product obtained from the raw materials used. Knowledge of the product yield of any product developed is essential in deciding the economic feasibility of the product. Hence, the cost of both the finally selected beverage from Pumpkin (T1PbS) and Ashgourd (T1AcH) was calculated as per the details given in section 3.5.4 of materials and methods.

The worked out cost for T1PbS beverage mixed with amla juice and sweetened with sugar was found to be Rs. 3.50/ 200ml and for T1AcH beverage mixed with ginger extract and honey, the cost calculated was Rs. 6.75/ 200ml. After adding the packaging charges (bottling and sealing), the final price was recorded to be Rs. 6.50/ 200ml and Rs. 9.75/ 200ml for Pumpkin based beverage and Ashgourd RTS respectively.

Discussion

5. Discussion

The results of the study entitled "Development of Ashgourd [*Benincasa hispida* (Thunb.) Cogn.] and Pumpkin (*Cucurbita moschata* Poir.) based Ready-To-Serve (RTS) beverage" are discussed under the following heads.

5.1 Physical characteristics of collected fruits

5.2 Standardization of RTS beverages

5.3 Quality assessment

5.4 Shelf stability of RTS beverages

5.5 Comparison of the constituents of best selected RTS beverage with FPO specification

5.6 Consumer acceptability study

5.7 Cost benefit analysis of the product

Cucurbits are a universal crop. The Asian and Pacific region produces many edible cucurbits and is the centre for origin for some of them. In the absence of detailed data, cucurbits may be considered as one of the largest botanical families of vegetables produced and consumed. Even with the gradual increase in production and consumption, there are certain factors that plague their production and consumption. Value addition in food products plus their diversity in cooking is one of their major areas of development (Prem Nath, 2007). Pumpkin and Ashgourd fruits are widely cultivated in tropical and sub tropical countries like India. Packed with nutrients and low in calories, they form a part of an adequate diet for today's health conscious generation. They have good shelf life and can be stored for months under optimum temperature and humidity. Since their product diversification has not been much explored, there exists an opportunity to develop products like RTS beverage which have good market potential.

5.1 Physical characteristics of collected fruits

The information pertaining to the physical attributes of the fruits Pumpkin and Ashgourd were assessed in terms of total weight of the fruit, peel weight, seed weight and weight of the edible portion for the better understanding of their physical characteristics and also because these features would influence the product yield.

The average weight of Ashgourd and Pumpkin as observed was 5.5 kg and 4.6 kg respectively. Several other workers reported similar findings. According to Ng, 1993, normally the weight of an Ashgourd fruit may go up to 35 kg. Mandal et al. 2002; Lovely, 2001; Menon, 1998 have also reported great variability in fruit size and fruit weight of Ashgourd (Benincasa hispida). Fruits may weigh upto 30 pounds (Molinar and Yang, 2001).

According to Saade and Hernandez (1994), the fruit of Pumpkin varies greatly in size and shape (generally following the form of ovary): smooth or with rounded ribs, rarely verrucose or granulose. According to Chadha 2005, Pumpkin fruit may weigh upto 5.0 kg. In another study by Orzolek et al. (2000) shape, size and appearance of the fruit Pumpkin vary, ranging from small (<5 lbs) to medium (12-24 lbs) and large (typically 40-60 lbs).

Average peel weight of the fruits Ashgourd and Pumpkin was observed to be 1.375 kg and 2.070 kg respectively. The high proportion of peel weight to fruit in Pumpkin may be due to its thicker and hard shell, as reported by Ng (1993).

The average weight of edible portion of the fruits was observed to be 4.12 kg for Ashgourd and 2.53 kg for Pumpkin.

The seeds of Ashgourd were observed to be creamish-white in colour and elliptical in shape and weighed (dried) 2.5g per average weight of fruits. The seeds of Pumpkin fruit were ovate/ elliptical having a yellowish-cream surface with shallow grooves. The weight as recorded was found to be 3.2g Saade and Hernandez (1994) had also reported similar values.

The colour of the pulp of Ashgourd fruit as observed was white with a cream or greenish tinge, while that of Pumpkin fruit was deep yellow to orange in colour. Maynard et al. (2001) reported similar observations for Pumpkin fruit.

Juice extracted from the pulp of the fruits Ashgourd and Pumpkin was recorded to be 3.910 litres and 2.248 litres respectively per average fruit weight.

5.2 Standardization of RTS beverages

Standardization is a pre-requisite of any food based industry. In the present scenario of fast growing beverage industry, natural fruit and vegetable juices are becoming extremely popular. Fruit beverages introduce variety in flavour, nutrients and other physiological benefits with greater margin of safety and lower inherent cost. The nutritive value of real fruit and vegetable based beverages is far greater than that of synthetic beverages. Mannan et al. (1993) stated that fruit based RTS and juices are not only rich in essential minerals, vitamins and other nutritive factors but are also delicious and have a universal appeal. RTS beverages are increasingly gaining popularity throughout the country (Chakraborthy et al., 2003).

So an effort has been made in this direction to promote the diversification of Pumpkin and Ashgourd that can contribute to the fast growing beverage industry.

In the present study Ashgourd and Pumpkin fruits were selected for the development of RTS beverages due to their easy availability, nutritional properties and high juice content which makes them suitable for RTS preparation. 10-40 per cent juice strength, was taken for RTS preparation. The RTS beverages were mixed with different fruit juices and spice extracts, especially to enhance their taste, flavour and nutritional properties. Lime juice, amla juice and pineapple juice not only enriched the RTS beverages with their vitamin C content but also increased the acidity of the beverages, since Pumpkin and Ashgourd are low in acidity. This in turn enhanced the shelf stability of the RTS beverages. Sugar and honey added to the beverages besides imparting sweetness also increased their energy content. Honey

not only imparts sweetness and energy but also enhances the therapeutic value of the RTS beverages due to their medicinal properties.

5.3 Quality assessment

Chemical constituents of fruits

The chemical composition of Ashgourd and Pumpkin with respect to moisture, acidity, TSS, total sugar, reducing sugar, fibre, total ash, β-carotene, vitamin C, sodium and Potassium content was assessed in both the fruits (Ashgourd and Pumpkin).

Under present investigation moisture levels observed was higher in ashgourd (95.0 per cent) than in Pumpkin (88.2 per cent). Higher moisture level in Ashgourd (96 per cent was also reported by Ng (1993). Similarly acidity in Ashgourd was reported to be higher (0.14 per cent) than that of pumpkin (0.12 per cent). The higher acidity in Ashgourd may be due to higher ascorbic acid content. Studies conducted by several workers (Robinson et al., 1976; Gurdeep et al., 1977; Swamy et al., 1985) in Musk melon (*Cucumis melo*) also of Cucurbitacae family revealed that acidity content varied from pH 3-7, 0.04- 0.16 per cent and 0.06-0.24 per cent respectively.

Total soluble solids in Pumpkin was found to be higher (9^0 Brix) than that of Ashgourd (2^0 Brix). Similar studies on musk melon and water melon of Cucurbitacae family was reported by Nandpuri et al. (1975) and Bindukala (2000) for the TSS content, 4.3-12.1 per cent and 10.19-10.57 per cent respectively.

Total sugar content was observed to be 1.3 per cent in Ashgourd and 5.2 per cent in Pumpkin. Reducing sugar content was also higher in Pumpkin (3.7 per cent) than in Ashgourd (0.6 per cent). Wills et al. (1984) has observed that waxgourd contains 0.5 gm glucose and 0.5 gm fructose per 100 gm of edible portion but no sucrose. In a study by Hazzard and Reidel (2006) it was revealed that high sugar content in Pumpkins not only contributes to the desirable sweet taste but also gives a

fruity flavour. Bindukala (2000) in water melon observed the total sugar to be in the range of 5.05-6.31 per cent.

Fibre content was not high in both the fruits. Ashgourd recorded 1.7 g/100 g whereas Pumpkin recorded 0.8 g/ 100 g of the edible portion. Total ash content as observed was found to be 0.9 g/100 g in Ashgourd and 0.4 g/100 g in Pumpkin.

Pumpkin contains one of the richest and easily assimilable form of β carotene. On the other hand Ashgourd has no β carotene content. The observed value of β carotene was 10710 µg/100 g. Similar results were also cited by Pandey et al. (2003) revealing that total carotenoid content in Pumpkin was in the range of 2.35-14.85 mg/100 g. In a study conducted by Saskia et al. (1998) it was observed that orange coloured fruits including *Cucurbita moschata* were the effective source of dietary retinol than green leafy vegetables.

Vitamin C content was found to be 9.5 mg/100 g in Ashgourd. Wills et al. (1984) found vitamin C content to be 69 mg/100 g in *Benincasa hispida* var. *Cheih-gua How*. Pumpkin fruit had an ascorbic acid content of 3.98 mg/100 g. Similar findings were also reported by Pandey et al. (2003) indicating the range of vitamin C in Pumpkin to be 1.53-6.74 mg/100 g.

Sodium content in Ashgourd and Pumpkin were observed to be 2 mg/100 g and 3 mg/100 g respectively. While potassium content, as recorded was high in both the fruits with Ashgourd containing 250 mg/100 g and Pumpkin containing 139 mg/100 g. Thus Pumpkin and Ashgourd can be considered as a good source of electrolytes. Low sodium content in Pumpkin and Ashgourd make them suitable for the people suffering from heart diseases whereas high potassium content help to combat conditions such as hypokalaemia.

Chemical constituents in RTS beverages

The results on reducing sugar content in RTS beverages revealed that honey based combinations had higher values than sugar based combinations. T1PcH

combination had the highest percentage (6.87) of reducing sugar. The second highest value (6.03 per cent) was also recorded by honey combination of T2PaH. The higher percentage of reducing sugar in these combinations may be due to the presence of reducing sugar in honey. Whereas the lowest value (2.40 per cent) was observed in T1AbS, sugar based beverage.

The total sugar content was found to be in the range of 11.02-13.94 per cent, being highest for T2PaH while the lowest value was recorded for T2AcS combination. The highest total sugar content in T2PaH combination may be due to 20 per cent of Pumpkin juice in it and 5 per cent of pineapple juice, which contains good amount of sugar.

The highest TSS content (21^0 Brix) was observed in three combinations viz., T1PcH, T1AcH and T1AaH. While the lowest value was found to be 15^0 Brix in two treatments of Ashgourd viz., T2AcS and T2AdS. An RTS beverage developed by Kumar and Manimegalai (2002) from soya milk whey blended with papaya was found to have TSS of 15^0 Brix.

