STANDARDISATION OF BLENDED CASHEW APPLE RTS BEVERAGES

By

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THESIS

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DECLARATION

I, hereby declare that this thesis entitled **"Standardisation of blended cashew apple RTS beverages"** is a bonafide record of research work done by me during the course of research and that it has not been previously formed the basis for the award to me of any degree, diploma, fellowship or other similar title, of any other University or Society.

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Certified that this thesis entitled **"Standardisation of blended cashew apple RTS beverages"** is a record of research work done independently by Miss. Remyamol, K.K., 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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EXTERNAL EXAMINER

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Dedicated to my
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ABBREVIATIONS

A.O.A.C.	Association of Official Analytical Chemists
CRD	Completely Randomised Design
CFTRI	Central Food Technological Research Institute
cm.	centimeter
cfu	colony forming unit
E.coli	*Escherichia coli*
ECD Agar	*E-coli* Direct Agar
FPO	Fruit Products Order
g.	gram
IU	International Unit
KAU	Kerala Agricultural University
Kg	Kilogram
KMS	Potassium Meta bi Sulphite
mg	milligram
ml	millilitre
µg	microgram
NEB	Non Enzymatic Browning
ppm	parts per million
RTS	Ready To Serve
TSS	Total Soluble Solids

Introduction

INTRODUCTION

Cashew (*Anacardium occidentale*, L.), one of the important plantation crops of India, and considered as the 'Gold Mine' of waste land was introduced to the country in the 16th century by the Portuguese mainly as a crop against soil erosion.

India is the largest producer, processor, consumer and exporter of cashew in the world, accounting for about 50 per cent of the world production. Cashew is mainly cultivated for its delicious and nutritious kernel obtained from the nut. This forms an important dollar earning crop where by it stands as the third highest foreign exchange earner among the agricultural products.

The cashew tree also produces the cashew apple, the pseudo fruit developed from the pedicel. The cashew apple production in India is estimated to be 45 lakh tonnes (Salam and Joseph, 2003). It is juicy and swollen and has innumerable medicinal properties and is used to cure scurvy, diarrhoea, uterine complaints, dropsy, cholera and rheumatism (Vijayakumar, 1991). Despite being a highly nutritious fruit with innumerable medicinal properties majority of the cashew apple is being wasted. Kerala alone produces approximately eight lakh tonnes of cashew apples annually, which are not at all utilised.

Though, different technologies have been developed to prepare various processed products like squash, syrup, RTS beverages, jam, candy, pickle, chutney etc from cashew apple, this nutritious fruit is not utilised commercially in the processing sector. The polyphenolic substances in the fruit which impart an astringent and unpleasant biting taste limits its utilisation in the processing industry.

Among the different fruit based processed products, juices and beverages are gaining popularity among the different sections of the society due to their

pleasing aroma, taste and better nutritional qualities. Fruit based beverages are highly refreshing, thirst quenching, appetising, easily digestible and far superior than synthetic drinks. The beverage industry is growing at a faster rate and more and more new health beverages are entering in the market. Among the different fruit based beverages, RTS beverages rank first in production and are preferred by the consumers mainly due to its ease of preparation and nutritional qualities.

The fruit based beverages are prepared from a single fruit like lime, orange, pineapple, mango, watermelon, grape etc. Since there is a great potential for commercialisation of blended fruit beverages as a natural health drink especially from under exploited fruits, in the present study an attempt has been made to blend cashew apple juice with other commonly available fruits and spice extracts in the preparation of RTS beverages. Hence, the present study entitled "Standardisation of blended cashew apple RTS beverages" has been undertaken with the following objectives.

1. To standardise cashew apple RTS beverages by blending with orange, pineapple and lime juices at different proportions with and without the addition of spice extracts.
2. To select the best beverages with high sensory qualities for storage studies.
3. To study the quality attributes of the RTS beverages during storage.

Review of literature

2. REVIEW OF LITERATURE

Cashew is one of the important commercial plantation crops of India. It is mainly cultivated for its delicious nuts and became an important source of foreign exchange for Indian economy. Besides the nut, the plant offers the pseudo fruit, a swollen pedicel which supports the nut. In India, cashew apple is not fully utilised except in Goa where it is utilised for the production of cashew feni. The potential of cashew apple as a raw material for conversion into different kinds of fruit products such as jam, jelly, syrup, candy, chutney etc. has been reported by many workers.

In this chapter, the literature pertaining to the study has been reviewed under the following subheadings.

2.1 Importance of cashew apple

2.2 Utilisation of cashew apple for product development

2.3. Processing of blended beverages

2.4. Storage stability of blended beverages

2.1. IMPORTANCE OF CASHEW APPLE

Many scientists have reported the nutritional and medicinal benefits of cashew apple. Edassery (1987) referred cashew apple as a natural nutrition capsule and stressed the importance of its utilisation.

Siddappa and Bhatia (1954) and Rao (1984) identified the sugars in cashew apple as glucose and fructose. Chakraborthy (1961) reported the presence of three sugars namely glucose, fructose and sucrose in cashew apple. However, Haq *et al*. (1975) found fructose, glucose and maltose as the principle sugars in this fruit.

Lopez (1972) reported cashew apple as a rich source of carbohydrates, minerals and vitamin C. Cashew apple contained 87.5 per cent moisture, 11.6 per cent carbohydrates, 0.2 per cent protein and 20 mg vitamin C per 100g and was found to be a rich source of minerals (Ohler, 1979). Natarajan (1979), Nambiar *et al*. (1990) and Nguyen *et al*. (1995) indicated that cashew apple is a rich source of vitamin C and contain more than five times as much vitamin C than that of citrus fruits.

The nutritional composition of average sized cashew apple was analysed by Shahjahan (1980) and reported that the apple contained 0.8 per cent protein, 0.6 per cent fat, 0.4 per cent minerals, 0.9 per cent fibre, 12 per cent starch, 53 Kilo calories energy, 39.10 IU vitamin A, 0.2 mg thiamine, 0.5 mg riboflavin, 0.4 mg nicotinic acid and 180 mg vitamin C per 100 g of fruits. Falade (1981) reported that cashew apple had low levels of pectin, carbohydrates, free amino acids and crude protein, moderate levels of calcium, phosphorous, iron and high sugar and vitamin C. The sugar content varied from 8.4 to 21.0 per cent and vitamin C from 156 to 485 mg per 100 g of juice.

Augustin (2001) reported that 100g of cashew apple contained 87.5 g moisture, 0.2 g protein, 0.1 g fat, 11.6 g carbohydrate, 0.9 g crude fibre, 10 mg calcium, 10 mg phosphorous, 0.2 mg iron, 261 mg minerals, 0.02 mg thiamine, 0.5 mg riboflavin, 0.4 mg nicotinic acid and 3.9 IU vitamin A.

Gopalan *et al.* (2002) reported the composition of 100 g of cashew apple as 86.3 g moisture, 0.2g protein, 0.1g fat, 0.2g minerals, 0.4g fibre, 12.3g carbohydrates, 51 K.cal energy, 10 mg calcium, 10 mg phosphorous, 0.2 mg iron, 25µg carotene, 0.02 mg thiamine, 0.05 mg riboflavin, 0.4 mg niacin and 180 mg ascorbic acid. Salam and Joseph (2003) found that juicy and swollen cashew apple had a rich reserve of vitamins and minerals.

Singh and Mathur (1953) studied the chemical composition of yellow and red fruits of cashew apple with respect to acidity, tannin, reducing sugar, total sugar, TSS, moisture and ascorbic acid and concluded that yellow fruits are distinctly superior to red ones. However, Lopez (1972) reported that the constituents did not vary significantly in the yellow and red varieties of cashew apple. Falade (1981), Ortiz and Arguello (1985) and Malkup *et al*. (1997) reported higher vitamin C in red apples when compared to yellow fruits.

Ortiz and Arguello (1985) also reported higher tannin in red coloured apples (0.40%) when compared to yellow coloured fruits (0.35%). Assuncao and Mercadante (2003) observed a higher carotenoid content in red apples than yellow coloured apples.

Physico-chemical attributes of high yielding cashew apple varieties of Kerala were evaluated by Vilasachandran and Damodaran (1982), Vilasachandran and Damodaran (1985) , Aravindakshan *et al*. (1986), Narayanankutty (2000) and Suman (2006) and indicated significant variation in different attributes. Vaidehi *et al.* (1990), Sapkal *et al*. (1992), Manoj (1992), Ghosh and Kundu (1993), Sena *et al*. (1995), Lenka *et al* .(1998) and Attri and Singh (1999) also indicated significant variation in the constituents of different cashew apple varieties . Vaidehi *et al*.(1990) screened the juice of 99 cashew varieties and indicated that varieties like 9/12 Taliparamba and 1/85 Mysore are suitable for processing into beverages as they had pleasant aroma, good taste, less astringency, higher percentage of sugars, vitamin C and juice yield and less tannic acid.

Evaluation of physico- chemical characters of different varieties of cashew apple was carried out by Ghosh and Kundu (1993) and reported significant variation in different characteristics with respect to apple weight, size, specific gravity, TSS,

acidity and reducing sugar. Sena *et al*. (1995) also reported similar findings when 17 cultivars of cashew apples were evaluated.

Suman (2006) analysed the nutritional attributes of 26 varieties of cashew apples available at Cashew Research Station, Madakkathara under Kerala Agricultural University and indicated significant variation in the nutrients of different varieties. The author also indicated that even though the cashew apple is having low protein and fat content, it is a rich source of carbohydrates, fibre, β- carotene, vitamin C and minerals especially potassium.

The medicinal properties of cashew apples were enumerated by Vijayakumar (1991) as a cure for scurvy, diarrhoea, uterine complaints and dropsy. It was also found to be useful against neurological pain and rheumatism and effective for preventing cholera and as a medicine for women after parturition. Ayurvedic medicine recommends the cashew fruit as antihelminthic, aphrodisiac, ascites and for dysentery, fever, loss of appetite, leucoderma, piles, tumour and obstinate ulcer.

Nair (1995) indicated the medicinal properties of cashew apple and cashew apple juice. The author stressed the importance of cashew apple juice as a remedy for cough and cold and for the treatment of syphilis. He also indicated that old cashew liquor in small doses is effective to get relief from stomach ache. Cashew apple was found to have antiscorbutic, astringent and diuretic effect and is used for cholera and kidney failure. In Brazil, Mozambique and Indonesia cashew wine is used for blood sugar problems, kidney troubles, and to treat cholera, cracks on sole of feet, hook worm infestation, corns and warts.

Augustin (1987) indicated that cashew feni, an alcoholic beverage prepared from cashew apple juice could be used to cure various ailments of infants and aged.

2.2. UTILISATION OF CASHEW APPLE FOR PRODUCT DEVELOPMENT

In India, the commercial utilisation of cashew apple has been investigated mainly by Central Food Technological Research Institute, Mysore and Kerala Agricultural University. A number of products such as jam, jelly, candy, syrup, chutney etc have been developed by various research workers. In India, 30 per cent of cashew apple is being commercially exploited for brewing cashew feni in Goa. Vijayakumar (1991) opined that wastage of cashew apple could be considerably reduced by preparing different products which are economically beneficial.

Jain *et al*. (1952) stressed the need of cashew apple utilisation and described the methods of preparation of juice, syrup and canned fruits from cashew apple. Cashew apple products from Brazil, like '*cashola*' (ready to serve carbonated beverages), preserves such as '*doce*', '*doce em calda'*, '*caju crslatizado*' and '*caju amexia*' were reported by Johnson (1977). Other products like *cajuina* (pasteurised juice), *cajuada* (juice mixed with water or milk and sugar), *cajuvita* (vitamin enriched juice), *caju aperativo* (juice mixed with sugar cane brandy) and *cremel decaju* and *caju aperavitao* were also reported by Johnson (1977).

Natarajan (1979) stated that a tasty wine could be prepared by fermentation of cashew apple juice and noticed that this is of less commercial interest due to the high cost of production. Shahjahan (1980) proposed that the products such as jam, syrup and candies could be easily prepared at household level from cashew apple. Processing of date- caramel from cashew apple was reported by Ortiz *et al*. (1982).

Augustin (1984) reported the method of preparation of juice, syrup, jam, candy and chutney from cashew apple. The author suggested the use of cashew apple residue after juice extraction for the recovery of low methoxyl pectin or as cattle feed

after drying. Augustin (1986 & 1987) reported the techniques for the production of cashew wine, cashew liquor and cashew vinegar.

Edassery (1987) highlighted the importance of using cashew fruit as a dried raw material for its extensive utilisation. He described the process for the preparation of dry fruit, upgraded to the higher order of any other dry fruit. Edassery (1988) developed a simple process to prepare dry fruits from cashew apple which can be used in fruit breads and other bakery items and fruit salads with better taste, good texture and good nutritive value and considered to be superior to other dry fruits like figs, grapes and dates.

Raju (1992) reported that cashew apples could be processed into nutritious candy. Sreeja (1996) prepared highly acceptable cashew apple candy with good shelf life. Akinwale (2000) reported that cashew apple juice could be blended with other tropical fruits to prepare acceptable and nutritious beverages. Excellent quality spray dried products were prepared with 10-15 per cent cashew apple juice and milk powder by Vaidehi (2002) and indicated that this could be utilised in reconstituted milk shakes, ice creams and flavoured dhahis.

Cashew apple and pineapple pulp in the ratio of 1.5:2 in the preparation of mixed jam was found to have high consumer acceptance (Trongpanich and Hiraga, 2001). Augustin (2001) and KAU (2003) reported the methods for the preparation of canned cashew apple as well as jam, candy, pickle, chutney, vinegar, liquor and wine from cashew apple.

Various products from cashew apple were standardised by Vaidehi *et al*. (2003). The products included ready to drink cashew apple juice, cashew apple water melon juice, cashew apple sapota toffee, cashew apple nutri mix, cashew apple bread spread, cashew apple pickle sweet, cashew apple pickle in oil and cashew apple

pickle in vinegar. Suman (2006) prepared highly acceptable cashew apple candy and tutty fruity with good shelf life from different varieties of cashew apple.

2.3. PROCESSING OF BLENDED BEVERAGES

Food processing industry has been termed as "sun-rise industry" and several efforts have been made during the last few years to give a big thrust to this sector. Fruits available during specific season should be preserved, so as to make it available in an acceptable form throughout the year. To avoid wastage during surplus, fruits have to be processed into juice, pulp, squash, jam and the like. The increasing demand for fruit and vegetable products had resulted with rising standard of living, the desire for a more diversified diet throughout the year (Saxena and Arora, 1997). Beverages are processed from natural juice obtained from single fruit or a combination of fruits.

The blending of fruit products could be an economic requisite to utilise 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.

Woodroof and Luth (1975) stated that in the manufacture of blended juice, traditional or popular juice had been used as a base and other juices could be used to build up the beverage qualities. The author also observed that the purees and juices of orange, banana, papaya, and guava could be successfully blended with passion fruit juice into tropical fruit drinks, punches and syrups.

Blending of fruit juices like papaya, mango, orange and pineapple with passion fruit juice was reported by Annapurna *et al*. (1977) and passion fruit juice

when blended with pineapple and cardamom was found to be highly acceptable. Khan *et al*. (1988) prepared carotene rich drink by blending carrot juice with fruit juices containing less β-carotene. A non- conventional carotene rich drink from mango was prepared by Kaur and Khurdiya (1993) by blending pineapple, orange and plum juices.

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). 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.

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

Sugahara *et al*. (1987) prepared blended juice using Satsuma mandarin and Shewasha in the ratio of 9:1, 7:3 and 5:5 and prepared RTS beverages using 10 and 20 per cent of the blended juice and the beverage containing 10 per cent of 9:1 blended juice was 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.

Multi fruit ready-to-serve 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 watermelon juice when blended with lime juice or pineapple juice also gave RTS beverages of acceptable quality.

A non- conventional carotene rich drink from mango was prepared by Kaur and Khurdiya (1993) by blending pineapple, orange and plum juices. 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 blends containing juice or pulp in the ratio of 1:1 and brix acid ratio of 60:1 were found to be highly acceptable due to balanced taste and flavour.

Vaidya *et al*. (1998) evaluated mixed fruit juice beverages based on guava and 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- 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.

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

The feasibility of blending of fruit juice or pulp of lime, aonla, grape, pineapple and mango in different proportions (5-90%) for the preparation of ready-to-

serve (RTS) beverages was organoleptically evaluated by Deka *et al*. (2001). Among the different combinations tried, lime and aonla in the ratio of 95:5 was found to be the best based on overall sensory score. The younger respondent in the age group of 22-23 years liked mango-pineapple and grape-pineapple blends while the senior respondents in the age group of 45-55years liked lime-aonla and mango-grape blends.