The treatments with highest acidity (0.19 per cent) were Ashgourd beverages T1AbS and T2AdS mixed with amla juice and lime juice respectively. The lowest acidity content (0.12 per cent) was reported in four treatments viz., T2AcS, T3PcS, T2PaH and T1AaH. The higher acidity content was found to be due to the presence of amla juice and lime juice in the combinations T1AbS and T2AdS. Kumar and Manimegalai (2003) reported 0.29 per cent of acidity for RTS preparation from pulp of culled apple pomace.

The highest β carotene value reported for Pumpkin RTS (3010 μg/100g) was observed to be in T3PcS combination. Higher value of β carotene in the combination was recorded due to higher percentage of Pumpkin juice used in it (40 per cent). Gonzalez et al. (2001) has also opined that Cucurbita moschata is an important source of pro-vitamin A. Since Ashgourd is nil in β carotene, therefore the RTS beverage developed from Ashgourd had negligible content except the treatment

T1AaH (170 μg/100g) mixed with pineapple juice and honey. Sindhumathi (2002) reported β carotene content of mango, pineapple and jackfruit blended RTS beverage varying from 450-875 μg/100 ml.

Vitamin C contents of Ashgourd RTS were more than Pumpkin RTS. The highest values of 51.77 mg/100g and 47.54 mg/100g were recorded for T1AbS combination of amla juice and sugar and T1PbS combination of amla juice and sugar respectively. Whereas the lowest value 1.76 mg/100g was observed in, T3PcS combination mixed with ginger extract and honey. It was encouraging to note that, by the addition of amla juice to the RTS beverages, vitamin C content was found to increase drastically. The findings are well supported by the similar observation made by Jain and Khurdiya (2004), when amla juice was blended with other fruit juices for the preparation of RTS beverages. It boosted the nutritional quality in terms of vitamin C content. Since it is the richest source of vitamin C containing 478.56 mg/100g of the fruit juice content. Toertia et al. (1992) observed the value to be 10.89 mg in muskmelon RTS.

The highest content (2.97 mg/100g) was observed in T1PdS combination of lime juice and sugar, whereas the lowest value was recorded for T1AcH (0.10 mg/100g) combination mixed with ginger extract and honey.

Since potassium content was high in both the fruits, therefore their treatments also recorded high content of potassium in them. The highest potassium content was recorded to be 189 mg/100g in T2AdS combination of lime juice and sugar. The lowest value (82 mg/100g) was recorded for T3PcS combination of ginger extract and sugar.

Organoleptic Qualities of RTS beverages

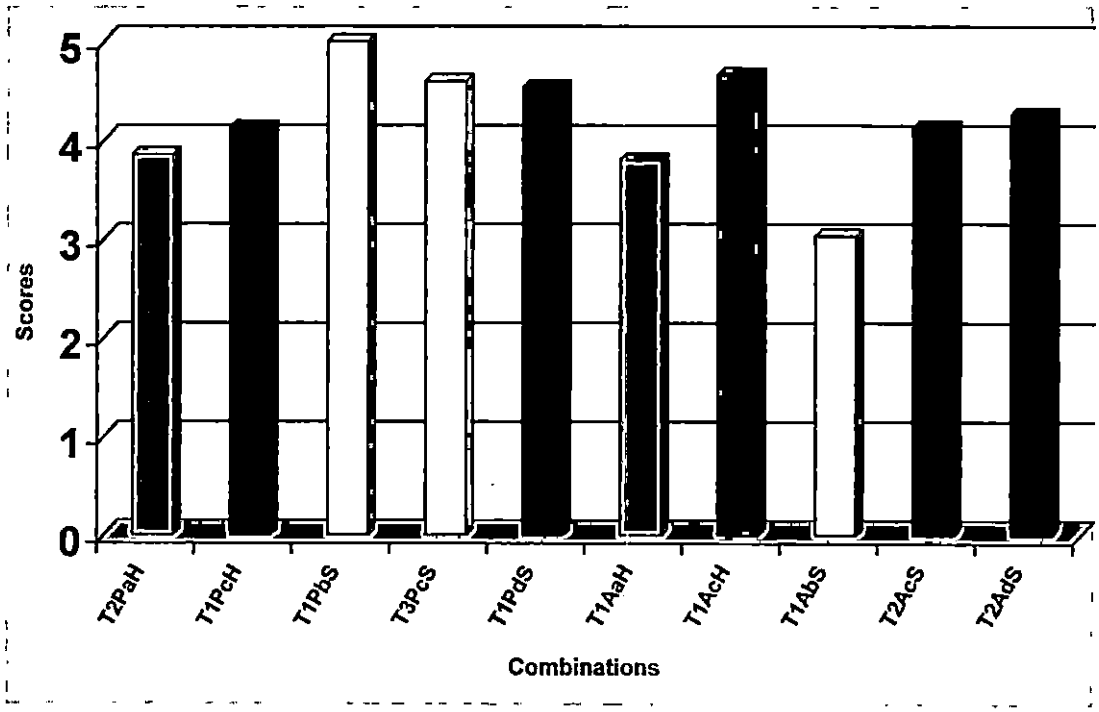
An organoleptic assessment stands as an essential element in the development of new products (Christeinson, 1985). According to Rajalekshmi (1993), sensory analysis is a scientific discipline used to evoke, measure, analyze and

interpret reaction to those characteristics of food materials as perceived by the sense of smell, sight, taste and touch. In the present study, appearance, colour, flavour and taste were the quality parameters assessed.

Appearance

Surface characteristics of food products contribute to the appearance. On assessing the appearance of the standardized RTS, it was found that the scores ranged between 3.03-5.00 out of 5, indicating 60-100 per cent acceptance as far as appearance is concerned. Fig 2. depicts the mean scores obtained for appearance. The highest score being recorded for T1PbS, while lowest score was observed for T1AbS combination. The highest score for Pumpkin based beverage was found due to the colour of Pumpkin fruit. Pandey (2005) also observed similar scores for jackfruit nectar, which was in the range of 3.96-4.30 out of 5.

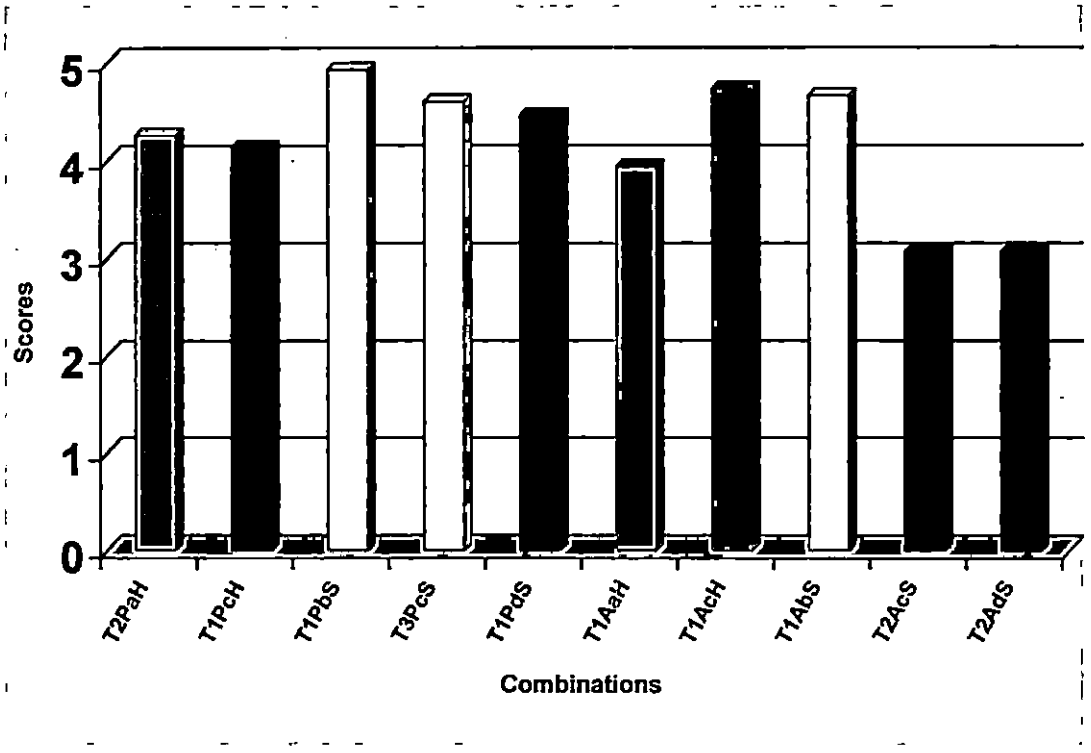
Fig. 2 Mean Score for Appearance of RTS beverages



Colour

Dorko and Penfeild (1993) are of the opinion that the aesthetic, safety, sensory characteristics and acceptability of foods are all affected by colour. Fig 3. shows the mean score obtained by the RTS beverages.

Fig. 3 Mean Score for Colour of RTS beverages

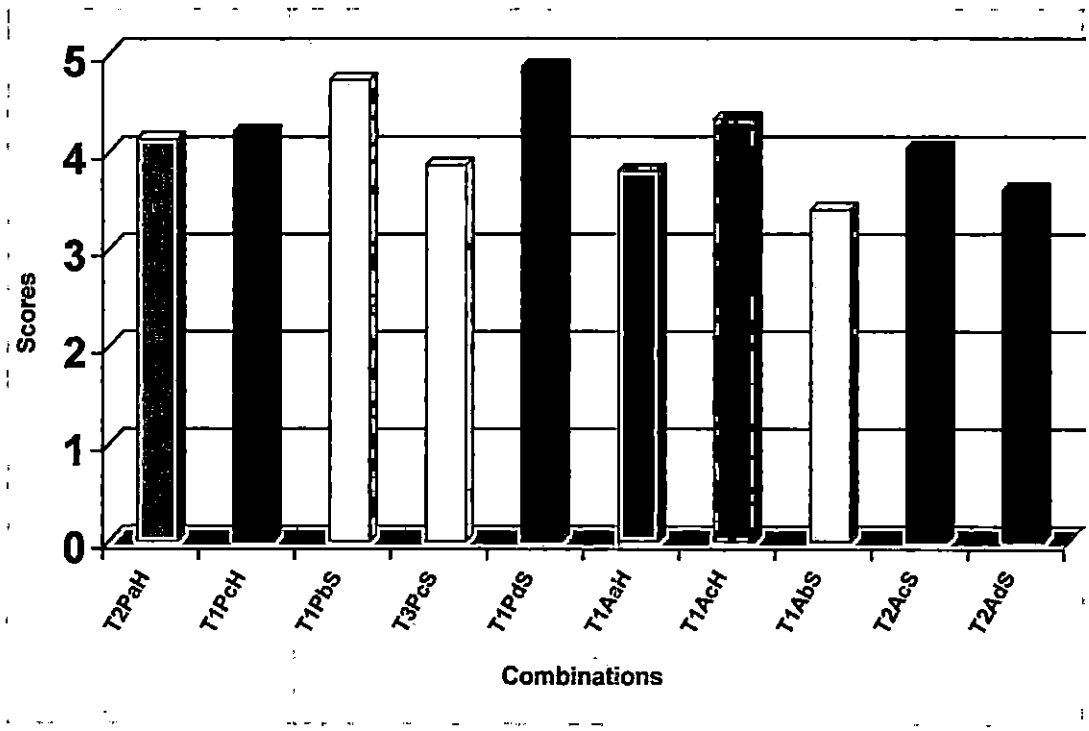


The scores of RTS beverages ranged between 3.06-4.93. The colour attribute of Pumpkin RTS was found to be highly favourable when it was mixed with amla juice and sugar, therefore it recorded the highest score (4.93) among all the beverages. The lowest score (3.06) was observed for two of Ashgourd RTS, T1AcS and T1AbS. Pumpkin based beverages were found to have more acceptability in terms of colour than Ashgourd based RTS beverages.