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 due to its appealing colour, appearance, flavour, taste and over all acceptability compared to other combinations (Nakadi *et al* ., 2001). Jain and Khurdiya (2004) indicated that RTS beverages prepared by blending goose berry and Pusa navrang grape juice in the ratio of 20:80 improved the sensory quality as well as nutritional quality of beverages in terms of vitamin C.

Muthukrishnan and Palaniswamy (1972) developed good quality highly acceptable squash by blending lime and pineapple juice with West Indian cherry in the ratio of 1:1. Begum *et al.* (1983) reported that mixed fruit juice had great consumer appeal and improved the nutritional quality of the drink. The author also prepared acceptable blended squash with pineapple and mango pulp in the ratio of 25:75, 50:50 and 75:25.

Manimegalai *et al.* (1994) and Hilda and Manimegalai (1996) prepared acceptable blended squash with papaya and mango, amla and lime and amla and pineapple in the ratio of 4:1. Lal *et al*. (1999) indicated that acceptable squash with appealing colour and sugar acid could be prepared by blending juices of apple, lemon and ginger in the ratio of 25:15:10.

Kinnow manadrin juice and ginger juice were blended in the ratio of 5:25, 10:20, 15:15, 20:10 and 25:5 to prepare squash and the blended mandarin and ginger juice squash in the ratio of 25:5 was found to have the highest acceptability in terms of sensory qualities (Nath *et al*., 2005).

Blends of guava and mango nectar were found to be superior to either guava or mango nectar (Kalra and Tandon, 1996). Immungi and Choge (1996) prepared nectars from the blends of passion fruit and papaya, mango and papaya and pear and papaya in the ratio of 10:90, 20:80, 30:70, 40:60 and 50:50 and the blended nectars in the ratio of 10:90 were found to be organoleptically most acceptable. Among the different proportions of passion fruit and pear and mango and pear to prepare blended nectars the proportion of 50:50 gave an acceptable product.

RTS spiced beverages were prepared from blended fruit juices of lime and aonla, mango and pineapple, grape and mango and grape and pineapple with the addition of various aqueous spice extracts and commercial spice drops by Deka and Sethi (2001). The spiced lime and aonla RTS beverage in the ratio of 95:5 with 0.5 per cent each of common salt, black salt, aqueous spice extracts of curry leaf, and 0.25 per cent each of cumin and cardamom and 0.1 per cent black pepper, 2 per cent ginger juice and 0.4 per cent mint was found to be the best among the 52 combinations tried. The authors also reported that among the commercial spice drops 0.006 per cent cardamom drops in mango (85 %) and pineapple (15 %) blended RTS beverages was found to be the best.

Four different acceptable combinations of carrot juice with two levels each of spinach and pineapple juices were prepared by Dhaliwal and Hira (2004). The juices were mixed in 95:4.5 and 90:9 proportions for carrot and spinach and 70:30 and 60:40 proportions for carrot and pineapple and fortified with lemon juice, ginger extract, sugar and black salt to improve the taste and flavour of juices.

Teotia *et al*. (1992) analysed the constituents of RTS beverages 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) standardised RTS beverages from a mixture of pineapple and guava juices in different proportions and the beverage 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 combinations of Dashehari and Banganpalli varieties with 15 per cent pulp, 14^0 brix and 0.25 per cent acidity. Saravanakumar and Manimegalai (2001) prepared acceptable RTS beverages by blending pear, pineapple and pomegranate juices in the ratio of 1:1 pear and pineapple and 1:1:1 pear, pineapple and pomegranate. 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 sugar, 14.52 and 14.76 per cent total sugars and 2.38 and 2.60 mg ascorbic acid per 100 ml respectively.

Sindhumathi (2002) analysed the vitamin C and β-carotene contents of RTS beverages prepared by blending equal proportions of mango, pineapple and jackfruit and the vitamin C and β-carotene contents of the beverages varied from 8.20 to 9.12 mg and 450 to 875 $\mu g100ml^{-1}$ of beverages respectively.

Pear squash and pear blended pineapple squash were prepared by Sudhagar (2001) and the constituents of the squash varied from 3.07 to 3.14 (pH), 1.08 and 1.68g (acidity), 1.97 and 2.01g (total sugars) per 100 ml of the beverages.

Wasker (2003) developed beverages by blending pomegranate and kokum juices in the proportion of 9:1, 8:2, 7:3, 6:4 and 5:5. The chemical composition of the blended juice varied between 16.1-16.8^0 brix TSS, 0.873-3.034 per cent acidity, 2.36 – 4.16 pH, 12.39-14.41per cent reducing sugar, 13.72-15.01 per cent total sugar and 0.469-0.824 per cent anthocyanin.

Deka *et al*. (2005) prepared mango-pineapple spiced beverages from Dashehari mango and Kew pineapple in different proportions and the RTS beverage prepared in the ratio of 80 per cent mango and 20 per cent pineapple juice having 10^0 brix , 0.2 per cent acidity, and 0.008 per cent cardamom spice drops was found to be highly acceptable.

2.4. STORAGE STABILITY OF BLENDED BEVERAGES

2.4.1. CHANGES IN CHEMICAL CONSTITUENTS DURING STORAGE

Kalra *et al*. (1991) did not observe any significant change in acidity and TSS during twelve months of storage in mango – papaya blended beverages at ambient temperature. Tripathi *et al*. (1992) noticed a decline in the acidity of pineapple-guava blended RTS beverages stored at ambient temperature for three months. The authors observed an increase in the reducing sugar and total sugar contents of the beverages and did not observe any change in pH during three months of storage.

Kalra *et al*. (1991) studied the storage behaviour of mango papaya blended pulp in glass containers and observed a slight decrease in TSS and carotenoid contents and an increase in acidity and reducing sugar during 12 months of storage.

A decline in the ascorbic acid and pro vitamin A contents 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.

Saxena *et al*. (1996) developed grape – mango and grape – pineapple blended beverages and did not observe any conspicuous change in the brix of the sample during six months of storage. However, the authors observed a slight decrease in the acidity in the grape and mango blend with corresponding increase in brix / acid ratio.

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

Dhaliwal and Hira (2001) did not observe any significant change in the acidity and total solids in carrot and beetroot blended beverages during storage. Nakadi *et al*. (2001) also did not observe any change in the TSS content of the beverages prepared by blending pomegranate and mango during the storage period of six months. An increase in acidity and reducing sugar was observed in papaya-pineapple blended RTS beverages during 120 days of storage (Sindhumathi, 2002). The author also observed a decrease in the p^H, ascorbic acid and β-carotene contents of the beverages during storage.

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. Srivastava *et al*. (1985) prepared three different combination of mango juice using different mango varieties namely Banganpalli, Bombay green and Langra; Causa, Fasli and Kauchan; Sukul and Safeda malihabad

and noticed a decreasing trend in the tannin content during six months of storage in all the three combinations.

Attri *et al*. (1998) reported an increase in reducing sugar with an increase in the blending ratio of pear with apple juice or apple juice concentrate. Further, the authors reported a significant increase in acidity and reducing sugars and decrease in non reducing sugars and ascorbic acid in the pear juice blends during storage.

Dhaliwal and Hira (2004) studied the storage behaviour of different combinations of carrot juice with two levels each of spinach and pineapple juice and did not observe any significant change in pH, acidity, total solids, minerals and viscosity of the juices during storage. During pasteurisation, a loss of 7 to 11 per cent in ascorbic acid and 14.18 to 24.56 per cent in β-carotene contents were observed. The authors also observed a further loss of 80 to 88.75 per cent in ascorbic acid and 52.02 to 61.41 per cent in β- carotene contents of the beverages during six months of storage.

An increase in the acidity (from 1.1 to1.32 per cent) and reducing sugar (from 33.3 to 43.4 per cent) and a decrease in carotene content (from 1476.3 to 1082.6) were observed in papaya – mango blended squash during storage of six months (Manimegalai *et al*., 1994). Sudhagar (2001) observed an increasing trend in acidity and total sugars and a decreasing trend in p^H 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 authors 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-pine apple and guava-mango blends during six months of storage. The author also noticed highest brix/acid ratio in mango-pine apple-cardamom spiced beverages and lowest in lime-aonla-ginger 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 total soluble solids, reducing sugars, total sugars and non enzymatic browning (NEB) and a gradual decrease in acidity, ascorbic acid and tannin contents. A gradual decrease in acidity, ascorbic acid and tannin content was observed by Deka *et al*. (2005) in mango-pine apple spiced RTS beverages during storage

2.4.2. CHANGES IN ORGANOLEPTIC QUALITIES

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 (Manimegalai *et al*., 1994). Sudhagar (2001) also observed a decrease in the scores for appearance, colour, flavour, taste and overall acceptability in pear and pear and pineapple blended squashes. However, Bobby and Sri (2003) observed that orange and musambi squash formulated in different combinations were acceptable even after two months of storage. Lakshmi and Begum (2004) also did not observe significant changes in the sensory profile of *Optuntia dilleni* and papaya blended squash during three months of storage. Nath *et al*. (2005) in a study

conducted in ginger –kinnow blended squash noticed a decreasing trend in the flavour, taste and overall acceptability scores with the increase in storage period irrespective of the blends of squash. However, the authors also observed an acceptable sensory score for the above three attributes in the blends prepared with kinnow and ginger juice in the ratio of 25:5 up to eighth month of storage.

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Chakraborthy *et al*. (1993) reported that the water melon RTS beverages prepared with or without blending with lime juice or pineapple juice had acceptable organoleptic quality and shelf life up to six months. 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. The RTS beverages prepared from tamarind juice and 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) also did not observe any change in the sensory qualities during storage for the RTS beverages and squashes prepared with Palmyra fruit and rose apple. However, a gradual decrease in overall acceptability scores was 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.

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.

2.4.3. CHANGES IN MICROBIAL LOAD

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. 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 the drinks was observed in the spiced RTS beverages.

Sindhumathi (2002) did not detect any bacterial load in papaya based blended RTS beverages up to 80 days of storage. However, bacterial growth was observed in the beverages during 100^{th} day which increased during 120^{th} day of storage.

Materials and Methods

3. MATERIALS AND METHODS

The present study entitled "Standardisation of blended cashew apple RTS beverages" was attempted to standardise RTS beverages using cashew apple juice blended with orange, pineapple and lime juices and volatile spice extracts at different proportions and to study the quality attributes of the beverages during storage. The study was divided into two experiments and the materials used and the methods followed in the study are given under the following headings.

3.1 EXPERIMENT 1

3.1.1 Standardisation of RTS beverages

3.1.1.1 Collection of fruits and spice extracts

Mature and ripe cashew apples were collected from Cashew Research Station, Madakkathara under Kerala Agricultural University. After removing the nuts, cashew apples were sorted and damaged ones were removed. The selected cashew apples were thoroughly washed in clean water, cut into pieces, juice was extracted using a plastic net and the juice was strained using a muslin cloth.

Three commonly available fruits namely orange, pineapple and lime and two volatile spice extracts namely ginger and cardamom were purchased from the local market. Fruit juice was extracted after washing the fruits thoroughly in cold water using standard procedure suggested by CFTRI (1999). The extracted juice was strained through muslin cloth.

3.1.1.2 Clarification of cashew apple juice

Cashew apple juice was clarified by adding sago at the rate of 2 g per liter of juice as suggested by Jayalekshmy and John (2004). Two gram of sago was

powdered, boiled in 10 ml of water and cooked to a paste. The prepared paste was added to the cashew apple juice with constant stirring and kept overnight for clarification. The supernatant clarified juice was collected by siphoning, strained through a muslin cloth and used for the preparation of RTS beverages.

3.1.1.3 Development of RTS beverages

Blended RTS beverages were prepared using cashew apple juice as the base and mixing with orange, pineapple and lime juices as well as with ginger and cardamom extracts at different combinations. All the treatments were prepared as per the FPO specifications as given in Table 1.

Table 1. FPO specifications selected to prepare RTS beverages

Sl.No	Constituents	Quantity
1	Juice (%)	15
2	TSS (^{0} brix)	15
3	Acidity (%)	0.3
4	KMS (ppm)	70
5	Colour (g/litre)	0.1

The acidity and Total Soluble Solids (TSS) of cashew apple, orange, pineapple and lime juices were determined as detailed in 3.2.2.1 and 3.2.2.2 respectively. The amount of citric acid and sugar to be added to prepare different beverages as per the FPO specification was computed taking into account the acidity and TSS already present in the fruit juices.

Design - CRD

No.of treatments - 34

Replication - 3

The quantity of fruit juices and spice extracts used to prepare the RTS beverages are detailed in Table 2.

Table 2. Quantity of fruit juices and spice extracts used to prepare RTS beverages .

Group	Beverages	Cashew apple Juice (%)	Other fruit juice (%)	Spice extract (Drops)
Control	B_1	100	-	-
I.	B_2	100	-	1 (G)
	B_3	100	-	2 (G)
	B_4	100	-	3 (G)
II.	B_5	100	-	1 (C)
	B_6	100	-	2 (C)
	B_7	100	-	3 (C)
III.	B_8	50	50 (O)	-
	B_9	75	25 (O)	-
	B_{10}	85	15 (O)	-
IV.	B_{11}	50	50 (P)	-
	B_{12}	75	25 (P)	-
	B_{13}	85	15 (P)	-
V.	B_{14}	50	50 (L)	-
	B_{15}	75	25 (L)	-
	B_{16}	85	15 (L)	-
VI.	B_{17}	50	50 (O)	1 (G)
	B_{18}	75	25 (O)	1 (G)
	B_{19}	85	15 (O)	1 (G)

VII.	B_{20}	50	50 (O)	1 (C)
	B_{21}	75	25 (O)	1 (C)
	B_{22}	85	15 (O)	1 (C)
VIII.	B_{23}	50	50 (P)	1 (G)
	B_{24}	75	25 (P)	1 (G)
	B_{25}	85	15 (P)	1 (G)
IX.	B_{26}	50	50 (P)	1 (C)
	B_{27}	75	25 (P)	1 (C)
	B_{28}	85	15 (P)	1 (C)
X.	B_{29}	50	50 (L)	1 (G)
	B_{30}	75	25 (L)	1 (G)
	B_{31}	85	15 (L)	1 (G)
XI.	B_{32}	50	50 (L)	1 (C)
	B_{33}	75	25 (L)	1 (C)
	B_{34}	85	15 (L)	1 (C)

O = Orange juice G = Ginger spice drop

P = Pineapple juice C = Cardamom spice drop

L = Lime juice

3.1.1.4 Preparation of RTS beverages

The RTS beverages were prepared by mixing the required quantity of sugar and citric acid in boiling water. After cooling, the solution was filtered through a muslin cloth. The required quantity of fruit juice / juices was added. The colour and preservatives were added after dissolving the same in little quantity of beverage. Ginger and cardamom extracts were added in the respective treatments. The beverages were filled in pastuerized bottles leaving 2.5 cm head space and sealed air tight using crown corks. The actual quantity of different ingredients used to prepare one liter of RTS beverages are furnished in Table 3.

Table 3. Actual quantity of ingredients used to prepare one litre of RTS beverage.

Beverages	Fruit juice		Sugar (g)	Citric acid (g)	KMS (mg)	Water (ml)
	Cashew apple (g)	Other fruits (g)				
B_1,B_2,B_3,B_4,B_5 B_6 and B_7	150	-	124	2.43	126	723.4
B_8, B_{17} & B_{20}	75	75	124	2.15	126	723.72
B_9,B_{18} & B_{21}	112.5	37.5	123.5	2.28	126	724
B_{10},B_{19} & B_{22}	127.5	22.5	123.5	2.34	126	724.2
B_{11},B_{23} & B_{26}	75	75	120.6	2.16	126	727
B_{12}, B_{24} & B_{27}	112.5	37.5	121.85	2.29	126	725.7
B_{13}, B_{25} & B_{28}	127.5	22.5	122.37	2.35	126	725.15
B_{14},B_{29}&B_{32}	75	75	127.82	-	126	722.05
B_{15},B_{30}&B_{33}	112.5	37.5	126.46	0.24	126	723.17
B_{16},B_{31}&B_{34}	127.5	22.5	125.13	1.12	126	723.6

3.1.1.5 Acceptability of RTS beverages

Acceptability of RTS beverages was evaluated using score cards by a panel of 10 judges.

3.1.1.5.1 Selection of judges

A series of organoleptic trials were carried out using simple triangle test at laboratory level to select a panel of 10 judges between the age group of 18-35 years as suggested by Jellinek (1985).

3.1.1.5.2. Preparation of score card

The score card used for the evaluation of RTS beverages is given in Appendix I

3.1.1.5.3. Organoleptic evaluation

Organoleptic evaluation of beverages was carried out in the morning time using the score card by a panel of 10 selected judges. Four quality attributes like appearance, colour, flavour and taste and overall acceptability were evaluated.

3.1.1.6. Selection of beverages

The acceptability scores were analysed by Kendall Wallace Analysis of Variance to select the most acceptable beverage in each group. Statistically, Kendall's coefficient of concordance (W) which expresses the degree of association among the ten judges was carried out for each beverage under study. After statistical analysis,

the most acceptable beverage from each group was selected for storage study. Thus, twelve beverages were selected for further study.

3.2 EXPERIMENT 2

3.2.1. Preparation of beverages for storage study

The selected beverages were prepared as per the procedure detailed in 3.1.1.4. They were filled in clean, pastuerized and dried RTS bottles of 200 ml capacity leaving 2.5 cm head space and sealed air tight using crown corks. The bottles were again pasteurized by keeping the bottles in boiling water for 15 minutes. The bottles were removed after cooling and kept both in ambient and refrigerated temperature for storage study (Plates 1 to 12).

Design – CRD

No. of treatment – 12

Replication – 3

3.2.2. Analysis of chemical constituents

The RTS beverages subjected to storage study were evaluated for the following chemical constituents initially and at monthly intervals for a period of three months.

1. Acidity
2. Total Soluble Solids
3. Reducing sugar
4. Total sugar
5. Vitamin C
6. β carotene
7. Tannin

Plate 1. 100 per cent Cashew apple juice

Plate 2. Cashew apple juice + ginger extract

Plate 3. Cashew apple juice + cardamom extract

Plate 4. Cashew apple juice + orange juice

Plate 5. cashew apple juice + orange juice+ ginger extract

Plate 6. Cashew apple juice + orange juice+ cardamom extract

Plate 7. Cashew apple juice + pineapple juice

Plate 8. Cashew apple juice + pineapple juice +ginger extract

Plate 9. Cashew apple juice + pineapple juice + cardamom extract

Plate 10. Cashew apple juice +lime juice

Plate 11. Cashew apple juice +lime juice + ginger extract

Plate 12. Cashew apple juice + lime juice + cardamom extract

3.2.2.1. Acidity

Titrable acidity of the beverages was estimated by the method suggested by Ranganna (1986). An aliquot of the sample was titrated against 0.1N sodium hydroxide using phenolphthalein as indicator. Acidity was expressed in terms of percentage of citric acid.

3.2.2.2. Total Soluble Solids (TSS)

TSS of the beverages was recorded using an Erma hand juice brix refractometer at room temperature and the values were expressed in degree brix (Ranganna, 1986).

3.2.2.3. Reducing sugar

Reducing sugar in the beverages was estimated by adopting the method given by Lane and Eyon (Ranganna, 1986). To 25 ml of RTS beverages, 100 ml distilled water was added and then clarified with neutral lead acetate. The excess lead was removed by adding potassium oxalate. The volume was then made up to 250 ml. An aliquot of this solution was titrated against a mixture of Fehlings solution A and B using methylene blue indicator. The reducing sugar was expressed as percentage.

3.2.2.4. Total sugar

The total sugar was determined using the method given by Lane and Eyon (Ranganna, 1986). From the clarified solution used for the estimation of reducing sugar, 50 ml was taken and boiled gently after adding citric acid and water. It was then neutralised with sodium hydroxide and the volume was made up to 250 ml. An

aliquot of this solution was titrated against Fehlings solution A and B. The total sugar content was expressed as percentage.

3.2.2.5. Vitamin C

Vitamin C content of the beverages was estimated by the method suggested by A.O.A.C. (1980) using 2,6 Dichlorophenol indophenol dye and the content was expressed in mg per 100 g of the sample.

3.2.2.6. β Carotene

β carotene was estimated by the method of A.O.A.C. (1980) using water saturated n-butanol. To 5 ml of the sample, 50 ml of water saturated butanol was added, shaken for one minute and kept overnight .The supernatant was decanted and read the colour intensity at 435.6 nm in a spectrophotometer.

3.2.2.7. Tannin

The tannin content was determined as tannic acid by colourimetric method using Folin-Denis reagent (Sadasivam and Manikam, 1992). One ml of sample was pipetted out to a volumetric flask having 75 ml water, added 5 ml Folin-Denis reagent and 10 ml of sodium carbonate and diluted to 100 ml. After 30 minutes the absorbance was read at 700 nm. The tannin content was expressed as percentage from the standard graph prepared using serial dilution of standard tannic acid.

3.2.3. Evaluation of acceptability of the RTS beverages during storage

Organoleptic evaluation of the selected beverages was conducted using score card (Appendix I) by a panel of 10 judges as described in 3.1.1.5. Four quality

attributes like appearance, colour, flavour and taste and overall acceptability were evaluated. Each of the above mentioned attribute was assessed initially and at monthly intervals for a period of three months.

3.2.4. Microbial enumeration of the beverages

The RTS beverages were evaluated for the presence of bacteria, fungi, yeast and *E. coli* initially and at the end of the storage period .The methods used for evaluation was serial dilution and plate count method as described by Agarwal and Hasija (1986). Ten ml of sample was added to 90 ml sterile water and shaken for 20 minutes. One ml of this solution was transferd to a test tube containing 9 ml of sterile water to get 10^{-2} dilution and similarly 10^{-3} ,10^{-4} ,10^{-5} and 10^{-6} dilutions were also prepared.

Enumeration of total microflora was carried out using Nutrient Agar Media for bacteria, Potato Dextrose Agar Media for fungi, Sabouraud's Dextrose Agar Media for yeast and ECD Media for *E. Coli* obtained from Hi Media lab, Mumbai.

3.2.5. Statistical Analysis

The observations recorded were tabulated and the data was analysed statistically using Completely Randomised Design (CRD).

The scores of organoleptic evaluation were assessed by Kendall's coefficient of concordance (W) which expresses the degree of association among the 10 judges. Logarithmic transform was affected to microbial count to satisfy the concept of analysis of variance. Friedman's test and Kruskal-Wallis one-way analysis of variance were also used for the statistical analysis of data.

3.2.6. Calculation of Availability – Acceptability ratio

The Availability –Acceptability ratio of the beverages was computed as the ratio of the sum of the respective content of vitamin C, β-carotene and overall acceptability in different beverages to the tannin content.

Results

4. RESULT

The results pertaining to the study entitled "Standardisation of blended cashew apple RTS beverages" are presented in this section under the following headings.

4.1. Preliminary Study

4.1.1. Organoleptic evaluation of RTS beverages and selection of beverages for storage study

4.2. Storage study

4.2.1. Chemical composition of selected RTS beverages and changes during storage

4.2.2. Organoleptic evaluation of selected RTS beverages and changes during storage

4.2.3. Enumeration of microbial count of beverages and changes during storage

4.3 Availability-Acceptability ratio (A-A ratio) of the beverages

4.1. Preliminary Study

4.1.1. Organoleptic evaluation of RTS beverages and selection of beverages for storage study

Thirty four RTS beverages were prepared using cashew apple juice as the base and mixing with orange, pineapple, and lime juices and volatile spice extracts at different combinations. Organoleptic evaluation of the beverages was carried out using score cards by a panel of ten judges. The mean scores obtained for various quality attributes like colour, appearance, flavour, taste and overall acceptability of different beverages are presented in Table 4. The mean and overall rank scores on the basis of Kendall's coefficient of concordance are also given in Table 4.

Among the thirty four RTS beverages, thirty three beverages obtained a mean acceptability score of above three. For overall acceptability also 32

Table 4. Organoleptic evaluation of RTS beverages

Group	Beverages	Scores					
		Appearance	Colour	Flavour	Taste	Mean Score	Overall Acceptability
1	Control	3.37	3.39	3.39	3.37	3.38 (19.68)	3.39 (15.29)
2	B_1	3.33	3.40	3.37	3.33	3.36 (18.68)	3.40 (14.47)
	B_2	3.23	3.13	3.11	3.23	3.18 (14.83)	3.13 (10.45)
	B_3	3.20	3.33	3.23	3.20	3.24 (17.58)	3.33 (14.30)
3	B_4	3.50	3.18	3.10	3.50	3.32 (15.18)	3.18 (16.09)
	B_5	3.40	3.18	3.14	3.40	3.28 (14.71)	3.18 (16.98)
	B_6	2.50	2.78	2.80	2.50	2.68 (9.03)	2.78 (7.18)
4	B_7	3.83	3.77	3.73	3.83	3.79 (24.44)	3.77 (20.97)
	B_8	3.67	3.31	3.29	3.67	3.48 (16.58)	3.31 (19.18)
	B_9	3.53	3.25	3.24	3.53	3.39 (16.39)	3.25 (17.36)
5	B_{10}	3.57	3.61	3.61	3.57	3.59 (22.91)	3.61 (19.21)
	B_{11}	3.70	3.26	3.27	3.70	3.48 (16.67)	3.26 (20.26)
	B_{12}	3.27	3.18	3.21	3.27	3.23 (16.21)	3.18 (12.92)
6	B_{13}	3.43	3.33	3.26	3.43	3.36 (16.79)	3.33 (15.91)
	B_{14}	3.63	3.34	3.47	3.63	3.52 (20.27)	3.34 (19.18)
	B_{15}	3.47	3.34	3.27	3.47	3.39 (17.14)	3.34 (16.38)

7	B_{16}	3.87	3.58	3.59	3.87	3.72 (22.86)	3.58 (20.85)
	B_{17}	3.57	3.22	3.20	3.57	3.39 (15.92)	3.22 (17.79)
	B_{18}	3.70	3.15	3.16	3.7	3.43 (14.67)	3.15 (19.50)
8	B19	3.77	3.17	3.15	3.77	3.46 (14.68)	3.17 (20.58)
	B_{20}	3.97	3.60	3.61	3.97	3.79 (23.15)	3.60 (23.18)
	B_{21}	3.73	3.12	3.14	3.73	3.43 (14.65)	3.12 (21.12)
9	B_{22}	3.53	3.63	3.59	3.53	3.57 (22.83)	3.63 (18.15)
	B_{23}	3.57	3.38	3.36	3.57	3.47 (19.11)	3.38 (17.80)
	B_{24}	3.40	3.38	3.39	3.40	3.39 (19.17)	3.38 (16.38)
10	B_{25}	3.90	3.48	3.54	3.90	3.71 (21.15)	3.48 (22.29)
	B_{26}	3.43	3.19	3.19	3.43	3.31 (15.48)	3.19 (15.74)
	B_{27}	3.27	4.24	3.20	3.27	3.49 (15.44)	4.24 (13.70)
11	B_{28}	3.53	3.23	3.22	3.53	3.38 (16.21)	3.23 (16.83)
	B_{29}	3.67	3.58	3.63	3.67	3.64 (23.52)	3.58 (19.08)
	B_{30}	3.34	3.12	3.13	3.47	3.30 (14.64)	3.12 (17.27)
12	B_{31}	3.67	2.92	2.92	3.67	3.30 (10.44)	2.92 (19.05)
	B_{32}	3.63	3.19	3.19	3.63	3.41 (15.27)	3.19 (18.76)
	B_{33}	3.77	3.40	3.36	3.77	3.57 (18.71)	3.40 (20.86)

Figures in parenthesis are mean rank scores

beverages obtained a score of above three. The RTS beverages prepared using cashew apple with the addition of three drops of cardamom spice extract (B_6) and cashew apple juice and lime juice at 50:50 ratios with one drop of cardamom extract (B_{31}) had an overall acceptability score of 2.78 and 2.92 respectively. For all four quality attributes evaluated, B_6 obtained scores less than three (2.50 to 2.80).

Among the twelve different groups, the RTS beverages prepared using 100 per cent cashew apple juice (control) had mean and overall acceptability scores of 3.38 and 3.39 respectively (Group 1). The scores obtained for different quality attributes also varied from 3.37 to 3.39.

The mean scores of beverages in the second group, which was prepared with 100 per cent cashew apple juice and adding 1, 2 and 3 drops of ginger extracts varied from 3.18 to3.36 and the overall acceptability scores from 3.13 to 3.40. Among the three treatments in group 2, highest mean and overall acceptability scores of 3.36 and 3.40 were obtained for the beverage prepared with one drop of ginger extract (B_1). For different quality characteristics also B_1 obtained the highest scores. The rank scores for B_1 on the basis of Kendall's coefficient of variation were also found to be high both for the mean acceptability (18.68) and overall acceptability (14.47). Hence, from group 2, the beverage prepared with 100 percent cashew apple juice and one drop of ginger extract was selected for storage study.

Among the three beverages prepared with 100 per cent cashew apple juice, adding 1, 2 and 3 drops of cardamom extracts (Group 3), the beverage prepared by adding one drop of cardamom extract obtained the highest score for appearance (3.50), colour (3.18) and taste (3.50). The highest overall acceptability score of 3.18 was obtained for the beverage prepared with one and two drops of cardamom extract. Since, the mean score (3.32), the scores for three quality attributes and the mean rank scores (15.18) were maximum for the beverage

prepared with 100 per cent cashew apple juice and one drop of cardamom extract (B_4), this beverage was selected for the storage study.

Among the three beverages included in group 4, the highest mean and overall acceptability scores of 3.79 and 3.77 were obtained for the beverage prepared using cashew apple juice and orange juice in equal proportions (B_7). The scores for all four quality attributes as well as the mean (24.44) and overall (20.97) rank scores on the basis of Kendall's coefficient of variation were also found to be high for this beverage. From group 4, the beverage prepared with cashew apple and orange juice in the ratio of 50:50 (B_7) was selected for further study.

In group 5, among the three beverages, the highest scores for colour (3.61) and flavour (3.61) were obtained for the beverage prepared using cashew apple juice and pineapple juice in the ratio of 50:50 (B_{10}). Since, the mean (3.59) and overall acceptability (3.61) scores and the mean rank scores (22.91) were also high for this beverage, from group 5, the beverage prepared with cashew apple juice and pineapple juice in the ratio of 50:50 (B_{10}) was selected for storage study.

Among the three beverages included in group 6, the highest scores for appearance (3.63), flavour (3.47) and taste (3.63) were obtained for the beverage prepared using cashew apple juice and lime juice in the ratio of 75:25 (B_{14}). The highest scores for colour (3.34) and overall acceptability (3.34) were recorded for the beverages prepared with cashew apple juice and lime juice in the ratio of 75:25 and 85:15. When the scores were analysed statistically, the beverage prepared using cashew apple juice and limejuice in the ratio of 75:25 (B_{14}) obtained the highest rank scores of 20.27 and 19.18 for mean and overall acceptability respectively. Hence, from group 6, B_{14} was selected for storage study.

In group 7, the highest mean and overall acceptability scores of 3.72 and 3.58 respectively were obtained for the beverage prepared using cashew apple juice and orange juice in the ratio of 50:50 with the addition of one drop of ginger extract (B_{16}). Since, the score for different quality attributes as well as the mean (22.86) and over all (20.85) rank scores on the basis of Kendall's coefficient of concordance were also high for this beverage, from group 7; B_{16} was selected for further study.

Among the three beverages in group 8 prepared using cashew apple juice and orange juice in different proportions and adding one drop of cardamom extract, the highest scores for appearance (3.97), colour (3.60), flavour (3.61) and taste (3.97) were obtained for the beverage prepared using cashew apple juice and orange juice in the ratio of 75:25 (B_{20}). The highest mean score (3.79) and overall acceptability score (3.60) and the mean (23.15) and overall acceptability (23.18) rank scores on the basis of Kendall's coefficient of variation were also high for this beverage. From group 8, the beverage prepared with cashew apple and orange juice in the ratio of 75:25 with one drop of cardamom extract (B_{20}) was selected for storage study.

In group 9, among the three beverages, the highest score for colour (3.63) and flavour (3.59) as well as mean (3.57) and overall acceptability (3.63) scores were recorded for the beverage prepared using cashew apple and pineapple juice in the ratio of 50:50 with one drop of ginger extract (B_{22}). Since, the mean (22.83) and overall acceptability (18.15) rank scores on the basis of Kendall's coefficient of variation were also high for this beverage (B_{22}), from group 9, the beverage prepared using cashew apple juice and pineapple juice in the ratio of 50:50 with one drop of ginger extract was selected for storage study.

Among the three beverages included in group 10, the highest score for appearance (3.90), flavour (3.54), taste (3.90) and mean total score (3.71) were found to be high in the beverage prepared using cashew apple and pineapple juice

in the ratio of 50:50 with one drop of cardamom extract (B_{25}). Highest scores for colour (4.24) and overall acceptability (4.24) were obtained for the beverage prepared using cashew apple juice and pineapple juice in the ratio of 85:15 with the addition of one drop of cardamom extract (B_{27}). Since, the mean (21.15) and overall (22.29) rank scores on the basis of Kendall's test were also found to be high for B_{25}, from group 10, the beverage prepared with cashew apple and pineapple juice in the ratio of 50 :50 with the addition of one drop of cardamom extract was selected for storage study.