Flavour

Sharma (2006) is of the opinion that flavour of food has three components – odour, flavour and composite sensations known as mouthfeel. Flavour imparts recognizable character to the food products (Bajaj et al., 2002). Fig 4. shows the mean score obtained by the RTS beverages. The flavour scores of the RTS beverages ranged from 3-4.86. As far as flavour attributes were concerned Pumpkin based RTS beverage T1PdS mixed with lime juice was adjudged to be

Fig. 4 Scores for flavour of RTS beverages



the best combination, whereas the lowest score was observed for, T1AbS mixed with amla juice and sugar. Haug (2003) had opined that citrus aromas are a dominant factor in the soft drink beverage market. They are recognized by their freshness, juiciness and fruitiness. Neelofer (2004) reported that when pineapple juice was

blended with tender coconut water, flavour of the RTS beverage enhanced considerably.

Taste

Qualities of foods are evaluated by sensory organs of which taste is the most important and unavoidable aspect. Wide difference was observed in the opinion given by consumers regarding the taste of prepared RTS beverages. Fig 5. shows the mean score obtained by the RTS beverages. Scores for taste ranged between 3.00-5.00. The highest value was recorded for T1PbS RTS, whereas T1AbS RTS was found to have the lowest score. Pumpkin based beverages were more acceptable in terms of taste due to their high sugar content and fruity flavour.

Fig. 5 Scores for taste of RTS beverages

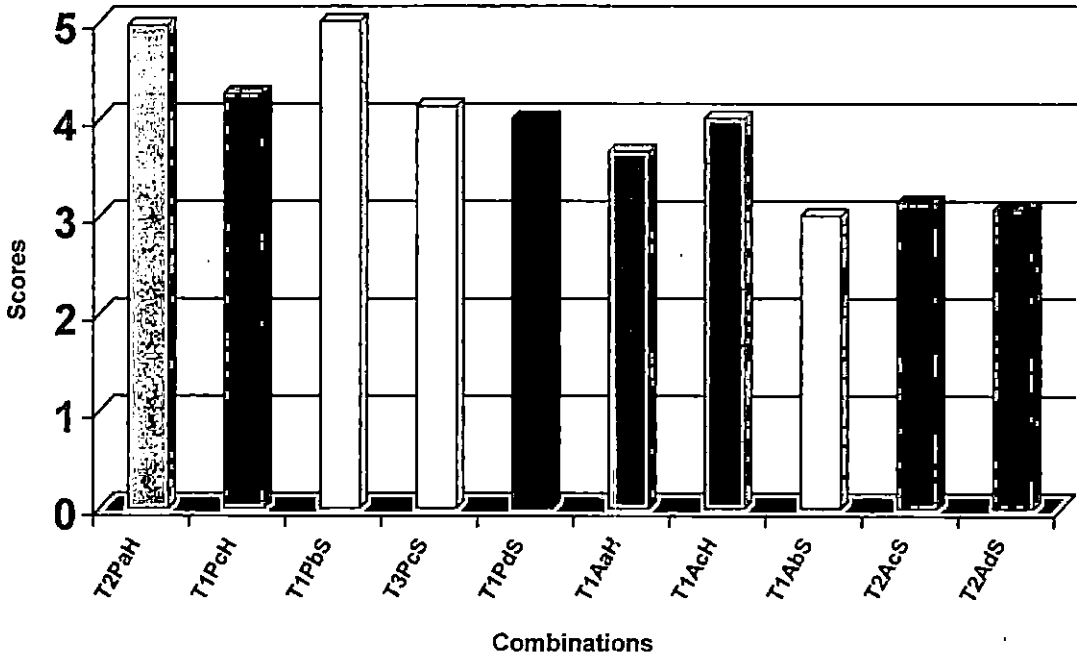
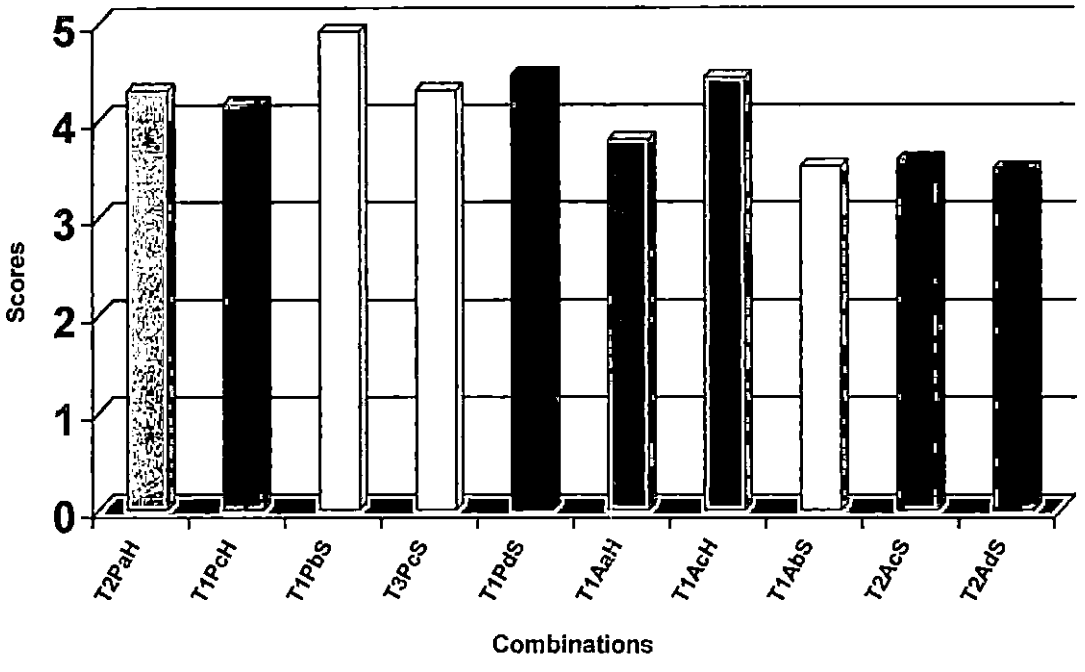


Fig. 6 Scores for overall acceptability of RTS beverages



Overall acceptability

On assessing the sensory attributes of RTS beverages, it was found that overall acceptability ranged from 3.49-4.91, indicating 70-98 per cent acceptability among the panel members. Fig. 6 shows the mean score obtained by the RTS beverages. The RTS with highest overall acceptability score was T1PbS, mixed with amla juice and sugar. The lowest score was recorded for Ashgourd RTS T2AdS mixed with lime juice and sugar. The highest score for Pumpkin based RTS beverage T1PbS may be due to attractive colour, fruity flavour and good taste. In the case of Ashgourd based RTS beverage, even though honey was present in it the appearance was not as good as Pumpkin based RTS beverage. Taste was also not as much acceptable as T1PbS beverage.

5.4 Shelf stability of RTS beverages

Shelf life of food varies with type of ingredients, the process, package, environmental conditions and consumer holding (Hurst et al., 1993). The quality of food also depends on the existing distribution and marketing systems and consumer food storage habits. The standardized RTS beverages from Pumpkin and Ashgourd were monitored daily for their change in sensory qualities and chemical constituents, initially and finally at the end of storage period for microbial load.

Changes in Organoleptic features of RTS beverages

Monitoring the storage behaviour in terms of sensory analysis is an easy and important method of testing the acceptability of the product. John (2002) has stated that for consumers the perceivable sensory attributes- appearance, colour, flavour and taste are the deciding factors for the acceptance of any food product.

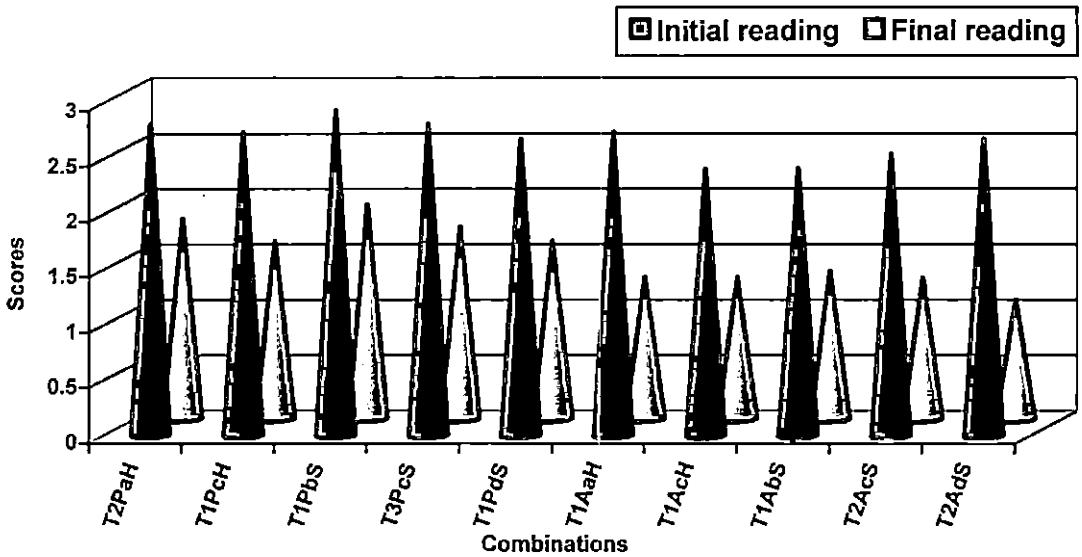
Appearance

Almedia and Noguiria (1995) stated that an organoleptic property determines the acceptance of food by the consumer with appearance being the first factor that decides the acceptance and rejection of a food. The appearance scores decreased significantly in all the RTS beverages with increase in the storage period. Fig 7 shows the assessment of changes in stored RTS beverages.