Among the three combinations tried in group 11, the highest mean and overall acceptability scores of 3.64 and 3.58 respectively were obtained for the beverage prepared using cashew apple and lime juice in the ratio of 75:25 with the addition of one drop of ginger extract (B_{29}). The scores for different quality attributes as well as the mean (23.52) and overall (19.08) rank scores on the basis of Kendall's test were also high in this beverage; thus B_{29} was selected for further study.

In group 12, the beverages were prepared using cashew apple juice and lime juice in different proportions with one drop of cardamom extract. Among the three combinations tried, the highest scores for appearance (3.77), colour (3.40), flavour (3.36) and taste (3.77) were obtained for the beverage prepared using cashew apple juice and lime juice in the ratio of 85:15 with the addition of one drop of cardamom extract (B_{33}). The highest mean score (3.57) and overall acceptability score (3.40) as well as the mean (18.71) and overall (20.86) rank scores on the basis of Kendall's coefficient of variation were also found to be high for this beverage and from group 12, B_{33} was selected for storage study.

Thus, from the preliminary study, from each group, one beverage each was selected for storage study. So, from 12 groups, 12 beverages were selected for storage study and the details of the beverages selected are given in Table 5. The

beverages selected were re-designated as T_1, T_2, T_3, T_4, T_5, T_6, T_7, T_8, T_9, T_{10}, and T_{11} instead of B_1, B_4, B_7, B_{10}, B_{14}, B_{16}, B_{20}, B_{22}, B_{25}, B_{29} and B_{33} respectively.

Table 5. Beverages selected for storage study.

Beverages	Combination
Control	100 % cashew apple juice without spice drops
T_1 (B_1)	100 % cashew apple juice + 1 drop ginger extract
T_2 (B_4)	100 % cashew apple juice + 1 drop cardamom extract
T_3 (B_7)	cashew apple juice +orange juice (50:50)
T_4 (B_{10})	cashew apple juice +pineapple juice (50:50)
T_5(B_{14})	cashew apple juice +lime juice (75:25)
T_6 (B_{16})	cashew apple juice +orange juice (50:50) + 1 drop ginger extract
T_7 (B_{20})	cashew apple juice+ orange juice (75:25) + 1 drop cardamom extract
T_8 (B_{22})	cashew apple juice+ pineapple juice (50:50) + 1 drop ginger extract
T_9 (B_{25})	cashew apple juice + pineapple juice (50:50) + 1 drop cardamom extract
T_{10} (B_{29})	cashew apple juice+ lime juice (75:25) + 1 drop ginger extract
T_{11} (B_{33})	cashew apple juice+ lime juice (85:15) + 1 drop cardamom extract

4.2. Storage study

4.2.1. Chemical composition of selected RTS beverages and changes during storage

The chemical constituents such as acidity, Total Soluble Solids (TSS), reducing sugar, total sugar, vitamin C, β carotene and tannin present in the selected RTS beverages were estimated initially and at monthly intervals for a period of three months. Since, the values obtained in the triplicate analysis for all chemical constituents except β carotene and tannin were found to be same, statistical analysis of the data was conducted using Friedman's test. For β carotene and tannin the statistical analysis was conducted using CRD.

4.2.1.1. Acidity

The acidity of RTS beverages stored at ambient temperature and refrigerated temperature are furnished in Table 6.

The acidity of all RTS beverages was found to be 0.32 per cent during the initial period of the experiment. No change in acidity was observed after one month of storage irrespective of storage conditions. However, after second month of storage, an increase in the acidity was observed in all RTS beverages stored at ambient temperature in which the content varied from 0.35to 0.64 per cent. Highest increase in acidity was observed in the beverage prepared with 100 per cent cashew apple juice (control). After third month of storage, the acidity of all beverages except T_1, T_2 and T_{10} further increased and the content varied from 0.35 to 0.70 per cent. The maximum increase in acidity was found in the beverages prepared with equal proportion of cashew apple and orange juice (T_3) and cashew apple and pineapple juice (T_4),followed by the beverages prepared with 100 per

Table 6. Acidity of RTS beverages during storage (g 100ml^{-1})

Treatments	Initial	Storage period in months					
		Ambient temperature			Refrigeration temperature		
		1MAS	2MAS	3MAS	1MAS	2MAS	3MAS
Control	0.32	0.32	0.64	0.67	0.32	0.28	0.28
T_1	0.32	0.32	0.35	0.35	0.32	0.25	0.25
T_2	0.32	0.32	0.35	0.35	0.32	0.32	0.32
T_3	0.32	0.32	0.57	0.7	0.32	0.32	0.32
T_4	0.32	0.32	0.57	0.7	0.32	0.28	0.22
T_5	0.32	0.32	0.48	0.6	0.32	0.28	0.25
T_6	0.32	0.32	0.35	0.38	0.32	0.28	0.25
T_7	0.32	0.32	0.35	0.38	0.32	0.28	0.25
T_8	0.32	0.32	0.44	0.48	0.32	0.28	0.25
T_9	0.32	0.32	0.44	0.48	0.32	0.28	0.25
T_{10}	0.32	0.32	0.35	0.35	0.32	0.28	0.22
T_{11}	0.32	0.32	0.41	0.48	0.32	0.32	0.32
Friedman's test statistic K P<0.05	0.004 (S)						

MAS – Months After Storage
S - Significant

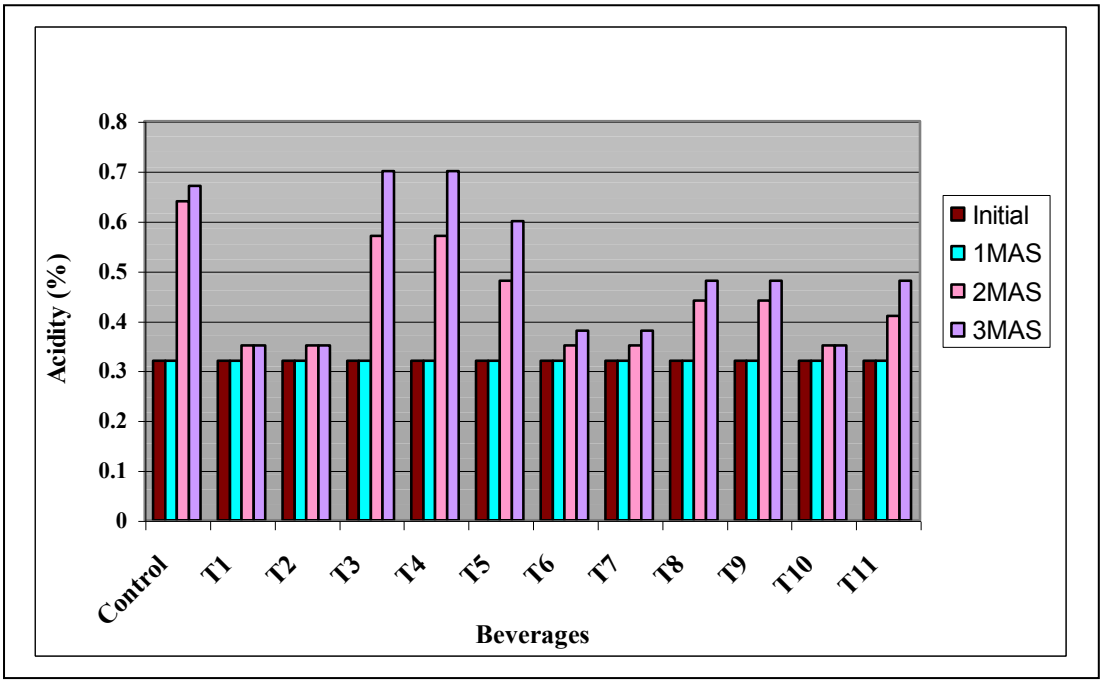
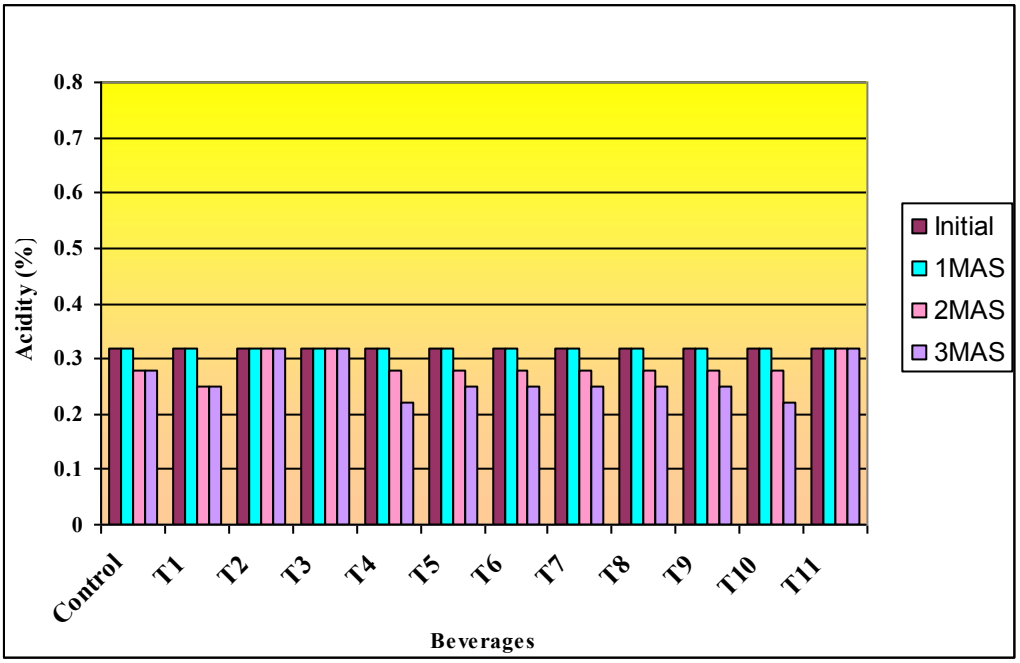


Fig 1.Acidity of RTS beverages stored under ambient condition



cent cashew apple juice (control) and 75 per cent cashew apple juice and 25 per cent lime juice (T_5).

In the RTS beverages stored under refrigerated condition, a gradual decrease in the acidity of almost all beverages except T_2, T_3, and T_{11} was observed. After second and third months of storage the acidity of all other beverages decreased up to 0.25 per cent and 0.22 per cent respectively. The lowest acidity of 0.25 per cent after second month of storage was noticed in T_1 and 0.22 per cent after third month of storage was observed in T_4 and T_{10}. In T_2, T_3 and T_{11} the acidity remained constant through out the storage period.

The variation observed in the acidity of RTS beverages between the two storage conditions was found to be statistically significant.

The acidity of RTS beverages observed during storage at ambient and refrigerated conditions are illustrated in Figure 1 and 2 respectively.

4.2.1.2. Total Soluble Solids (TSS)

The TSS content of the RTS beverages during storage is furnished in Table 7.

The TSS content of RTS beverages varied from 14 to 15 ^{0}brix initially and the content increased up to 15.2^{0}brix (T_8) at ambient temperature and 15.0^{0}brix (T_8) at refrigerated temperature at the end of the storage period (Table 7).

After first month of storage under ambient conditions except in control, T_1 and T_9, an increase in the TSS content was observed. In control, T_1 and T_9 the TSS content remained constant after first month of storage. After the second and third months of storage, a gradual decrease in the TSS content was observed in all

Table 7. Total Soluble Solid (TSS) of RTS beverages during storage (^{0}brix)

Beverages	Initial	Storage period in months					
		Ambient temperature			Refrigeration temperature		
		1MAS	2MAS	3MAS	1MAS	2MAS	3MAS
Control	14.4	14.4	14.4	14.4	14.4	14.4	14.4
T_1	14.4	14.4	14.4	14.4	14.4	14.4	14.4
T_2	14	14.4	14.3	14.2	14	14.3	14.6
T_3	14	14.4	14.4	14.4	14	14.4	14.6
T_4	14.6	14.8	14.2	14.3	14.6	14.6	14.6
T_5	14	14.6	14.6	14.2	14	14.2	14.4
T_6	14	14.6	14.4	14	14	14	14
T_7	14.6	14.8	14.6	14.4	14.6	14.6	14.6
T_8	15	15.2	15.2	15.2	15	15	15
T_9	14.8	14.8	15	15	14.8	14.8	14.8
T_{10}	14	14.4	14.2	14	14	14.1	14.3
T_{11}	14	14.5	14.3	14	14	14.1	14.2
Friedman's test statistic K $p<0.05$	0.001 (S)						

MAS- Months after storage

Significant at 5 % level

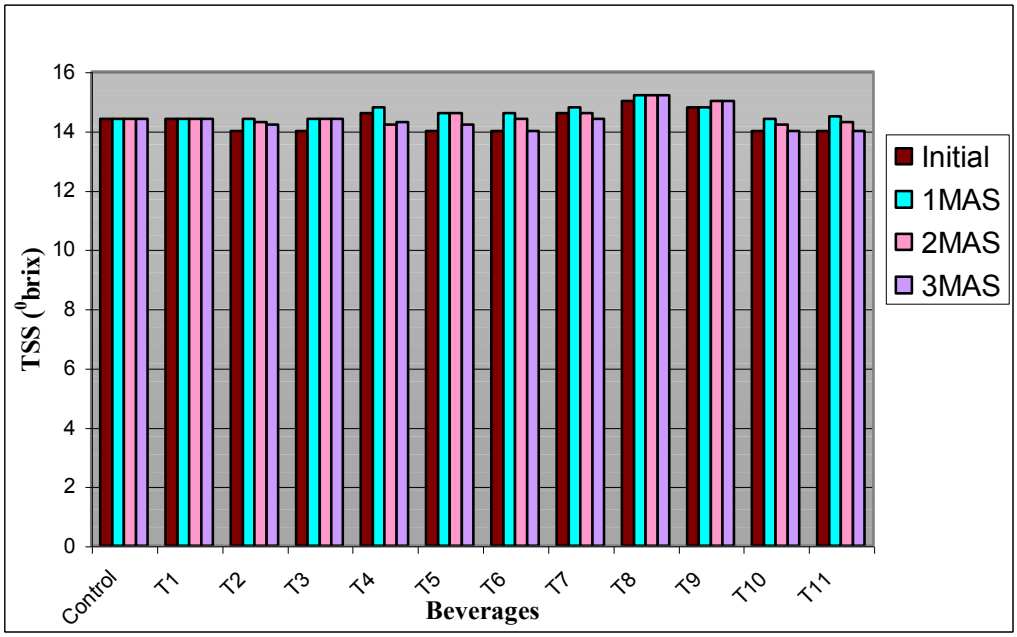
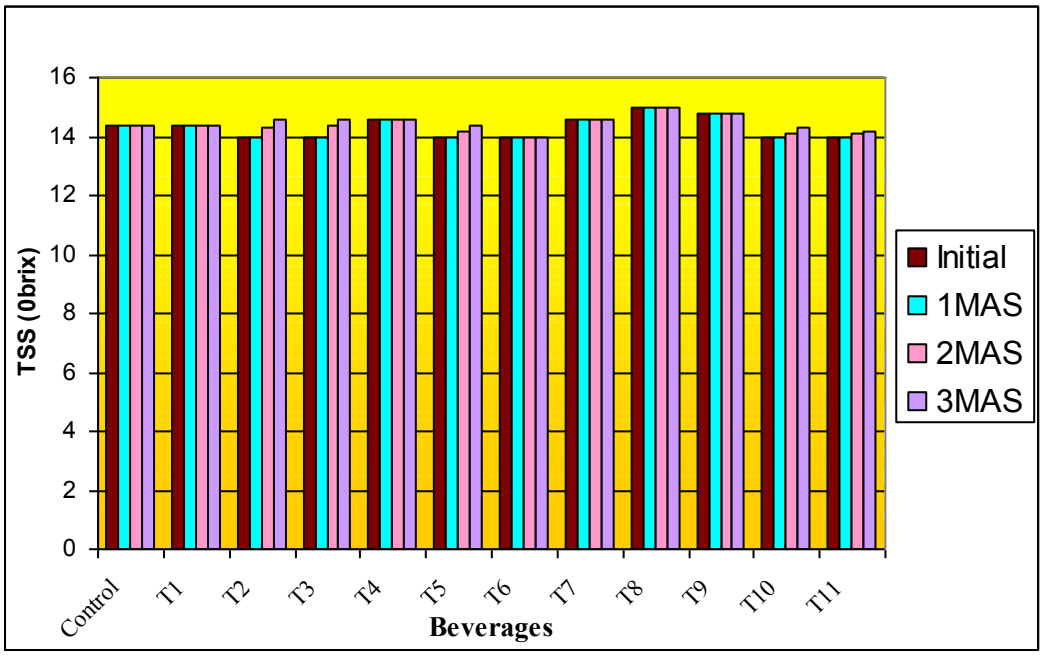


Fig.3 TSS of RTS beverages stored under ambient condition



beverages except control T1 T3 and T8. In control, T1 T3 and T8, the TSS content remained sasme till the end of storage period

Under refrigerated conditions, the TSS content of all beverages remained stable after first month of storage. In control, T_1, T_4, T_6, T_7, T_8 and T_9 the TSS content remained constant throughout the storage period. In all other treatments a slight increase in the TSS content was observed after second and third months of storage.