The overall mean score for Pumpkin based RTS beverages (2.387) remained high even after the storage period, whereas the score for Ashgourd RTS (2.080) decreased significantly throughout the storage period. Among the ten combinations of Pumpkin and Ashgourd RTS, T1PbS retained the highest score throughout the storage period with a mean score of (2.532). The lowest score after storage (1.07) was awarded for T2AdS. The initial overall mean score of the RTS beverages decreased from 2.668 to 1.485 during the storage period. Similar results were

reported by Irene (1997), Hema (1997) and Diju (1995) for the decrease in appearance attribute of the beverages when stored for a period of three to six weeks.

Fig. 7 Assessment of changes in appearance of RTS beverages (mean scores)

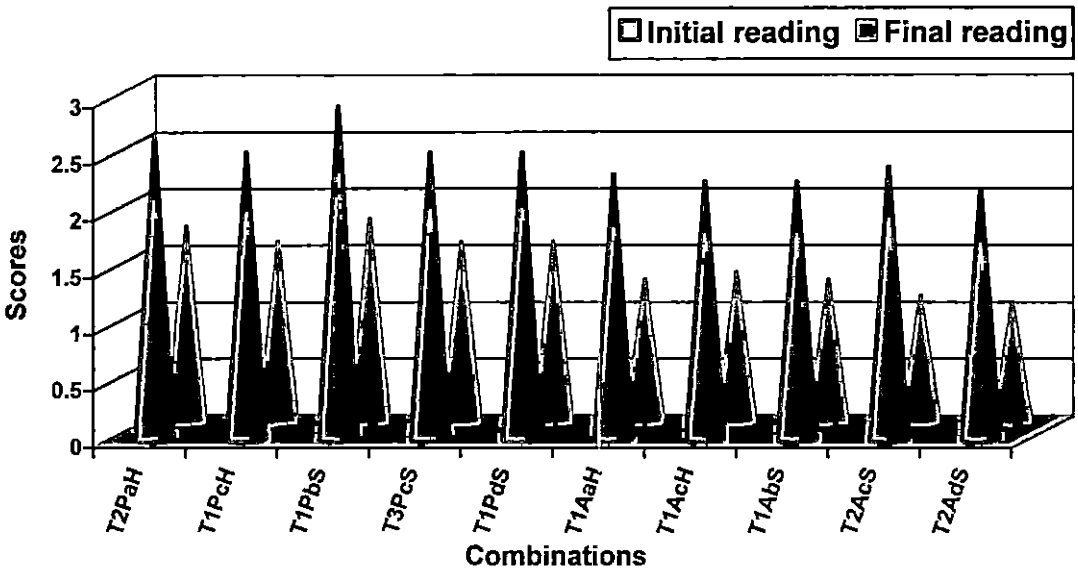


Colour

According to Sharma et al. (1995), colour scores were significantly related to acceptability. Fig 8 shows the assessment of changes in stored RTS beverages. Significant difference was observed in the colour of RTS beverages from Pumpkin and Ashgourd. The combinations applied, significantly influenced colour of the beverages. The overall mean score for Pumpkin RTS (2.285) remained high even after storage period when compared to Ashgourd RTS beverages (1.190). While considering all the ten combinations together, T1PbS RTS maintained the highest mean score, whereas the lowest mean score (1.877) was assigned to T1AbS. Overall mean scores decreased from 2.466 to 1.440 indicating the deteriorative changes taking place in the RTS beverages on storage.

Saini and Grewal (2000) reported decrease in the colour scores of bleached and unbleached pear juice over seven months of storage. Hema (1997) and Diju (1995) reported a decrease in colour scores in the RTS beverages formulated from jamun and passion fruit when stored for five to six weeks. According to Ranote et al. (1992) colour scores of kinnow RTS also declined during storage.

Fig. 8 Assessment of changes in colour of RTS beverages (mean scores)



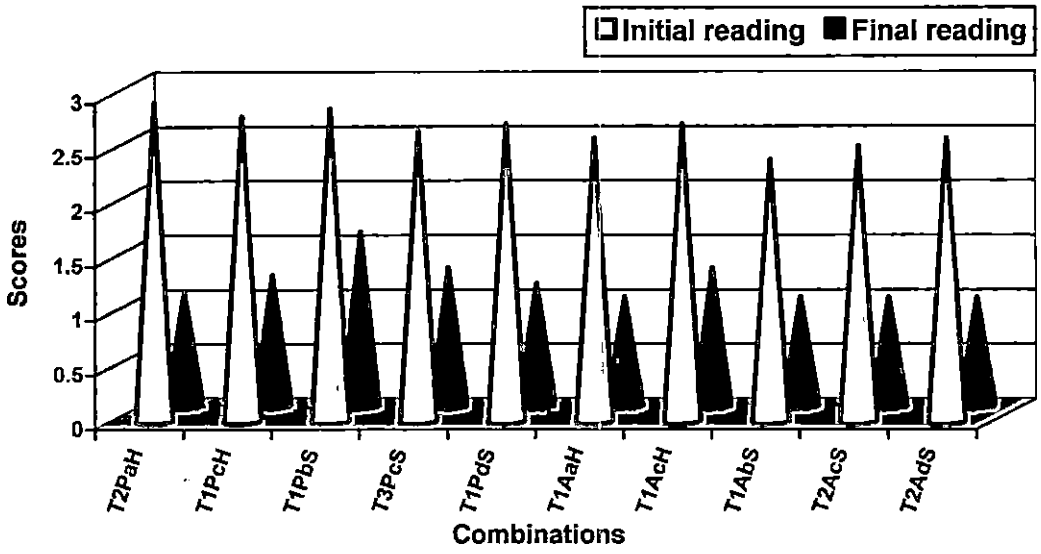
Flavour

Birch et al. (1988) stated that flavour is a unitary experience of sensation produced by a material taken in the mouth, perceived principally by the senses of basic smell and by the other cutaneous sensations in the mouth. Flavour is defined as the combination of taste and odour and is influenced by heat and cold sensations. Fig 9 shows the assessment of changes in stored RTS beverages.

Significant difference was seen in the flavour of RTS beverages formulated from Pumpkin and Ashgourd. Storage period had a significant influence on the

flavour changes especially in Ashgourd RTS. Fifty one per cent decrease in score was observed for Ashgourd RTS, whereas the Pumpkin RTS beverages recorded 45 per cent decrease in the mean scores. The highest score (2.42) was achieved by T1PbS, while the lowest score (1.818) after storage was seen in T1AbS RTS. Mean score of the combinations decreased from 2.685 to 1.206 after storage period.

Fig. 9 Assessment of changes in flavour of RTS beverages (mean scores)



Cantwell et al. (1996) has reported that flavour change can occur during storage of Ashgourd, which turns to acidic and has a less agreeable flavour. Saini and Grewal (2000) had observed reduction in flavour scores of pear juice, during storage period of seven months. Irene (1997) and Hema (1997) also reported similar findings in RTS beverages formulated from passion fruit and jamun.

Taste

According to Sharma (2006), food is valued for its taste. Taste sensations, which the taste buds register, are categorized as sweet, salty, sour or bitter.

Fig. 10 Assessment of changes in taste of RTS beverages (mean scores)

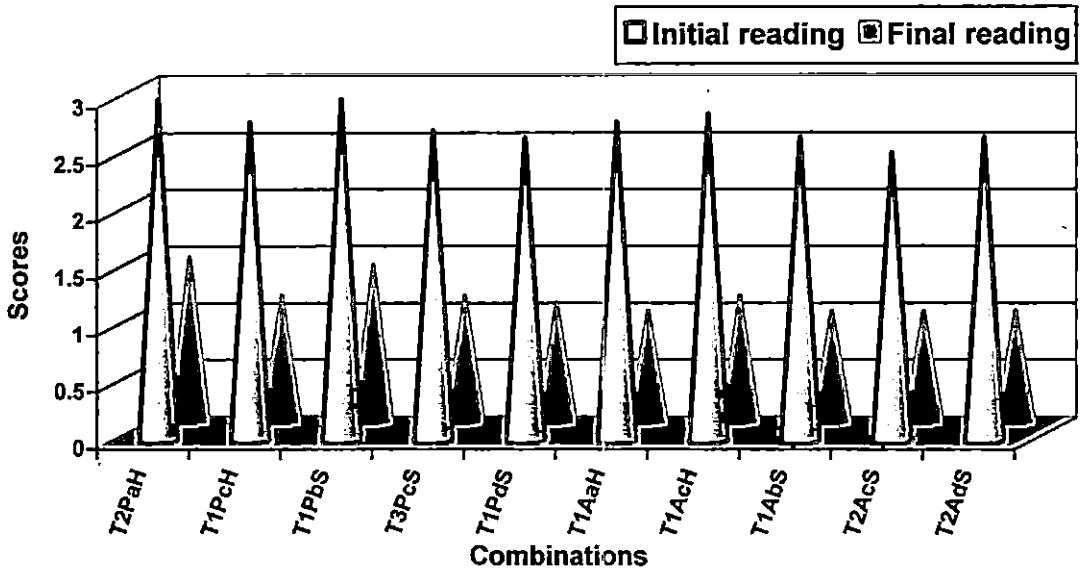


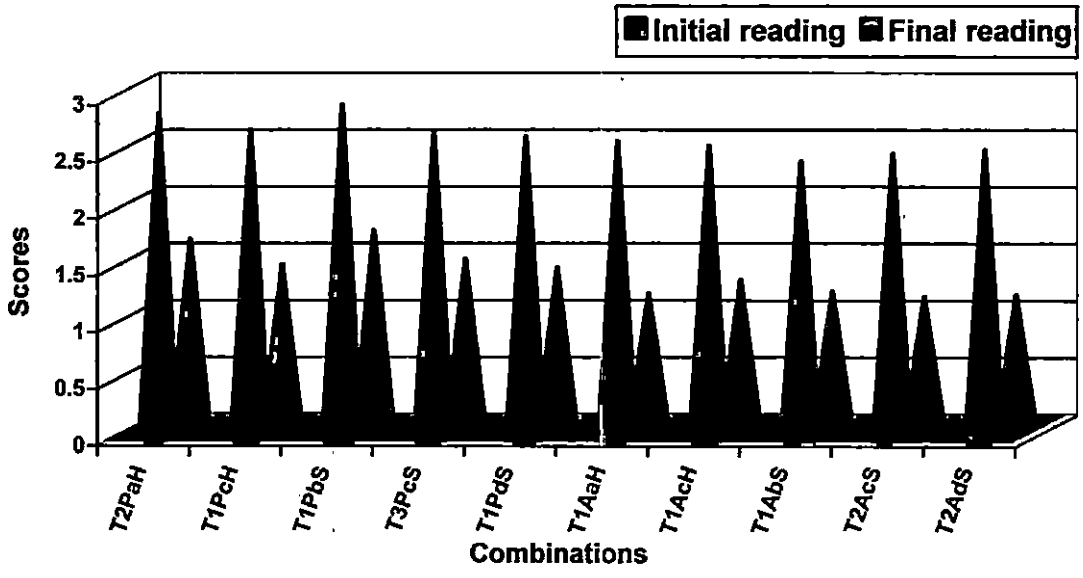
Fig 10 shows the assessment of changes in stored RTS beverages. Significant difference was observed in the taste attribute of RTS beverages standardized from Pumpkin and Ashgourd. A gradual decline in the scores was observed during storage period, bringing undesirable taste towards the end of shelf life study. The overall mean score for Pumpkin RTS remained higher (2.236) than Ashgourd RTS (1.943) throughout the storage period. Among all the combinations, the highest score was recorded for T1PbS (2.418). .

Diju (1995), Irene (1997), Hema (1997) and Beena (1998) also reported reduction in the taste scores of the RTS beverages and nectar formulated from different fruits.

Overall acceptability

Fig 11 shows the assessment of changes in stored RTS beverages. Overall decrease in acceptability scores was observed in all the treatments. As mentioned in all the above attributes it can be concluded that Pumpkin based RTS beverages were more acceptable to the panel members than Ashgourd based RTS beverages. The mean scores were also recorded higher (2.312) for Pumpkin RTS than Ashgourd RTS (1.964) over the storage period. The highest (2.46) and the second highest (2.39) overall mean score was recorded for T1PbS and T2PaH respectively. Mean scores of all the treatments also showed a marked decrease from 2.648 to 1.131 indicating the deteriorative changes taking place in all the beverages. Hema (1997) also recorded a reduction in scores of jamun RTS except for clarity.

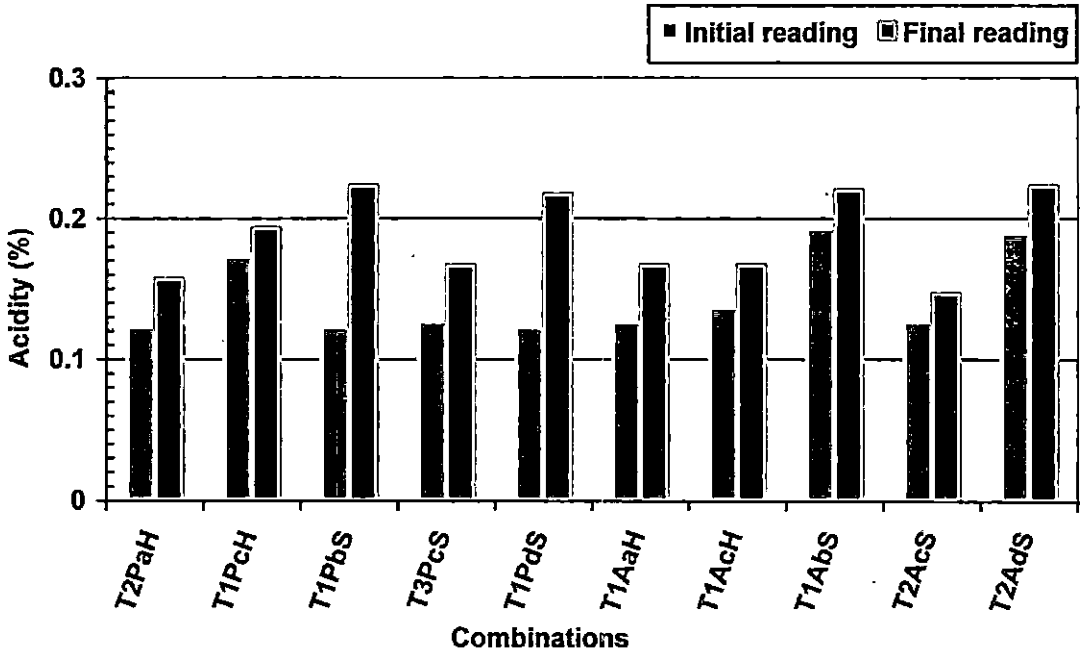
Fig. 11 Assessment of changes in overall acceptability of RTS beverages (mean scores)



Changes in Chemical Constituents of RTS beverages

Stability of the original quality of any processed food product is of paramount importance during storage and it should be checked to detect the acceptability of the product. Sharma (2006) has opined that chemical estimation of food products during storage is a useful criterion to judge the quality. Lesser or higher amount of certain chemicals in food make them acceptable or non-acceptable. Shelf life qualities of the RTS beverages were assessed by monitoring the changes occurring in the chemical components throughout the storage period. Main chemical components viz., acidity, TSS, total sugar and reducing sugar were assessed to detect the deteriorative changes occurring in the beverage.

Fig. 12 Changes in Acidity (per cent) of the stored RTS beverages



Acidity

According to Ashurst (1986), acidity gives flavour and offer antimicrobial protection to the beverages. Fig 12 shows the changes in acidity (per cent) of the

stored RTS beverages. Significant difference was observed in the acidity of RTS beverages stored. The total mean score for acidity increased from 0.156 to 0.188 per cent in all the combinations.

Combinations with the highest overall mean score (0.207 per cent) for acidity were found to be T1AbS and T2AdS, due to the presence of amla juice and lime juice in them. The increase in the acidity as reported by Prasad and Mali (2000) was due to the formation of organic acids from ascorbic acid.

Significant difference was noted in the acidity after the storage period, though the increase was not found to affect the quality of the RTS beverages. The increase in acidity contents was still within the specified limits of FPO (0.3 per cent).

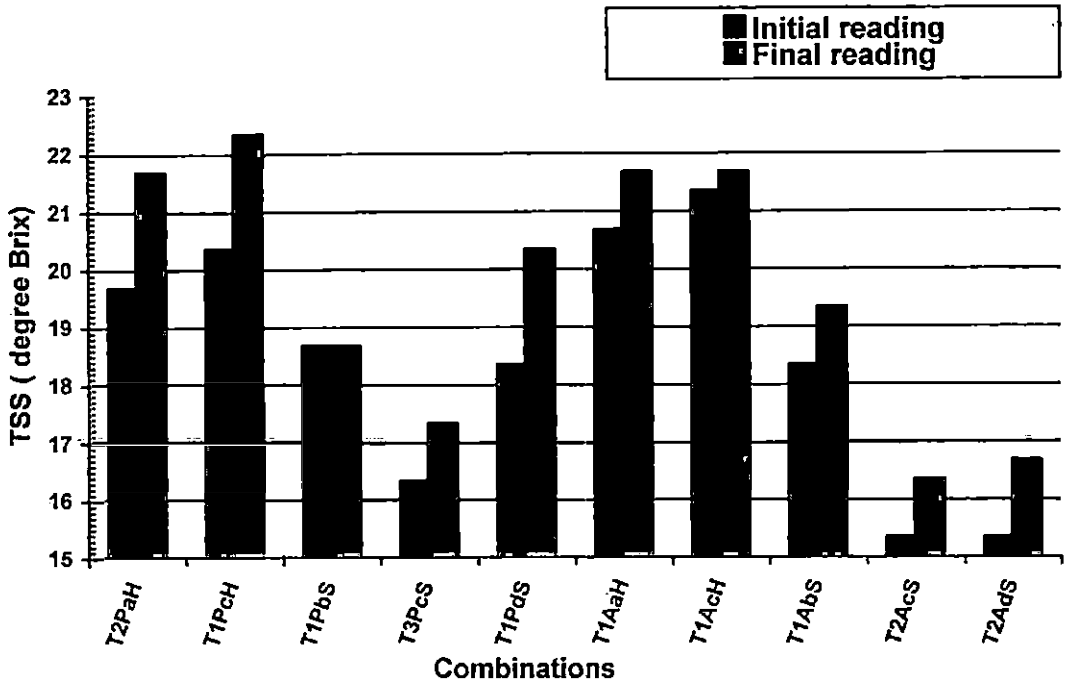
Increase in acidity was reported in whey based mango RTS by Kumar and Manimegalai (2001). Study conducted by Tripathi et al. (1988) in amla juice marked an increase of 0.86 per cent during storage. However banana RTS from cv. Poovan decreased during storage of 90 days (Narayana et al., 2002). Similar increase in acidity was reported by Hema (1997); Joshua (1997); Sogi and Singh (2001); Kotecha and Kadam (2003) and Sararvanakumar and Manimegalai (2003). Storage period showed a decrease in acidity in jamun RTS as observed by Kannan and Thirumaran (2004).

On the other hand no change in the acidity of mango RTS was observed by Oommen (1997) for a period of two weeks but thereafter it increased.

TSS

Fig 13 shows the changes in TSS (^{0} Brix) of the stored RTS beverages. Overall mean TSS content of the RTS beverages formulated from Pumpkin and Ashgourd showed significant increase at the end of storage period. However, there was no significant difference seen in a particular combination during storage. The beverage with highest mean TSS content (21.50^0 Brix) was reported to be T1AcH, followed by T1PcH with a mean score of 21.33^0 Brix. However in general, there was a negligible increase in the TSS content during storage.

Fig. 13 Changes in TSS (^{0} Brix) of the stored RTS beverages



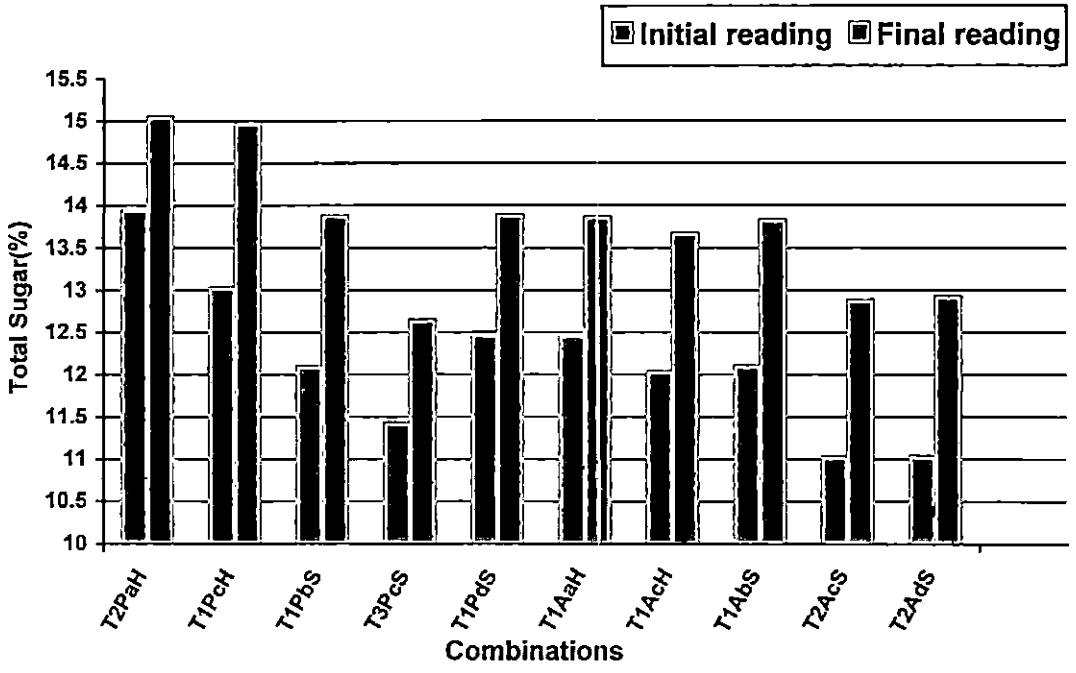
Mahajan et al. (1994) found that TSS content increased as the storage period advanced reaching a peak in 150 days in fruit beverages. TSS of red banana RTS remained almost unchanged during the storage period (Lekshmi, 2005). Similar studies were reported by Khurdiya and Ananad (1981); Khurdiya and Roy (1985); Islam et al. (1990) and Kalra et al. (1991). Saini and Baini (1994) also observed no change in the TSS content of watermelon juice.