The variation in the TSS content of the beverages between the two storage conditions was found to be statistically significant. The TSS content of the RTS beverages during storage at ambient and refrigerated conditions is depicted in Figure 3 and 4 respectively.

4.2.1.3. Reducing Sugar

The reducing sugar content of RTS beverages during storage at ambient and refrigerated conditions is furnished in Table 8. Initially, the reducing sugar content of RTS beverages varied from 6.76 (T_7) to 9.8 per cent (T_2).

An increase in the reducing sugar content of the beverages was observed with the advancement of the storage period up to three months under ambient storage conditions. After first month of storage, the reducing sugar content varied from 10.2 to 12.1 per cent and at the end of the storage period the content varied from 12.2 per cent (T_{10}) to 14.28 per cent (T_3, T_7 and T_8).

At refrigerated storage conditions also a gradual increase in the reducing sugar content was observed in control and T_1 throughout the storage period. But in all other treatments there was a slight decrease in the reducing sugar content after first month of storage. From second month onwards a gradual increase in the reducing sugar content was observed in all beverages up to the end of the storage

Table 8. Reducing Sugar content of RTS beverages during storage (g $100ml^{-1}$)

Beverages	Initial	Storage period in months					
		Ambient temperature			Refrigeration temperature		
		1MAS	2MAS	3MAS	1MAS	2MAS	3MAS
Control	9.43	11.3	11.6	13.16	10.4	10.46	10.6
T_1	8.93	10.4	11.36	13.16	9.25	11.3	12.2
T_2	9.8	12.1	12.19	13.8	9.08	10.25	11.3
T_3	8.92	11.1	11.6	14.28	5.81	7.64	8.92
T_4	6.84	11.9	12.19	13.56	5.1	8.06	9.21
T_5	6.94	11.36	12.5	13.8	5.29	8.06	8.62
T_6	7.94	10.2	11.9	13.8	5.26	7.69	8.06
T_7	6.76	11.3	11.6	14.28	6.66	7.6	8.62
T_8	8.2	10.2	12.5	14.28	5.37	8.9	9.62
T_9	7.94	11.11	12.19	12.5	5.29	6.66	7.14
T_{10}	7.69	10.6	11.1	12.2	5.43	7.14	8.62
T_{11}	7.69	11.6	12.19	13.16	5.1	6.36	7.81
Friedman's test statistic K $p<0.05$	0.001 (S)						

MAS- Months after storage
S- Significant at 5 % level

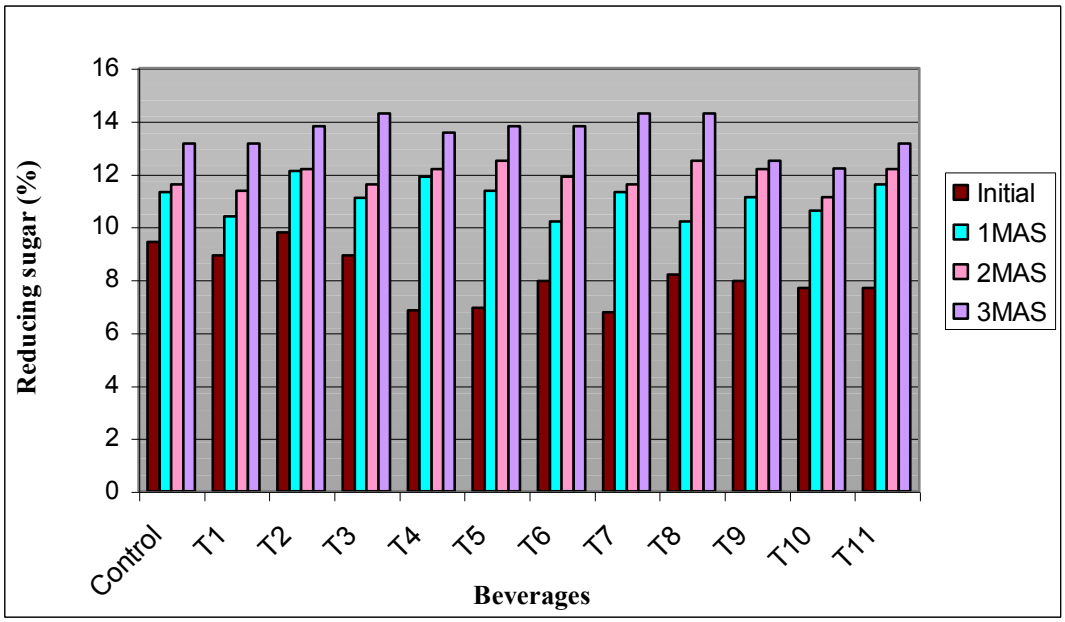


Fig.5 Reducing sugar content of RTS beverages stored under ambient condition

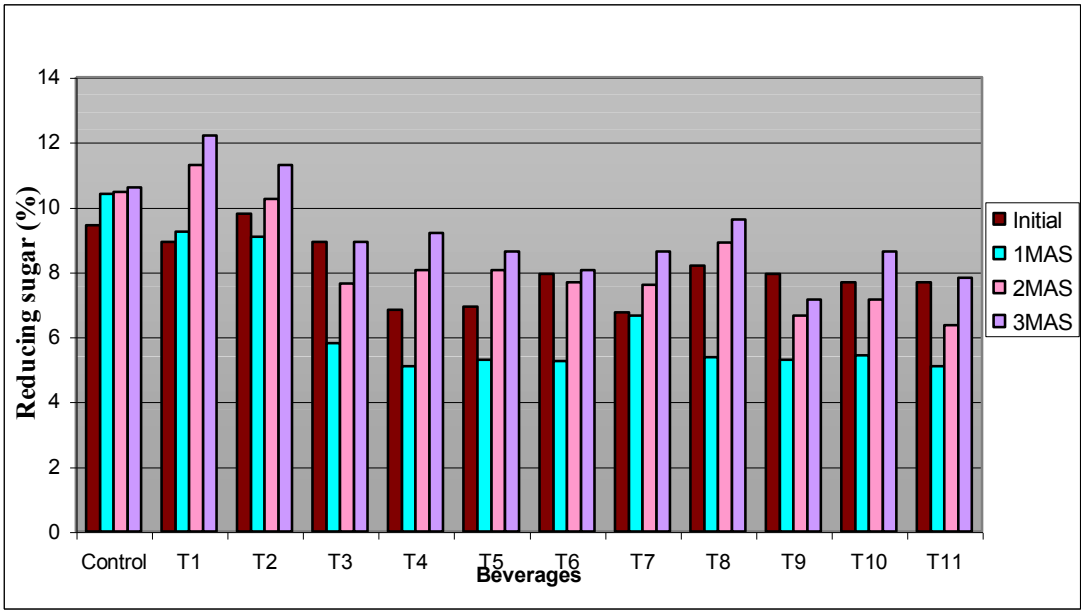


Fig.6 Reducing sugar content of RTS beverages stored under refrigerated condition

period. After three months of storage, the reducing sugar content varied from 7.14 (T_9) to 12.2 per cent (T_1).

The variation in the reducing sugar content of the beverages observed between the two storage conditions was found to be statistically significant. The reducing sugar content of the beverages during storage at ambient and refrigerated conditions is depicted in Figure 5 and 6 respectively.

4.2.1.4.Total Sugar

The total sugar content of RTS beverages during ambient and refrigerated storage conditions are furnished in Table 9.

The total sugar content of the RTS beverages varied from 11.11 per cent (T_{10}) to 13.16 per cent (control and T_3) initially. After first month of storage a decrease in the total sugar content of the beverages stored at ambient condition was noticed which varied from 10.2 (T_3, T_7, T_8 and T_{10}) to 12.1 per cent (T_2). During the later stages of storage the total sugar content of the beverages increased gradually and at the end of the storage period the total sugar content varied from 12.38 (T_9) to 13.88 per cent (T_7).

Under refrigerated condition, gradual decrease in the total sugar content was observed after second and third months of storage. At the end of the storage period the total sugar content varied from 11.09 per cent (T_{10}) to 11.9 per cent (T_4).

The variation observed in the total sugar content of the beverages between the two storage conditions was found to be statistically insignificant. The total sugar content of the beverages during storage at ambient and refrigerated conditions is illustrated in Figure 7 and 8 respectively.

Table 9. Total Sugar content of RTS beverages during storage (g $100ml^{-1}$)

Beverages	Initial	Storage period in months					
		Ambient temperature			Refrigeration temperature		
		1MAS	2MAS	3MAS	1MAS	2MAS	3MAS
Control	13.16	11.3	12.6	13.51	11.6	11.31	11.21
T_1	12.95	10.4	13.4	13.16	12.95	12.25	11.68
T_2	12.82	12.1	12.8	12.89	12.62	12.37	11.21
T_3	13.16	10.2	13.2	13.37	12.82	12.25	11.74
T_4	12.08	11.9	12.5	13.66	13.73	13.15	11.9
T_5	11.9	11.11	12.5	12.82	12.75	12.25	11.74
T_6	11.68	11.3	11.4	12.63	12.25	11.74	11.57
T_7	11.57	10.2	11.6	13.88	12.37	11.9	11.31
T_8	11.52	10.2	12.19	13.23	12.37	11.9	11.31
T_9	11.63	10.6	12.19	12.38	13.15	12.25	11.6
T_{10}	11.11	10.2	11.11	13.59	12.25	11.31	11.09
T_{11}	11.63	10.6	12.19	13.02	12.88	12.25	11.74
Friedman's test statistic K $p<0.05$	0.263 (NS)						

MAS- Months after storage
NS- Non Significant

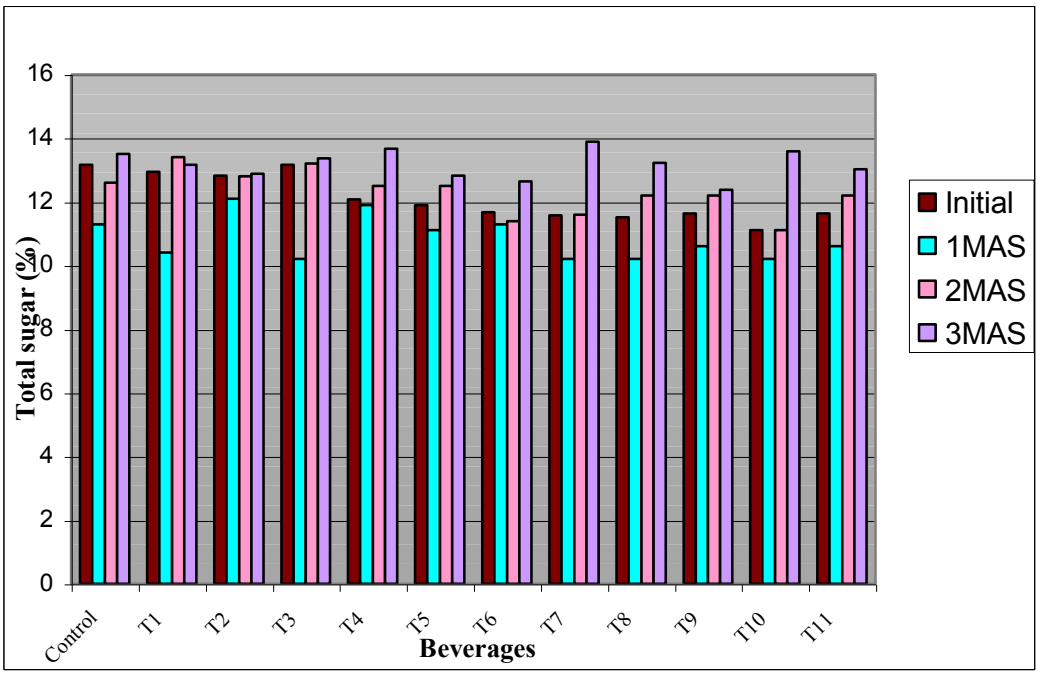


Fig.7 Total sugar content of RTS beverages during storage under ambient condition

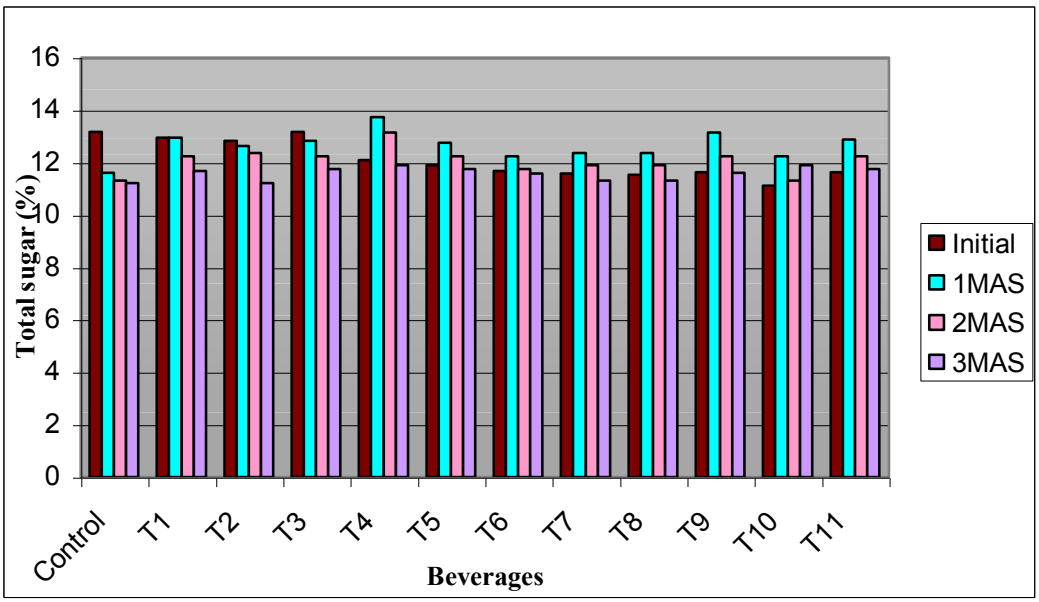


Fig.8 Total sugar content of RTS beverages stored under ambient condition

4.2.1.5. Vitamin C

The vitamin C content of RTS beverages during storage are furnished in Table 10.

The vitamin C content of the beverages varied from 17.14 to 23.08 mg100ml^{-1} initially and the highest vitamin C content was noticed in T_1 followed by control and T_2 and the lowest content was observed in T_3, T_4, T_6, T_8 and T_9.

Under ambient and refrigerated storage conditions a drastic decrease in the vitamin C content was observed. At the end of storage period under ambient condition the vitamin C content varied from 5.60 (T_4 and T_8) to 9.43 mg 100ml^{-1} (T_{10} and T_{11}). Under refrigerated storage condition it decreased to 12.72 (T_8) to 16.18 mg 100ml^{-1} (control).

The variation in the vitamin C content of RTS beverages between the two storage conditions was found to be statistically significant. The vitamin C content of the beverages during storage at ambient and refrigerated conditions is depicted in Figure 9 and 10 respectively.

4.2.1.5.β carotene

The β carotene content of RTS beverages during storage at ambient and refrigerated conditions are furnished in Table 11.