Total Sugar

Fig 14 shows the changes in total sugar (per cent) of the stored RTS beverages.Mean total sugar content of the RTS beverages increased significantly during storage period. However, there was no significant difference recorded for a particular combination in the initial stage of storage as well as at the final stage of

storage period. Pumpkin combinations recorded higher total sugar content (13.33 per cent) than Ashgourd combinations (12.57 per cent). The combination with highest total sugar content (14.49 per cent) after storage was found to be T2PaH whereas the lowest value (11.95 per cent) was recorded for T2AcS.

Fig. 14 Changes in Total sugar (per cent) of the stored RTS beverages



The increase in total sugars may be due to the hydrolysis of complex carbohydrates. Raj and Khurdiya (2003) reported similar findings in RTS beverages prepared from culled apple pomace, where the total sugar increased when stored at ambient condition. Palainswamy and Muthukrishnan (1974) found the increase in total sugar, when lemon juice was stored.

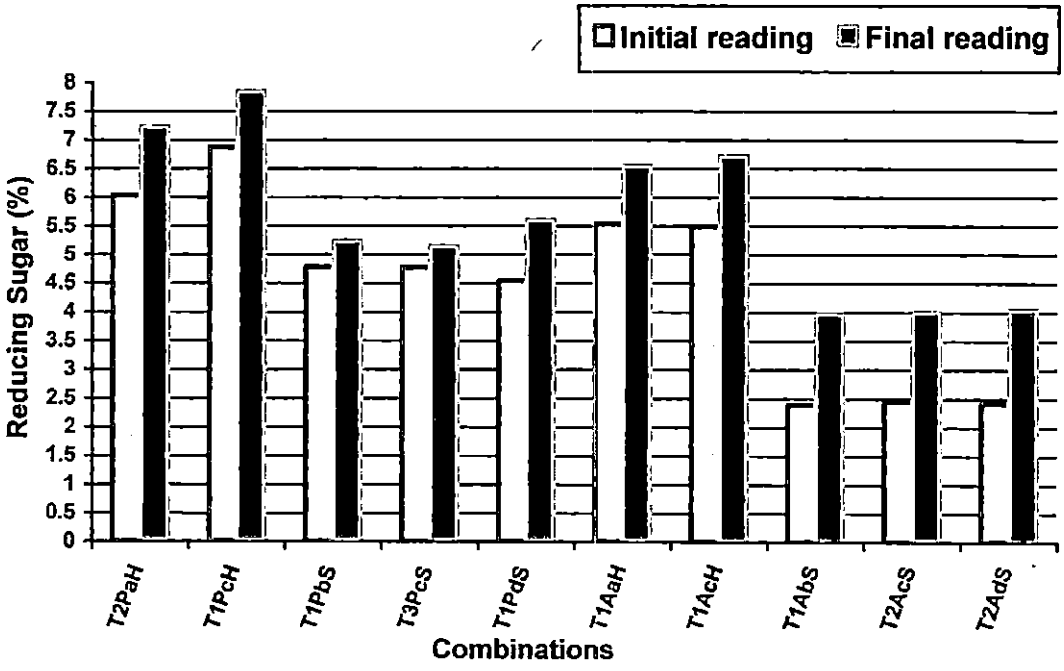
In contrast to the above findings, Bawa and Saini (1987) reported a decline in total sugar content of carrot juice when stored at room temperature. However,

Dinesh and Tiwari (2001) during their storage study of guava RTS found that total sugars remained almost constant.

Reducing Sugar

Fig 15 shows the changes in reducing sugar (per cent) of the stored RTS beverages. On assessing the qualitative changes in the reducing sugar content of the RTS beverages, there was an increase with storage. Non significant difference was observed in the overall mean value of both the stages (initial and final). However significant difference was recorded for a particular combination in their mean values at the initial stage and final stages of storage. The mean reducing sugar content of all the beverages increased gradually from 4.52 to 5.63. The beverage with the highest mean value (7.35) was found to be T1PcH, while the lowest content (3.20) was seen in T1AbS.

Fig. 14 Changes in Reducing Sugar (per cent) of the stored RTS beverages



Labuza et al. (1970) reported that increase in reducing sugar content during storage may be mainly due to the acid hydrolysis of sucrose and the inversion is temperature dependent, the inversion rate being higher at higher temperature. The reducing sugar content of mango RTS was found to increase with the increase in storage period (Jain et al. 1996; Oommen, 1997 and Roy et al. 1997). An increase in reducing sugars was also observed in jamun RTS over a storage period of six months (Kannan and Thirumaran, 2004).

Microbial Changes

Consumption pattern of beverages are changing and consumer demands the variety and shelf stability of beverages as well as preservation techniques used (Cahill, 2000). There has been considerable increase in the consumption of fruit and vegetable based beverages in the world during last few years. Beverages may be sources of food borne diseases, if proper food safety precautions are not adhered to (Kowsalya and Shyny, 2005). Serious health problems are arising all over the world due to the consumption of foods contaminated with pathogens or microbially spoilt foods (Raghuramaiah, 2001).

Microbial quality is one of the most critic quality parameter in a dynamic system such as food. There are different threats in food quality originating from microbial source. Khan et al. (2002) stressed the need for microbiological safety of foods. Spoilage causing micro-organisms are responsible for the development of an off flavour and off taste that leads to economic loss (Rao, 1998). The concept of spoilage by micro-organisms are the primary cause curtailing the shelf life and hence reducing initial microbial population is a strategy to extend shelf life (Zargory, 1999).

The keeping quality of the products very much depends upon the microbial contamination. Initially the microbial count was recorded nil to very low in all the treatments. However at the final stage of storage the bacterial count in the RTS was found to be in the range of 2-7 x 10^6 cfu/ml, whereas the fungal growth was recorded

to be in the range of 2-5 x 10^4 cfu/ml. No yeast cells were observed in the RTS treatments.

The bacterial colonies identified were slimy and cream to deep yellow in colour. Aspergillus, Penicillium and Mucor were observed to be the fungal colonies present in RTS beverages. The presence of these colonies may be the result of improper handling of food materials during preparation of RTS beverages, inadequate pasteurization and improper handling of glasswares while transferring the samples.

Irene (1997) detected colonies of Penicillium in the RTS beverage prepared from Neelam mangoes after 4 weeks of storage. Doodnath and Badreil (2000) reported that microbial infestation was minimum (10-100 cfu/ml) in the watermelon nectar stored for 5 weeks. Chitra (2000) reported that the microbial population of the banana RTS were 1-12 x 10^6/g and 1-6 x 10^6/g for bacteria and 1-13 x 10^4/g and 1-6 x 10^4/g for fungi and yeast respectively stored under ambient temperature and refrigerated condition for 300 days.

5.5 Comparison of the constituents of best selected RTS beverage with FPO specification

Food product order (FPO) is a government enacted law that regulates the standards for fruits, vegetables and their products. According to Sharma (1995) formulation of food standards is a dynamic activity, involving the co-operation of many experts in the field. Kapoor (1993) is of the opinion that food laws are essential for food safety. In the present study, RTS beverages finally selected were analyzed for specifications prescribed by FPO for the similar products. This is an essential step to ensure the quality of the food product.

Comparing the fruit juice strength, TSS, acidity and preservative content present in the best selected RTS beverages with FPO standards, it was found that beverages fulfill the FPO specification.

5.6 Consumer acceptance and preference for RTS beverage

Consumer awareness and preference decide the success of food products standardized. According to Watt et al. (1989), acceptance and preference are consumer oriented tests. The factors that motivates, consumer's consumption of fruit and vegetable juice and their products include exceptional taste experience, good mouthfeel, premium quality, enjoyment, wellness and naturalness (Kramer and Eck, 2003).

The selected 30 respondents accepted both developed RTS beverage (T1PbS and T1AcH). However, a higher percentage of respondents preferred Pumpkin RTS (T1PbS) than Ashgourd RTS (T1AcH) in terms of taste, refreshing effect and overall acceptability score. Better preference of Pumpkin RTS by the consumers was found due to the fruity flavour, attractive colour and a tangy taste imparted by amla juice. An "after taste" was felt by a larger percentage of respondents after consuming Ashgourd RTS, which may be the reason for its preference to become low when compared to that that of Pumpkin based RTS beverages.

5.7 Cost effectiveness of the RTS beverages

Costing can be defined as the process of determining how much it costs to produce and sell a product. Costing is very important as the cost of a product can decide its profit or loss (Awasthi, 2006). According to Kumbhar and Singh (1991), cost of production depends on the purchase of the raw materials, cost involved in processing, packaging and marketing and profit margin set up by the industry. While developing any new food product, the cost is to be kept at the minimum.

The cost worked out for RTS beverages T1PbS and T1AcH was found to be Rs. 6.50 and 9.75 per 200ml respectively that was quite reasonable. It is pertinent to record that sweetening the combination T1AcH with honey enhanced its cost due to high price of honey in the market. Though the price was found to be high, RTS

beverages developed are novel product of Pumpkin and Ashgourd fruit, they have good therapeutic value and also very less RTS beverages developed from vegetables are available in the market.

Neelofer (2004) found that the cost of coconut RTS beverages ranged between Rs. 19.8-27.5 per litre. Nectars developed by Pandey (2005) from Jackfruit were found to be cheap varying from Rs. 12-21 per litre.

T1PbS combination of Pumpkin, mixed with amla juice and sweetened with sugar was found to be the best among all the standardized beverages from Pumpkin, whereas T1AcH combination of Ashgourd juice, ginger extract and honey was adjudged the best among Ashgourd based RTS beverages. After the consumer acceptability study it was revealed that T1PbS combination was more acceptable among the consumers. It also costs less than T1AcH combination which makes it suitable for marketing. On the other hand T1AcH combination was not much preferred especially due to its flavour and feeling of "after taste" but its therapeutic value cannot be neglected.

Summary

6. SUMMARY

The present study entitled "Development of Ashgourd [*Benincasa hispida* (Thunb.) Cogn.] and Pumpkin (*Cucurbita moschata* Poir.) based Ready-To-Serve (RTS) beverage" was aimed at developing RTS beverages by utilizing the juice of Pumpkin and Ashgourd and to ascertain their qualities. Chemical, nutritional, organoleptic and shelf life qualities were studied along with the consumer acceptance and preference.

The physical characteristic of the fruits were studied and was found that 30-40 days mature fruit of Ashgourd and Pumpkin were to be selected for the preparation of RTS beverage. Ashgourd with light green skin colour and waxy coating while Pumpkin with light orange to light brown skin colour and flesh colour with deep yellow to orange was suitable for RTS development. The juice obtained from these fruit were mixed with other fruit juices and spice extracts (pineapple juice, amla juice, lime juice, ginger extract and mint extract) using sugar and honey as sweeteners.

The chemical and nutritional constituents of the fruits Ashgourd and Pumpkin revealed that Ashgourd fruits showed higher moisture content, acidity, total fibre, total ash, vitamin C and potassium while Pumpkin fruits showed higher content of TSS, total sugar, reducing sugar, β carotene and sodium content.

Preliminary trials were carried out with different concentrations (10 per cent to 60 per cent) of Ashgourd juice and Pumpkin juice. Initially a total number of 120 RTS beverages were prepared, sixty from each Ashgourd and Pumpkin, using five other fruit juices and spice extracts (pineapple juice/ amla juice/ lime juice/ ginger extract/ mint extract) to enhance the flavour and taste and two sweetening agents (sugar/ honey) in all the six treatments (10 per cent to 60 per cent). Evaluation of these 120 RTS beverages revealed that 10 per cent to 40 per cent juice concentration was more acceptable for RTS preparation than with 50 per cent and 60 per cent juice

concentration. Hence, a total number of 80 combinations of RTS beverages were standardized.

After analyzing the organoleptic mean scores of 80 standardized RTS beverages, those with the highest mean scores were ranked accordingly and 14 best combinations were selected. Hedonic scoring was conducted by a panel of 10 judges on these selected 14 combinations to choose 5 combinations from Pumpkin and Ashgourd. These selected ten combinations were then assessed for its chemical, nutritional, organoleptic and shelf life qualities.

Chemical constituents of the developed RTS beverages were assessed and it was found that acidity level was in the range of 0.12-0.19 per cent, whereas reducing sugar and total sugar were in the range of 2.40-6.87 per cent and 11.02-13.94 per cent respectively. TSS as observed was found to be between 15-21^0 Brix.

Pumpkin based RTS beverages showed higher β-carotene content whereas negligible amount was seen in Ashgourd based beverages. Vitamin C content of the combinations treated with amla juice, lime juice and pineapple juice showed higher values. Sodium content in the beverages ranged from 0.10-2.97 mg/100gm while potassium content was found to be in the range of 86-189 mg/100gm.

Organoleptic evaluation of RTS beverages revealed that the mean scores for appearance ranged from 3.03-5.00. The highest mean score obtained by (T1PbS) Pumpkin based RTS beverage mixed with amla juice and sweetened with sugar. The highest mean scores among Ashgourd based RTS beverage 4.66 was achieved by (T1AcH) Ashgourd RTS beverage mixed with ginger extract and honey. The mean scores obtained by RTS beverages for colour ranged from 3.06-4.93. The highest score was recorded for Pumpkin RTS, T1PbS. Among Ashgourd RTS beverages the highest mean score of 4.73 was recorded for T1AcH. The mean scores obtained for flavour was in the range 3.40-4.86. The highest mean score of 4.86 was recorded for Pumpkin based RTS beverage T1PdS, mixed with lime juice and sweetened with sugar. Among Ashgourd based RTS beverage the highest mean score of 4.33 was

recorded for T1AcH. From the mean scores obtained for taste, the range of scores lie between 3.00-5.00. The highest mean score 5.00 was recorded for Pumpkin based RTS beverage T1PbS and among Ashgourd based RTS beverages the highest mean score of 4.00 for taste was recorded for T1AcH. Organoleptic evaluation of the RTS beverages indicated that overall acceptability mean scores ranged from 3.49-4.91. Among Pumpkin based RTS beverages the highest mean score 4.91 was noted for T1PbS combination, whereas in the case of Ashgourd the highest mean score of 4.43 was achieved by T1AcH.

The freshly developed RTS beverages were stored at ambient temperature to assess their shelf stability. RTS beverages were assessed organoleptically and chemically throughout the storage period whereas changes in microbial load were studied initially and finally at the end of storage period.

Organoleptic assessment of the RTS beverages during storage period of seven days showed a decreasing trend in the mean scores of all the combinations. The combination, which maintained highest mean score 2.532 throughout the storage period for appearance was T1PbS, Pumpkin based RTS beverage, whereas among Ashgourd RTS, T1AcH combination showed highest mean score of 2.142. Assessment of changes in colour showed that T1PbS combination secured highest mean score 2.486 among Pumpkin RTS whereas three of Ashgourd RTS combination shared highest mean score 1.942 viz., T1AaH, T1AcH and T2AcS. While assessing flavour changes the highest mean score of 2.420 was recorded for Pumpkin based RTS beverage T1PbS and the highest mean score 2.104 among Ashgourd based RTS beverages was recorded for (T1AcH). The highest mean score for taste 2.418 was recorded for Pumpkin RTS (T1PbS) and the highest mean score 2.105 among Ashgourd based RTS beverage was recorded for (T1AcH). Analysis of the data on the overall acceptability mean score of RTS beverages revealed that mean scores at the end of the storage period for Pumpkin based RTS beverages 2.312 was greater than the mean scores of Ashgourd based RTS beverages 1.964. The

highest score among Pumpkin RTS was secured by T1PbS combination (2.46) while among Ashgourd RTS, T1AcH combination secured highest score (2.41).

The changes in chemical constituents of the RTS beverages showed a increasing trend in values of each character, viz., total sugar, reducing sugar, TSS and acidity. While assessing the changes in acidity, it was revealed that T1PbS combination recorded highest acidity per cent (0.203) among Pumpkin RTS, whereas among Ashgourd RTS, T1AbS and T2AdS combination showed highest value of (0.207 per cent). Changes in TSS content was observed and found that T1PcH combination recorded highest value 21.33^0 Brix for Pumpkin RTS and T1AcH among Ashgourd RTS 21.50^0 Brix. Total sugar content as recorded was found to be highest in T2PaH combination (14.49 per cent) of Pumpkin RTS and T1AaH combination maintained highest value (13.16 per cent) among Ashgourd RTS. Reducing sugar content showed highest mean value (7.35 per cent) for Pumpkin RTS T1PcH and T1AcH among Ashgourd RTS (6.06 per cent).

Microbial growth (fungi, bacteria and yeast) was very less in the developed RTS beverages initially. After storage period yeast cells were not observed in any of the combinations but the fungal and bacterial load increased. The fungal colonies identified were of Aspergillus, Mucor and Penicillium while bacterial colonies were found to be slimy and cream to deep yellow in colour.

The best selected RTS beverages from Pumpkin (T1AbS) and Ashgourd (T1AcH) developed when compared with FPO specification were found to have values meeting the minimum specified limits for fruit juice and TSS and maximum specified limits for acidity and SO_2. Minimum fruit juice was 10 per cent, minimum TSS was 18^0 Brix, maximum acidity 0.12-0.19 per cent and maximum SO_2 was found to be 70 ppm present in the developed RTS which were within the prescribed limits. The combination which retained highest organoleptic scores and showed least chemical changes and negligible microbial count was selected for consumer acceptability study. One combination each from Pumpkin RTS (T1PbS) and

Ashgourd RTS (T1AcH) were selected and were assessed by 30 volunteers for 3 consecutive days. The result revealed that both the combinations were acceptable but Pumpkin RTS was much preferred by the consumers.

Cost of the product was worked and was found that T1PbS cost Rs. 6.50 per (200ml) bottle and T1AcH Rs. 9.75 per (200ml) bottle which was quite reasonable.

From the above findings, it can be concluded that freshly prepared RTS beverages were more acceptable than consuming it after storage. The organoleptic changes were markedly noticeable in Ashgourd RTS beverages and hence it was not as acceptable as Pumpkin based RTS beverage after storage. On the other hand, Pumpkin based RTS beverages were much preferred by the consumers as well as showed less organoleptic changes during storage.

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Appendix

Appendix I

Score Card for Organoleptic evaluation of Standardized RTS beverages

Criteria	Score	Sugar based RTS beverages				Honey based RTS beverages			
		T1	T2	T3	T4	T1	T2	T3	T4
Appearance									
Highly acceptable	5								
Moderately acceptable	4								
Less acceptable	3								
Slightly non-acceptable	2								
Non-acceptable	1								
Colour									
Highly acceptable	5								
Moderately acceptable	4								
Less acceptable	3								
Slightly non-acceptable	2								
Non-acceptable	1								
Flavour									
Highly acceptable	5								
Moderately acceptable	4								
Less acceptable	3								
Slightly non-acceptable	2								
Non-acceptable	1								
Taste									
Highly acceptable	5								
Moderately acceptable	4								
Less acceptable	3								
Slightly non-acceptable	2								
Non-acceptable	1								

T1 = 10 per cent Ashgourd/ Pumpkin juice
T2 = 20 per cent Ashgourd/ Pumpkin juice
T3 = 30 per cent Ashgourd/ Pumpkin juice
T4 = 40 per cent Ashgourd/ Pumpkin juice