The β carotene content of the RTS beverages varied from 13.91 to 26.60 µg 100ml^{-1} initially and it decreased up to 7.75µg (T_2) and 11.49µg (T_8) 100ml^{-1} under ambient and refrigerated storage conditions respectively at the end of the storage period. Initially, the highest β carotene content was noticed in beverage T_1 followed by T_6 (25.31µg) and T_3 (23.37µg). After third month of storage under

Table 10. Vitamin C content of RTS beverages during storage (mg $100ml^{-1}$)

Beverages	Initial	Storage period in months					
		Ambient temperature			Refrigeration temperature		
		1MAS	2MAS	3MAS	1MAS	2MAS	3MAS
Control	22.9	9.81	9.19	7.31	18.98	17.14	16.18
T_1	23.08	16.66	9.43	9.09	18.09	16.36	15.14
T_2	21.92	13.06	9.09	7.43	17.75	17.18	15.16
T_3	17.14	12.54	7.43	7.2	15.2	14.09	13.2
T_4	17.4	10.41	7.2	5.6	15.09	14.5	13.2
T_5	20	14.5	10.9	7.54	18.18	16.36	14.5
T_6	17.14	12.54	7.54	7.2	15.09	14.5	13.2
T_7	20.93	12.66	9.39	9.09	17.69	16.63	14.21
T_8	17.14	12.72	10.9	5.6	16.36	15.09	12.72
T_9	17.14	14.5	9.09	7.54	16.36	15.14	14.5
T_{10}	20	14.5	10.9	9.43	18.18	16.36	15.14
T_{11}	20	14.5	10.9	9.43	17.04	16.36	15.09
Friedman's test statistic K $p<0.05$	0.001 (S)						

MAS- Months after storage
S- Significant at 5 % level

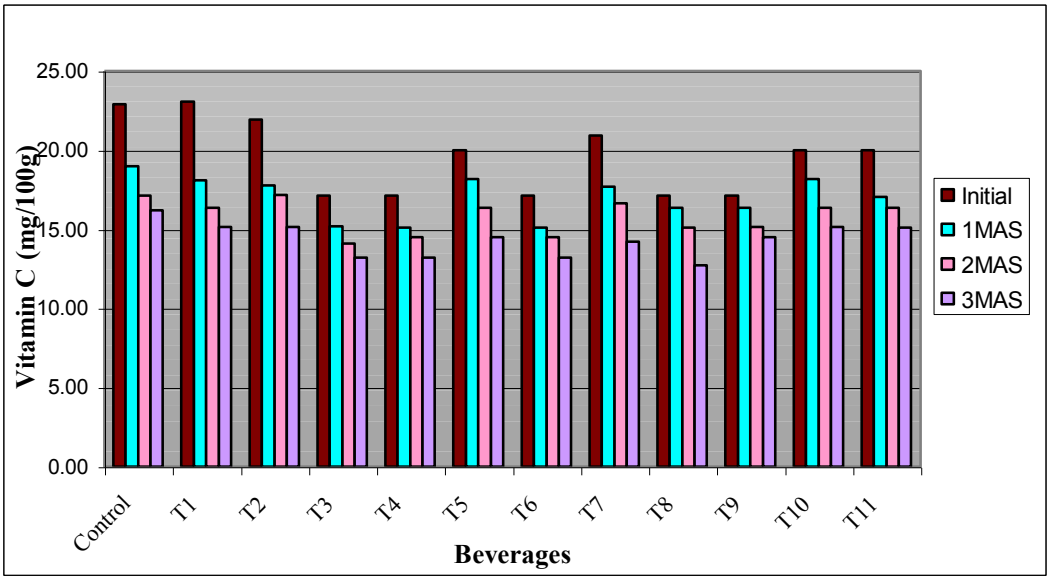


Fig.9 Vitamin C content of RTS beverages stored under ambient condition

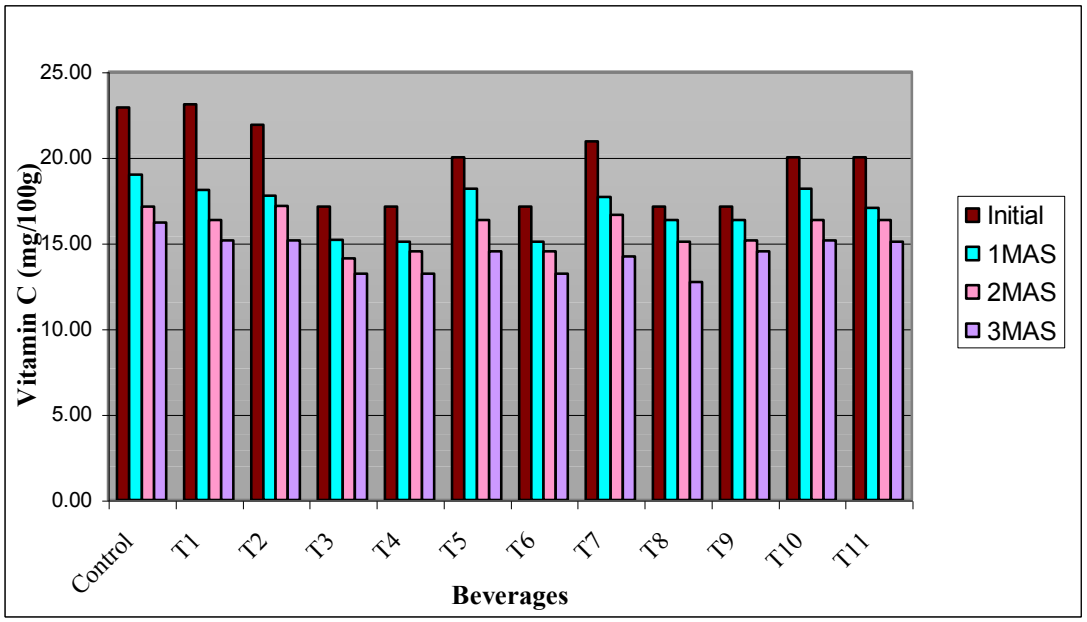


Fig.10 Vitamin C content of RTS beverages stored under refrigerated condition

Table 11. β-Carotene content of RTS beverages during storage (µg 100ml^{-1})

Treatm	Storage period in months							
	Ambient temperature				Refrigeration temperature			
	Initial	1MAS	2MAS	3MAS	Initial	1MAS	2MAS	3MAS
Control	21.32^{cdeA}	20.25^{aA}	16.1^{abB}	13.80^{aC}	21.32^{cdeA}	21.10^{bA}	20.3^{bA}	18.89^{aA}
T_1	26.60^{aA}	20.43^{aB}	16.83^{aC}	14.29^{aD}	26.60^{aA}	24.13^{aB}	21.27^{aC}	18.69^{aD}
T_2	15.24^{fgA}	12.55^{fB}	9.68^{fC}	7.75^{fD}	15.24^{fgA}	13.60^{hB}	12.87^{gB}	12.25^{eB}
T_3	23.37^{bcA}	16.37^{cdB}	12.78^{dC}	10.94^{dD}	23.37^{bcA}	20.46^{cB}	18.42.^{dC}	14.43^{cdD}
T_4	14.66^{fgA}	10.66^{gB}	9.52^{fC}	9.31^{eB}	14.66^{fgA}	13.88^{hAB}	12.91^{gC}	12.35^{eC}
T_5	22.99^{bcdA}	17.36^{bcB}	15.32^{bC}	12.89^{bD}	22.99^{bcdA}	20.3^{cB}	19.36^{cC}	18.76^{aC}
T_6	25.31^{abA}	18.63^{bB}	14.13^{cC}	12.58^{bcD}	25.31^{abA}	19.6^{dB}	16.1^{efC}	15.42^{bC}
T_7	16.91^{fA}	14.57^{eB}	13.7^{cC}	12.49^{bcC}	16.91^{fA}	16.26^{gAB}	15.48^{fC}	14.03^{dC}
T_8	13.91^{gA}	12.54^{fAB}	11.32^{eC}	9.67^{eC}	13.91^{gA}	13.44^{hAB}	12.37^{gC}	11.49^{eC}
T_9	20.51^{deA}	15.35^{deB}	12.65^{dC}	11.86^{cC}	20.51^{deA}	18.42^{eB}	15.48^{fC}	14.53^{bcdC}
T_{10}	19.37^{eA}	16.73^{cdB}	12.65^{dC}	12.19^{bcC}	19.37^{eA}	17.54^{fB}	16.46^{eBC}	15.32^{bcC}
T_{11}	20.72^{cdeA}	18.64^{bB}	12.65^{bC}	12.56^{bcC}	20.72^{cdeA}	18.46^{eB}	16.33^{eC}11	15.16^{bcC}

Values with different superscripts differ significantly

MAS- Months After Storage

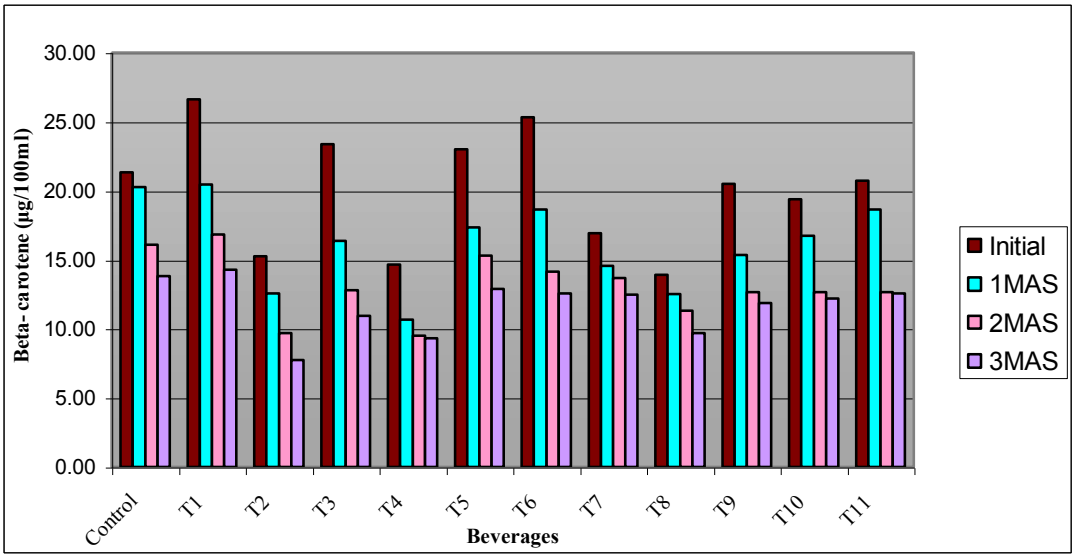


Fig.11 β -carotene content of RTS beverages stored under ambient condition

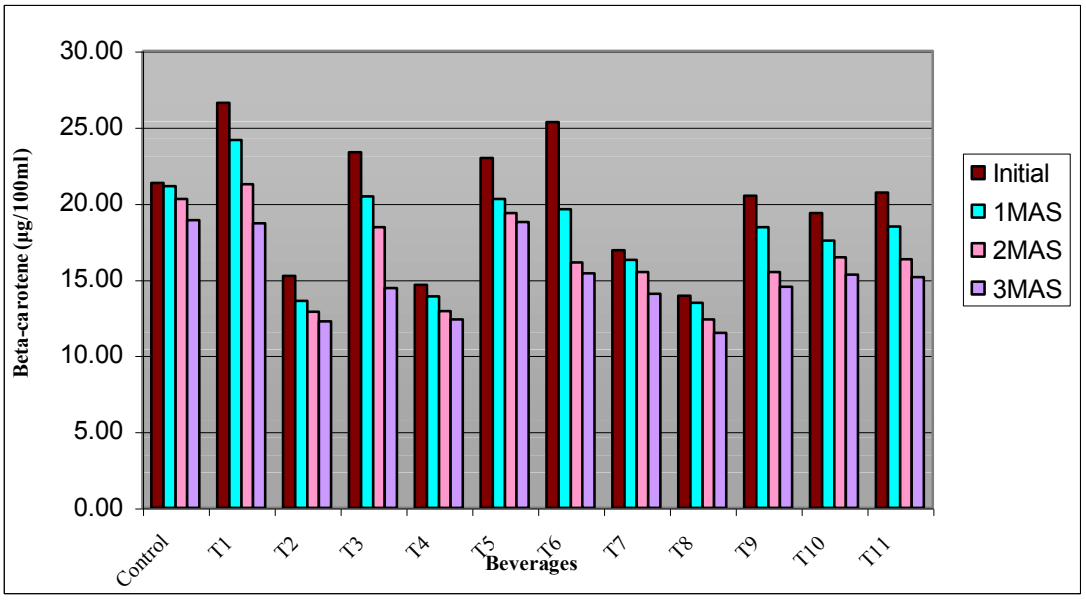


Fig.12 β -carotene content of RTS beverages stored under refrigerated condition

ambient condent the higest β carotene content of 14.29μg was noticed in T_1 followed by control (13.80μg) and T_5 (12.89 μg)

At refrigerated storage condition the β carotene content of the beverages varied from 13.44μg (T_8) to 24.13 μg (T_1) at first month of storage and the highest content was maintained in T_1 at second month of storage also. At the end of storage highest β carotene content was noticed in control (18.89 μg) followed by T_5 (18.76 μg) and T_1 (18.69 μg) and the lowest in T_8 (11.49μg).

Significant decrease in the β carotene content of beverages was observed at the end of storage under both conditions except in control stored under refrigerated conditions. During the initial period of storage under ambient conditions significant decrease in the β carotene was noticed in all beverages except control. Under refrigerated conditions also significant decrease was observed during the initial period of storage in T_1, T_2, T_3, T_5, T_6, T_9, T_{10} and T_{11}. The β carotene content of the

4.2.1.7. Tannin

The tannin content of RTS beverages during storage at ambient and refrigerated conditions are furnished in Table 12.Initially, the tannin content of RTS beverages varied from 0.027 to 0.066 mg100 ml^{-1}. Highest tannin content was noticed in control followed by T_1, T_2, T_5 and T_{10} and the lowest content in T_8. After third month of storage under ambient condition the tannin content varied between 0.009 to 0.036 mg100ml^{-1} with the highest content in control followed by T_2 (0.026 mg) and T_3 (0.023 mg) and lowest in T_9 (0.009 mg) followed by T_8 (0.015 mg).

Table 12. Tannin content of cashew apple RTS beverages stored at ambient and refrigerated condition (mg100ml^{-1})

Treatments	Storage period in months							
	Ambient temperature				Refrigeration temperature			
	Initial	1MAS	2MAS	3MAS	Initial	1MAS	2MAS	3MAS
Control	0.066^{aA}	0.044^{bB}	0.039^{aB}	0.036^{aB}	0.066^{aA}	0.054^{bAB}	0.047^{a}	0.041^{aB}
T_1	0.059^{bA}	0.054^{aA}	0.034^{bB}	0.020^{dB}	0.059^{bA}	0.060^{aA}	0.037^{b}	0.028^{bcdB}
T_2	0.052^{cA}	0.042^{bAB}	0.032^{cB}	0.026^{bB}	0.052^{cA}	0.042^{cAB}	0.034^{bc}	0.031^{bB}
T_3	0.034^{fgA}	0.03^{deA}	0.027^{deA}	0.023^{cA}	0.034^{fgA}	0.032^{eA}	0.031^{c}	0.029^{bcA}
T_4	0.036^{fgA}	0.034^{cA}	0.023^{fA}	0.02^{dA}	0.036^{fgA}	0.032^{eA}	0.031^{cd}	0.026^{bcdeA}
T_5	0.046^{dA}	0.029^{efB}	0.020^{gB}	0.014^{fB}	0.046^{dA}	0.036^{dAB}	0.032^{c}	0.021^{efB}
T_6	0.034^{fgA}	0.032^{cdAB}	0.026^{deAB}	0.015^{efB}	0.034^{fgA}	0.032^{eAB}	0.026^{de}	0.020^{fB}
T_7	0.033^{gA}	0.031^{cdA}	0.025^{efB}	0.017^{eB}	0.033^{gA}	0.033^{deA}	0.026^{de}	0.020^{fA}
T_8	0.027^{hA}	0.026^{fA}	0.019^{gAB}	0.015^{fB}	0.027^{hA}	0.022^{fA}	0.021^{f}	0.020^{efA}
T_9	0.031^{fgA}	0.027^{fA}	0.015^{hAB}	0.009^{gB}	0.031^{fgA}	0.029^{eA}	0.025^{e}	0.022^{efA}
T_{10}	0.041^{eA}	0.032^{cdAB}	0.025^{efAB}	0.020^{dB}	0.041^{eA}	0.032^{eA}	0.026^{de}	0.024^{deA}
T_{11}	0.039^{efA}	0.033^{cdAB}	0.028^{dAB}	0.021^{cdB}	0.039^{efA}	0.033^{dcA}	0.030^{cd}	0.024^{cdeA}