Appendix II

Mean Scores of the standardized RTS beverages

Combinations	Appearance	Colour	Flavour	Taste	Total
Pumpkin + Pineapple					
T_1PaH	57	62	64	63	246
T_2PaH	66	64	70	**65**	**265**
T_3PaH	66	67	60	62	255
T_4PaH	66	67	60	60	253
T_1PaS	66	59	60	63	248
T_2PaS	67	63	58	59	247
T_3PaS	69	66	62	58	255
T_4PaS	71	68	64	61	264
Ashgourd + pineapple					
T_1AaH	57	59	57	55	228
T_2AaH	56	58	54	54	222
T_3AaH	55	57	55	52	219
T_4AaH	56	56	51	47	210
T_1AaS	65	65	69	**73**	**272**
T_2AaS	62	60	58	56	236
T_3AaS	59	63	58	53	233
T_4AaS	60	62	60	50	232
Pumpkin + Amla					
T_1PbH	75	75	75	**75**	**300**
T_2PbH	62	62	66	59	249
T_3PbH	53	57	65	40	215
T_4PbH	49	49	57	30	185
T_1PbS	75	74	73	**75**	**297**
T_2PbS	67	67	70	64	268
T_3PbS	60	62	65	47	234
T_4PbS	56	56	59	38	209
Ashgourd + Amla					
T_1AbH	67	67	60	62	236
T_2AbH	59	57	57	60	233
T_3AbH	50	59	50	42	191
T_4AbH	44	55	50	32	170
T_1AbS	74	70	66	**75**	**285**
T_2AbS	65	64	62	62	253
T_3AbS	54	58	60	50	222
T_4AbS	45	46	56	38	185

Pumpkin + Ginger					
T_1PcH	65	64	65	**64**	**258**
T_2PcH	63	61	63	61	248
T_3PcH	59	51	55	52	217
T_4PcH	62	62	54	54	232
T_1PcS	60	60	60	62	242
T_2PcS	63	63	58	61	245
T_3PcS	69	69	58	**62**	**258**
T_4PcS	53	51	48	46	198
Ashgourd + Ginger					
T_1AcH	65	71	65	**64**	**265**
T_2AcH	65	62	59	61	247
T_3AcH	58	53	55	60	226
T_4AcH	44	41	47	52	184
T_1AcS	63	65	63	62	253
T_2AcS	63	67	65	**71**	**266**
T_3AcS	63	58	62	64	247
T_4AcS	56	59	56	53	224
Pumpkin + Lime					
T_1PdH	61	64	59	66	250
T_2PdH	61	62	58	58	239
T_3PdH	59	63	58	54	234
T_4PdH	61	60	55	45	221
T_1PdS	68	67	71	**75**	**281**
T_2PdS	63	63	62	62	250
T_3PdS	65	63	53	47	228
T_4PdS	63	62	52	40	217
Ashgourd + Lime					
T_1AdH	61	57	55	9	232
T_2AdH	74	71	63	**75**	**283**
T_3AdH	62	60	58	66	246
T_4AdH	45	44	47	36	172
T_1AdS	65	60	59	66	250
T_2AdS	73	70	66	73	282
T_3AdS	71	69	65	70	275
T_4AdS	53	49	53	41	196

Pumpkin + Mint					
T_1PeH	75	74	75	**75**	**299**
T_2PeH	67	61	61	60	249
T_3PeH	55	59	59	45	218
T_4PeH	42	47	47	33	169
T_1PeS	74	74	75	**75**	**298**
T_2PeS	65	63	64	64	256
T_3PeS	59	59	60	53	231
T_4PeS	46	52	53	35	186
Ashgourd + Mint					
T_1AeH	69	69	69	64	271
T_2AeH	68	69	65	69	271
T_3AeH	59	62	60	54	245
T_4AeH	51	53	51	35	190
T_1AeS	73	75	71	**71**	**290**
T_2AeS	68	64	65	71	268
T_3AeS	59	61	60	54	234
T_4AeS	48	50	49	36	183

Appendix III

Score card for storage study of RTS beverages

Criteria	Scores	Pumpkin based RTS beverages					Ashgourd based RTS beverages				
		T_2PaH	T1PcH	T1PbS	T3PcS	T1PdS	T1AaH	T1acH	T1AbS	T2AcS	T2AdS
Appearance											
Highly acceptable	3										
Moderately acceptable	2										
Non acceptable	1										
Colour											
Highly acceptable	3										
Moderately acceptable	2										
Non acceptable	1										
Flavour											
Highly acceptable	3										
Moderately acceptable	2										
Non acceptable	1										
Taste											
Highly acceptable	3										
Moderately acceptable	2										
Non acceptable	1										

Appendix IV

Mean Scores of RTS beverages obtained during storage

Sensory attributes	1st Day	2nd Day	3rd Day	4th Day	5th Day	6th Day	7th Day	Total
Appearance								
T_2PaH	42	42	42	42	41	40	40	**289**
T_1PcH	40	40	40	39	39	38	37	273
T_1PbS	42	42	40	40	40	39	39	282
T_3PcS	38	38	38	35	35	35	34	253
T_1PdS	41	40	40	40	39	39	38	277
T_1AaH	34	34	33	32	31	29	28	221
T_1AcH	35	34	34	32	32	31	31	**229**
T_1AbS	26	26	24	24	24	23	23	169
T_2AcS	20	19	19	19	17	17	15	126
T_2AdS	25	25	24	22	22	22	21	161
Colour								
T_2PaH	43	42	42	40	39	35	35	276
T_1PcH	40	40	39	39	39	36	36	269
T_1PbS	43	43	42	42	42	40	40	**292**
T_3PcS	41	41	40	40	40	38	38	278
T_1PdS	40	39	39	39	36	36	34	263
T_1AaH	28	28	27	27	25	24	22	181
T_1AcH	41	41	40	39	38	38	37	**274**
T_1AbS	41	24	22	22	20	19	18	166
T_2AcS	42	18	18	18	15	15	12	138
T_2AdS	39	20	20	18	18	15	14	144
Flavour								
T_2PaH	41	40	40	38	38	35	35	267
T_1PcH	35	31	30	30	30	29	28	213
T_1PbS	42	42	40	39	39	38	38	**278**
T_3PcS	38	36	36	35	35	35	34	249
T_1PdS	39	37	37	37	34	34	33	251

T_1AaH	35	35	34	34	34	33	31	**236**
T_1AcH	40	24	24	24	22	22	21	177
T_1AbS	30	21	21	20	20	18	18	148
T_2AcS	31	21	20	20	20	19	17	148
T_2AdS	32	25	24	22	20	19	17	159
Taste								
T_2PaH	42	40	40	38	38	35	34	267
T_1PcH	30	27	25	25	24	23	23	177
T_1PbS	43	43	40	40	38	38	37	**279**
T_3PcS	25	22	20	20	19	19	16	144
T_1PdS	25	24	24	23	21	20	20	157
T_1AaH	42	40	38	37	37	35	34	263
T_1AcH	43	43	40	40	39	38	37	**280**
T_1AbS	25	22	21	20	20	16	15	139
T_2AcS	22	17	15	15	12	12	10	103
T_2AdS	23	20	15	15	11	11	9	104

Appendix V

Composition of Media for Microbial Analysis

Martin's Rose Bengal Agar

Glucose – 10g

Peptone – 5g

K2HPO4 – 1g

MgSO4.7H2O – 0.5g

Streptomycin – 30mg

Agar – 15g

Rose Bengal colour – 0.035g

Water – 1000ml

Nutrient Agar

Peptone – 5g

Beef extract – 3g

Agar – 16g

Water – 1000ml

Yeast Extract Mannitol Agar

Mannitol – 10g

K2HPO4 – 0.5g

MgSO4 – 0.2g

NaCl – 0.1g

Yeast extract – 1g

Agar – 20g

Water – 1000ml

DEVELOPMENT OF ASHGOURD [*Benincasa hispida* (Thunb.) Cogn.] AND PUMPKIN (*Cucurbita moschata* Poir.) BASED READY-TO-SERVE (RTS) BEVERAGE

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ABSTRACT

The present investigation was carried out at the department of Home Science, College of Agriculture, Vellayani during 2006-2007 with the objective to study the suitability of the fruits Ashgourd [*Benincasa hispida* (Thunb.) Cogn.] and Pumpkin (*Cucurbita moschata* Poir.) for the development of Ready-To-Serve (RTS) beverages and to ascertain their qualities.

In-depth analysis of physico-chemical characteristics of the fruits Ashgourd and Pumpkin were assessed. RTS beverages were developed utilizing the juice of Pumpkin and Ashgourd and mixing it with other fruit juices and spice extracts (Pineapple juice, amla juice, lime juice, ginger extract and mint extract) separately. Preliminary trials were carried out with different concentrations (10 per cent to 60 per cent) of Ashgourd juice and Pumpkin juice. Initially a total number of 120 RTS beverages were prepared, sixty from each Ashgourd and Pumpkin. Evaluating these 120 RTS beverages, it was found that 10 per cent to 40 per cent juice concentration was more acceptable for RTS preparation than with 50 per cent and 60 per cent juice concentration. Hence, a total number of 80 combinations of RTS beverages were standardized and organoleptically tested. Based on the overall mean scores 14 combinations having the highest scores were selected. Hedonic scoring test was conducted on these selected 14 combinations so as to select 10 best combinations, 5 each from Pumpkin and Ashgourd were selected for detailed study.

The results revealed that T1PbS combination of Pumpkin juice mixed with amla juice and sweetened with sugar and T1AcH combination of Ashgourd juice mixed with ginger extract and honey secured highest overall acceptability mean score, 4.91 and 4.43 respectively.

Chemical constituents of the developed RTS beverages were assessed and it was found that acidity content was in the range of 0.12-0.19 per cent, whereas reducing sugar and total sugar were in the range of 2.40-6.87 per cent and 11.02-13.94 per cent respectively. TSS as observed was found to be between 15-21^{0}brix.

Pumpkin based RTS beverages showed higher β-carotene content. Vitamin C content of the combinations treated with amla juice, lime juice and pineapple juice showed higher values. Sodium content in the beverages ranged from 0.10-2.97 mg/100gm while potassium content was found to be in the range of 86-189 mg/100gm.

Freshly prepared RTS beverages were filled in sterilized glass bottles (200ml), crown corked and pasteurized at 72^0C for 15 minutes after which they were cooled to room temperature. The bottles were stored at ambient condition for assessing their shelf stability. RTS beverages were assessed for the changes organoleptically and the change in chemical constituents were also determined throughout the storage period, while microbial load were determined at the initial as well as at the final stage of the storage period.

The organoleptic results revealed that among Pumpkin RTS T1PbS beverage retained highest overall acceptability mean score whereas T1AcH secured highest overall mean score for Ashgourd RTS. Major chemical constituent of RTS beverages viz., total sugar, reducing sugar, TSS and acidity showed an increasing trend in all the combinations.

Microbial load was also assessed in the selected ten combinations and the result revealed that initially nil to very low microbial count was found, while at the final stage of storage period, yeast cells were not seen in any combination whereas negligible growth of fungi and bacteria was observed in all the combinations.

When compared with FPO specification, it was observed that the values for developed RTS beverages were on par with the specified value and even after storage period, the values were still found to be within the prescribed limit.

The combination with highest organoleptic score from each Pumpkin and Ashgourd was chosen for consumer acceptability and preference study. It was found that Pumpkin based RTS beverage T1PbS was more acceptable as well as more preferred by the consumers than Ashgourd based RTS beverage T1AcH.