Values with different superscripts differ significantly

MAS- Months After Storage

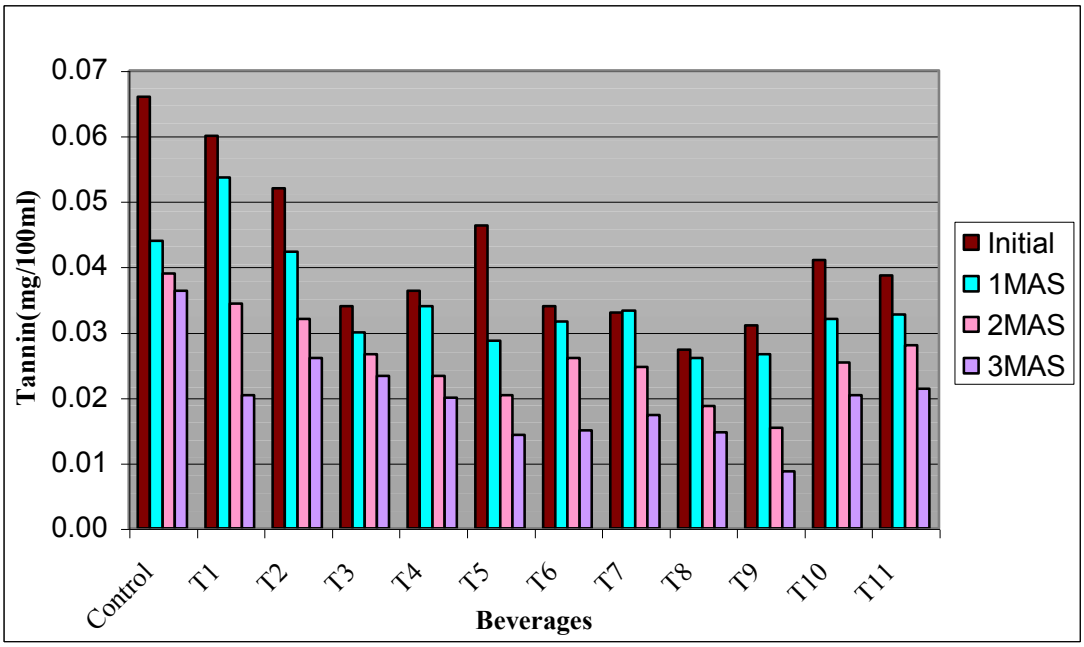


Fig.13 Tannin content of RTS beverages stored under ambient condition

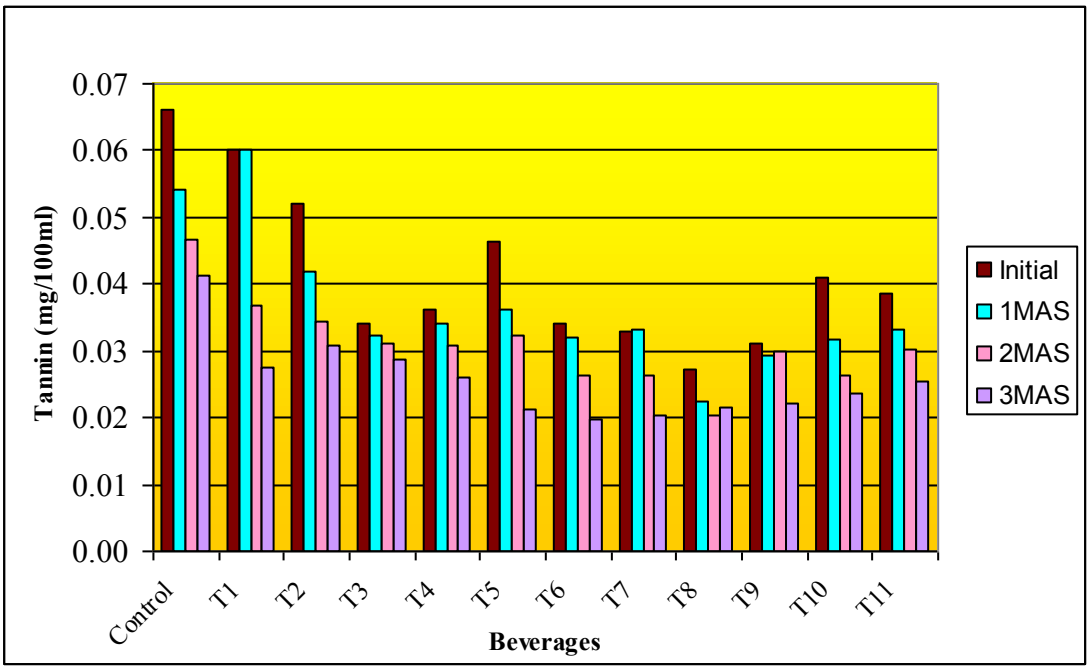


Fig.14 Tannin content of RTS beverages stored under refrigerated condition

At refrigerated storage condition after third month of storage the tannin content varied from 0.020 to 0.041 mg100ml^{-1}. The highest content was observed in control followed by T_2 (0.031 mg) and lowest in T_6 and T_7 and T_8 (0.020 mg).

The decrease observed in the tannin content of all beverages at the end of storage period was found to be statistically significant from the initial value except in T_3 and T_4 under ambient storage conditions. Under refrigerated conditions the decrease was statistically significant in control, T_1, T_2, T_5, and T_6.

During the first month of storage the decrease observed in the tannin content of almost all beverages was statistically insignificant under both storage conditions except control and T_5 stored under ambient conditions. During the later part of storage also the decrease was found to be statistically insignificant in all beverages under both storage conditions. The tannin content of the beverages during ambient and refrigerated storage conditions are depicted in Figure13 and 14 respectively.

4.2.2. Organoleptic evaluation of selected RTS beverages and changes during storage.

The RTS beverage were evaluated organoleptically using score cards for different quality attributes like appearance, colour, flavor, taste and overall acceptability initially, after first, second and third months of storage under ambient and refrigerated conditions. Each beverage was ranked for all these quality attributes based o their mean rank scor4e using Kendall's W test. The results of the organoleptic evaluation of RTS beverages during storage at ambient and refrigerated conditions are presented in this section.

4.2.2.1.Appearance

The initial score for appearance of RTS beverages varied from 4.13 to 4.23. The highest score of 4.23 was obtained for four beverages namely T_1, T_3 , T_5 and T_8 and the lowest score of 4.13 was found in control, T_2, T_4, T_6, T_9 and T_{10} (Table 13). During storage, a gradual decrease in the appearance was noticed and the scores at the end of the storage period varied from 2.73 (control and T_3) to 3.10 (T_6 and T_{10}) under ambient condition.

The beverages namely T_2, T_5, T_6, T_8 and T_{10} obtained a score of above three for appearance during the entire storage period. After third month of storage the mean rank score varied from 6.57 to 9.03 with the highest rank score in T_2 followed by T_7, T_9 and T_{11}. The beverage which was prepared with 100 per cent cashew apple juice obtained the lowest rank scores throughout the storage period under ambient conditions except after two months.

Under refrigerated conditions, all beverages recorded a mean score of above 3.7 during the entire period of storage. After third month of storage the appearance of RTS beverages varied from 3.77 to 3.80. All the beverages except T_6, T_7, T_{10} and T_{11} obtained the highest score of 3.80.

While comparing the two storage conditions, the mean rank scores for appearance were found to be high in RTS beverages stored under refrigerated conditions. After third month of storage, the mean rank scores varied from 16.87 to 17.30. The highest mean rank scores was observed in all beverages except T_6,T_7, T_{10} and T_{11}.

Kendall's coefficient of concordance was worked out during different storage periods and the score recorded for appearance was found to be statistically insignificant during the initial period. During the storage periods, W was found to

Table 13. Effect of storage on the mean score for appearance of RTS beverages

Beverages	Initial	Storage period in months					
		Ambient temperature			Refrigeration temperature		
		1MAS	2MAS	3MAS	1MAS	2MAS	3MAS
Control	4.13 (11.97)	3.73 (11.43)	3.33 (9.5)	2.73 (6.57)	3.9 (13.43)	3.87 (15.9)	3.8 (17.3)
T_1	4.23 (13.17)	3.90 (13.43)	3.33 (9.5)	2.77 (6.8)	3.73 (11.43)	3.87 (15.9)	3.8 (17.3)
T_2	4.13 (11.97)	3.77 (11.83)	3.23 (8.3)	3.07 (9.03)	3.9 (13.43)	3.87 (15.9)	3.8 (17.3)
T_3	4.23 (13.17)	3.73 (11.43)	3.33 (9.5)	2.73 (6.57)	3.77 (11.83)	3.87 (15.9)	3.8 (17.3)
T_4	4.13 (11.97)	3.73 (11.43)	3.33 (9.5)	2.77 (6.8)	3.9 (13.43)	3.87 (15.9)	3.8 (17.3)
T_5	4.23 (13.17)	3.90 (13.43)	3.33 (9.5)	3.03 (8)	3.9 (13.43)	3.87 (15.9)	3.8 (17.3)
T_6	4.13 (11.97)	3.90 (13.43)	3.33 (9.5)	3.1 (6.8)	3.73 (13.43)	3.87 (15.9)	3.77 (16.87)
T_7	4.20 (12.77)	3.90 (13.43)	3.23 (8.3)	2.83 (8.7)	3.9 (13.43)	3.87 (15.9)	3.77 (16.87)
T_8	4.23 (13.77)	3.90 (13.43)	3.33 (9.5)	3.03 (8)	3.77 (11.83)	3.87 (15.9)	3.8 (17.3)
T_9	4.13 (11.97)	3.73 (11.43)	3.23 (8.3)	2.93 (8.7)	3.73 (11.43)	3.87 (15.9)	3.8 (17.3)
T_{10}	4.13 (11.97)	3.77 (11.83)	3.33 (9.5)	3.1 (6.8)	3.9 (13.43)	3.87 (15.9)	3.77 (16.87)
T_{11}	4.20 (12.77)	3. 73 (11.43)	3.23 (8.3)	2.83 (8.7)	3.9 (13.43)	3.87 (15.9)	3.77 (16.87)
W	0.022^{NS}	0.057**	0.437**	0.635**	0.057**	0.437**	0.635**
Probability of significance (%)	88.5	1.7	0.1	0.1	1.7	0.1	0.1

MAS- Months After Storage
Figures in parenthesis are mean rank scores
W-Kendall's coefficient of concordance

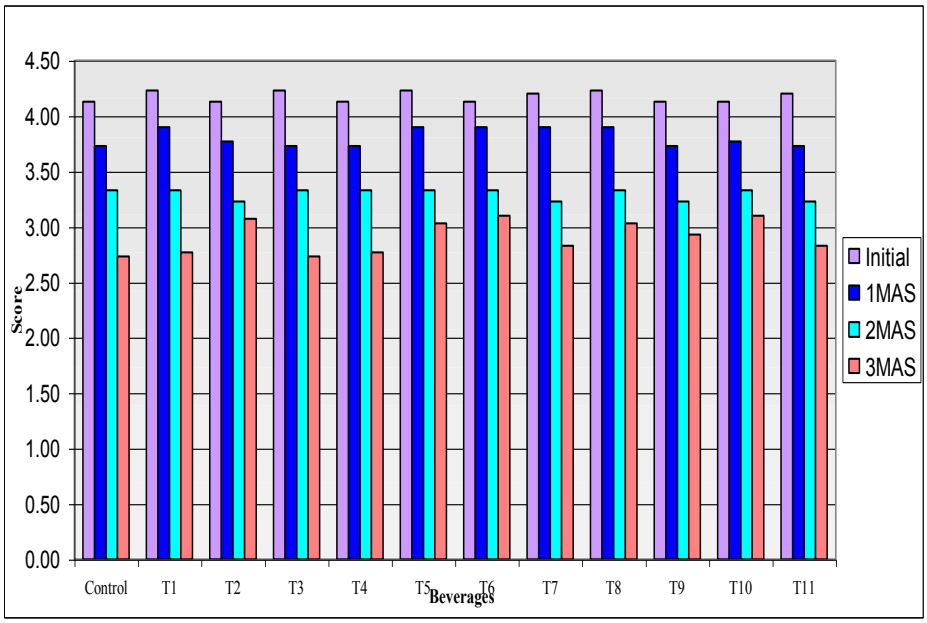
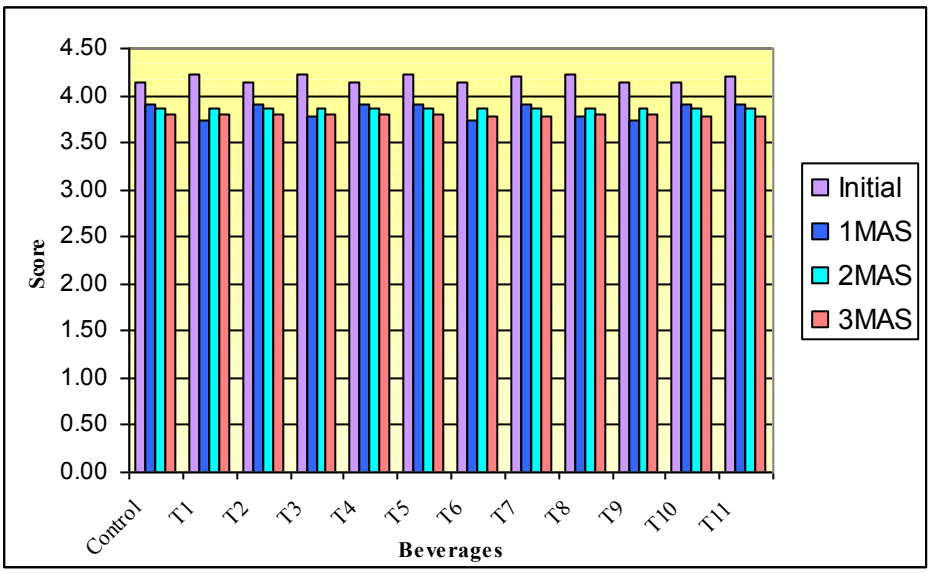


Fig 15. Score for appearance of RTS beverages stored under ambient condition



be significant at 1.7 per cent and 0.1 percent respectively for first, second and third months of storage (Table 13).

Effect of storage on the mean score for appearance of RTS beverages stored under ambient and refrigerated conditions is shown in Figure 15 and 16 respectively.

4.2.2.2.Colour

Initially, the score for colour of RTS beverages varied from 4.13 to 4.23. Considering the ambient storage condition, a gradual decrease in the colour was noticed during storage and at the end of storage, the score varied from 2.73 to 3.10 (Table 14). The beverages T_2, T_4, T_7, T_9 and T_{10} had a score of above three during the different storage periods. After third month of storage T_4 and T_{10} had the highest score of 3.10 followed by T_2, T_7 and T_9. The lowest score for colour was noticed in control and T_3. Control and T_3 obtained the lowest rank scores (6.57) also for colour at the end of the storage.

Under refrigerated storage conditions a gradual decrease in the score for colour was noticed. All the beverages had a score of above 3.70 during the entire storage period. After third month of storage the scores varied from 3.77 to 3.80. The highest score of 3.80 was observed in almost all beverages at the end of the storage period except T_6, T_7, T_{10} and T_{11}.

While observing the mean rank scores for colour of beverages stored under ambient and refrigerated conditions highest mean rank scores were recorded for beverages stored under refrigerated conditions during different storage periods. At the end of storage period under refrigerated conditions the rank scores varied from 16.87 to17.37. The highest rank score was noticed in T_3 and T_5 followed by control, T_1, T_2 and T_9 (17.3)

Table 14. Effect of storage on the mean score for colour of RTS beverages

Beverages	Initial	Storage period in months					
		Ambient temperature			Refrigeration temperature		
		1MAS	2MAS	3MAS	1MAS	2MAS	3MAS
Control	4.13 (11.97)	3.73 (11.47)	3.33 (9.5)	2.73 (6.57)	3.90 (13.47)	3.87 (15.9)	3.80 (17.3)
T_1	4.23 (13.17)	3.90 (13.47)	3.33 (9.5)	2.77 (6.8)	3.73 (11.47)	3.87 (15.9)	3.80 (17.3)
T_2	4.13 (11.97)	3.77 (11.87)	3.23 (8.3)	3.07 (9.03)	3.90 (13.47)	3.87 (15.9)	3.80 (17.3)
T_3	4.23 (13.17)	3.73 (11.47)	3.33 (9.5)	2.73 (6.57)	3.77 (11.87)	3.87 (15.9)	3.80 (17.37)
T_4	4.13 (11.97)	3.73 (13.47)	3.33 (9.5)	3.10 (9.3)	3.90 (11.47)	3.87 (15.9)	3.80 (17.28)
T_5	4.23 (12.77)	3.90 (13.47)	3.33 (8.3)	2.93 (8)	3.90 (13.47)	3.87 (15.9)	3.80 (17.37)
T_6	4.13 (11.97)	3.90 (11.47)	3.33 (9.5)	2.77 (6.8)	3.73 (13.47)	3.87 (15.9)	3.77 (16.87)
T_7	4.20 (13.17)	3.90 (13.47)	3.23 (9.5)	3.03 (8.7)	3.90 (11.87)	3.87 (15.9)	3.77 (16.87)
T_8	4.23 (11.97)	3.90 (11.47)	3.33 (8.3)	2.83 (7.13)	3.77 (11.47)	3.87 (15.9)	3.80 (17.28)
T_9	4.13 (13.17)	3.73 (13.47)	3.23 (9.5)	3.03 (8.7)	3.73 (13.47)	3.87 (15.9)	3.80 (17.3)
T_{10}	4.13 (11.97)	3.77 (11.87)	3.33 (9.5)	3.10 (9.3)	3.90 (13.47)	3.87 (15.9)	3.77 (16.87)
T_{11}	4.20 (12.77)	3.73 (11.47)	3.23 (8.3)	2.83 (7.13)	3.83 (12.67)	3.87 (15.9)	3.77 (16.87)
W	0.022^{NS}	0.057**	0.437**	0.635**	0.057**	0.437**	0.635**
Probability of significance (%)	88.5	1.7	0.1	0.1	1.7	0.1	0.1

MAS- Months After Storage
Figures in parenthesis are mean rank scores
W-Kendall's coefficient of concordance

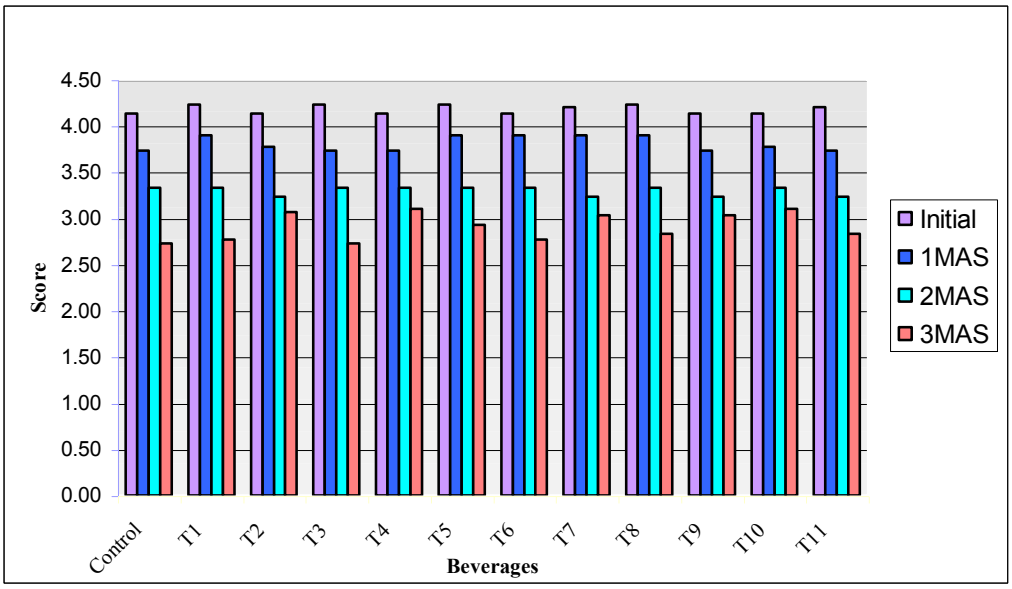


Fig 17. Score for colour of RTS beverages stored under ambient condition

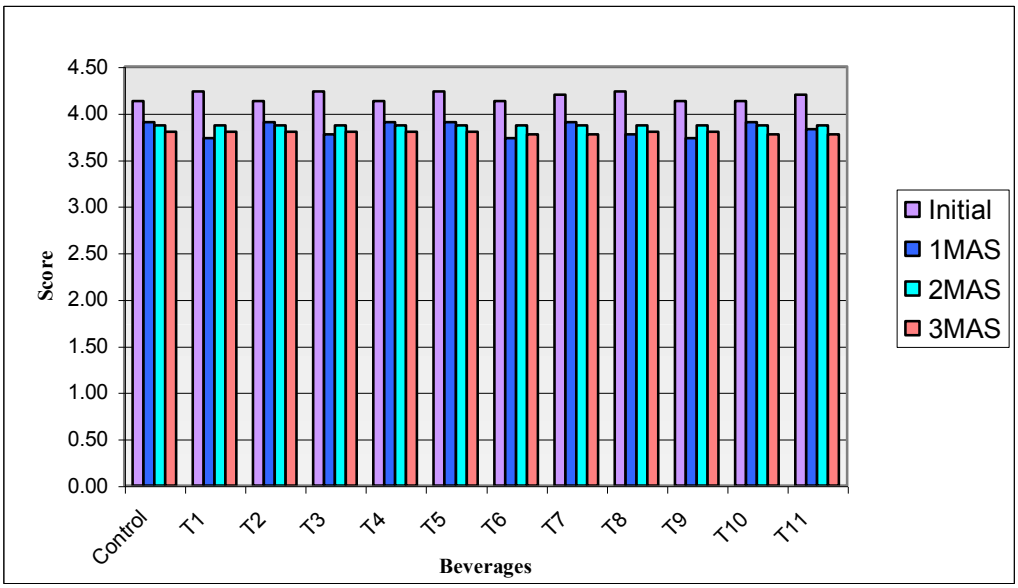


Fig 18. Score for colour of RTS beverages stored under refrigerated condition

Kendall's coefficient of concordance (W) registered for colour shows that there was a significant agreement among judges after first, second and third months of storage. During initial period of storage W was found to be statistically insignificant.

Effect of storage on colour of RTS beverages stored under ambient and refrigerated condition is illustrated in Figure17 and 18 respectively.

4.2.2.3.Flavour

Initially, the score for flavour varied between 3.70 to3.87 with the highest score in T2 and T_4 (Table 15).

Under ambient storage conditions the score for flavour decreased gradually and after first and second months of storage the scores varied from 2.97 to 3.07 and 2.13 to 2.40 respectively. After third month of storage the scores varied from 1.57 to 1.67.

Under refrigerated storage conditions all the beverages had a score of above three during the entire storage period. After third month of storage, the scores for flavour varied between 3.17 to 3.33 with the highest score in T_7 and T_{11}.

While comparing the two storage conditions, in refrigerated condition the mean rank scores was found to be high in all RTS beverages throughout the storage period. After third month of storage, the mean rank scores for flavour varied from 18.08 to 19.08 with the highest score in T_6 and T_{11} followed by control, T_2 and T_9.

Kendall's coefficient of concordance (W) registered for flavour was worked out during different storage periods and it was found to be insignificant

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Table 15. Effect of storage on the mean score for flavour of RTS beverages

Beverages	Initial	Storage period in months					
		Ambient temperature			Refrigeration temperature		
		1MAS	2MAS	3MAS	1MAS	2MAS	3MAS
Control	3.70 (12.17)	3.07 (9.32)	2.20 (6.9)	1.60 (6.4)	3.60 (15.67)	3.30 (17)	3.30 (18.88)
T_1	3.70 (12.17)	3.07 (9.32)	2.33 (8.27)	1.57 (6.2)	3.57 (15.22)	3.30 (17.18)	3.17 (18.08)
T_2	3.87 (14.17)	3.07 (9.32)	2.20 (6.77)	1.60 (6.4)	3.70 (16.87)	3.43 (18)	3.30 (18.88)
T_3	3.70 (12.17)	2.97 (8.38)	2.33 (8.27)	1.57 (6.2)	3.60 (15.67)	3.33 (17.5)	3.17 (18.08)
T_4	3.87 (14.17)	2.97 (8.38)	2.13 (6.27)	1.63 (6.6)	3.60 (15.67)	3.27 (17.13)	3.27 (18.68)
T_5	3.70 (12.17)	3.07 (9.32)	2.40 (8.77)	1.63 (6.6)	3.60 (15.67)	3.33 (17.4)	3.17 (18.08)
T_6	3.70 (12.17)	3.07 (9.32)	2.20 (6.17)	1.67 (6.8)	3.57 (15.22)	3.30 (17.08)	3.17 (19.08)
T_7	3.70 (12.17)	3.07 (9.32)	2.40 (8.9)	1.63 (6.6)	3.70 (16.87)	3.37 (17.75)	3.33 (18.68)
T_8	3.70 (12.17)	3.07 (9.32)	2.40 (8.77)	1.60 (6.4)	3.57 (15.22)	3.27 (16.88)	3.17 (18.08)
T_9	3.70 (12.17)	3.07 (9.32)	2.13 (6.27)	1.67 (6.8)	3.70 (16.87)	3.33 (17.35)	3.30 (18.88)
T_{10}	3.70 (12.17)	2.97 (8.38)	2.40 (8.9)	1.63 (6.6)	3.57 (15.22)	3.33 (17.48)	3.17 (18.08)
T_{11}	3.70 (12.17)	3.07 (9.32)	2.13 (6.27)	1.60 (6.4)	3.70 (16.87)	3.43 (18.13)	3.33 (19.08)
W	0.027^{NS}	0.045**	0.67**	0.851**	0.045**	0.67**	0.851**
Probability of significance (%)	72.7	0.01	0.01	0.01	0.01	0.01	0.01

MAS- Months After Storage
Figures in parenthesis are mean rank scores
W-Kendall's coefficient of concordance

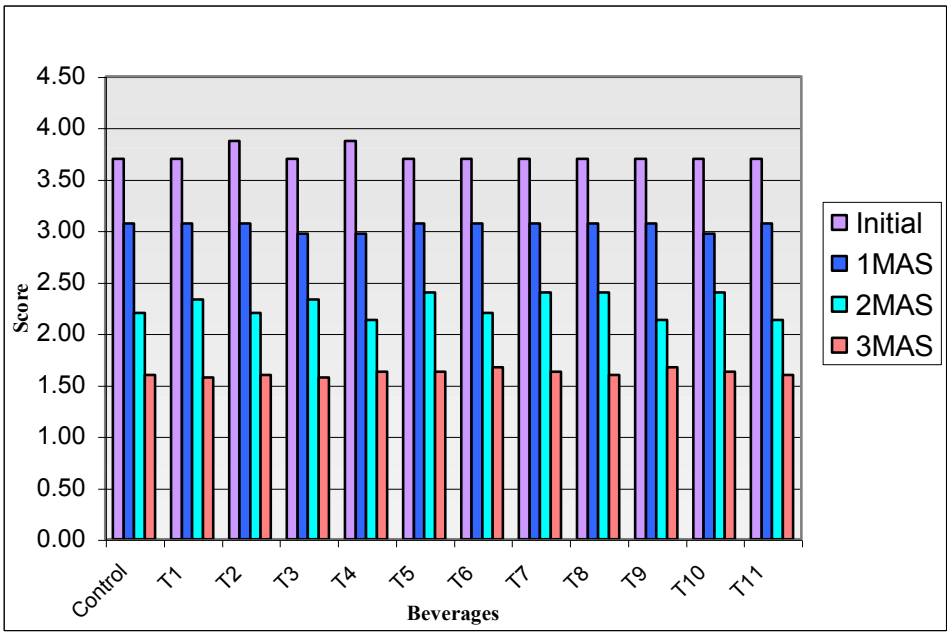

Fig 19. Score for flavour of RTS beverages stored under ambient condition

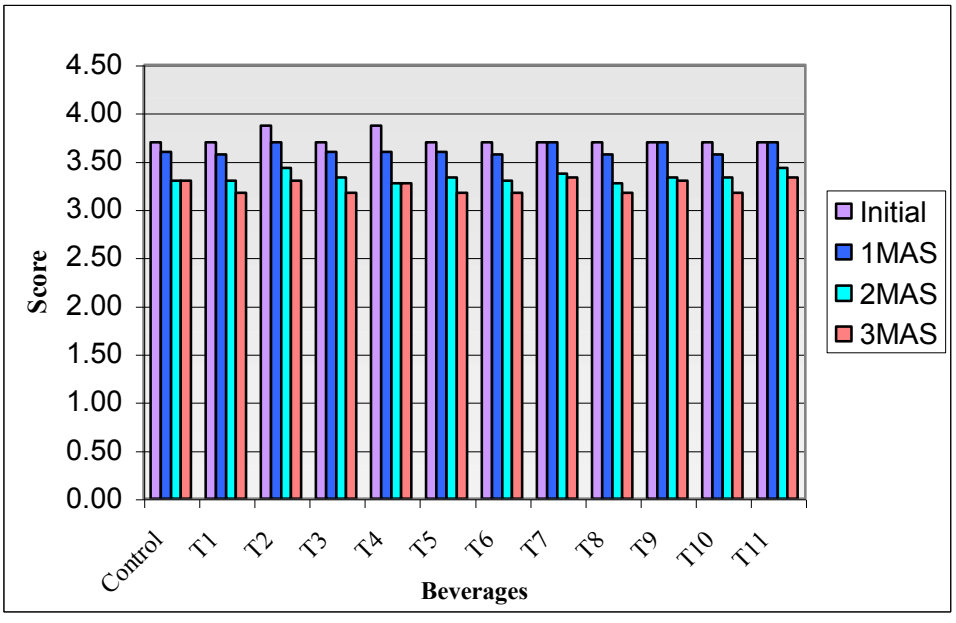

Fig 20. Score for flavour of RTS beverages stored under refrigerated condition

during initial period. But, during rest of the storage periods, W was found to be significant at 0.01 per cent probability level during different storage periods (Table 15).

Effect of storage on flavour of RTS beverages under two storage conditions is shown in Figure 19 and 20 respectively

4.2.2.4. Taste

The initial score for taste of RTS beverages varied from 3.70 to 3.87 with the highest score in T_1 and T_7 and lowest in all other beverages (Table 16).

Under ambient storage conditions, a gradual decrease in the scores was noticed after first month of storage and the score varied from 2.97 to 3.07. After second and third months of storage a sudden decrease in the score was observed in all beverages. The scores varied from 2.13 to 2.40 and 1.57 to 1.67 respectively after second and third months of storage. After second month of storage the highest score of 2.40 was observed in control, T_4 and T_6 and lowest score of 2.13 was observed in T_7.

Under refrigerated storage conditions all the RTS beverages registered a score of above three during the different storage periods. After third month of storage the scores of taste varied between 3.17 to 3.33 with the highest score in T_1 and T_8 and the lowest score in control, T_3, T_4, T_5, T_7 and T_{11}.

The mean rank scores for taste was found to be high in beverages stored under refrigerated conditions during different storage periods. After third month of storage the mean rank scores varied between 18.08 to19.08 and 6.2 to 6.8 under refrigerated and ambient storage conditions respectively. The highest score of 19.08 was observed in T_1 and T_8 followed by T_6, T_9 and T_{10} under refrigerated conditions.

Table 16. Effect of storage on the mean score for taste of RTS beverages

Beverages	Initial	Storage period in months					
		Ambient temperature			Refrigeration temperature		
		1MAS	2MAS	3MAS	1MAS	2MAS	3MAS
Control	3.70 (12.17)	3.07 (9.32)	2.40 (6.73)	1.63 (6.6)	3.57 (15.22)	3.30 (17.07)	3.17 (18.08)
T_1	3.87 (14.17)	2.97 (8.38)	2.20 (8.23)	1.60 (6.4)	3.70 (16.87)	3.37 (17.75)	3.33 (19.08)
T_2	3.70 (12.17)	3.07 (9.32)	2.33 **(6.73)**	1.67 (6.8)	3.60 (15.67)	3.27 (17.12)	3.27 (18.68)
T_3	3.70 (12.17)	3.07 (9.32)	2.20 (8.87)	1.63 (6.6)	3.57 (15.22)	3.27 (16.87)	3.17 (18.08)
T_4	3.70 (12.17)	3.07 (9.32)	2.40 (6.87)	1.60 (6.4)	3.57 (15.22)	3.33 (17.47)	3.17 (18.08)
T_5	3.70 (12.17)	3.07 (8.38)	2.20 (8.23)	1.57 (6.2)	3.57 (15.22)	3.30 (17.17)	3.17 (18.08)
T_6	3.70 (12.17)	2.97 (8.38)	2.40 (6.23)	1.63 (6.6)	3.70 (16.87)	3.33 (17.35)	3.30 (18.88)
T_7	3.87 (14.17)	3.07 (9.32)	2.13 (8.73)	1.60 (6.4)	3.60 (15.67)	3.33 (17.4)	3.17 (18.08)
T_8	3.70 (12.17)	3.07 (9.32)	2.20 (8.23)	1.57 (6.2)	3.70 (16.87)	3.43 (18.12)	3.33 (19.08)
T_9	3.70 (12.17)	3.07 (9.32)	2.33 **(6.73)**	1.60 (6.4)	3.60 (15.67)	3.30 (17)	3.30 (18.88)
T_{10}	3.70 (12.17)	3.07 (9.32)	2.33 (6.73)	1.67 (6.8)	3.70 (16.87)	3.43 (18)	3.30 (18.88)
T_{11}	3.70 (12.17)	3.07 (9.32)	2.20 (8.87)	1.63 (6.6)	3.60 (15.67)	3.33 (17.5)	3.17 (18.08)
W	0.027^{NS}	0.409**	0.663**	0.851**	0.409**	0.663**	0.851**
Probability of significance (%)	72.7	0.01	0.01	0.01	0.01	0.01	0.01

MAS- Months After Storage
Figures in parenthesis are mean rank scores
W-Kendall's coefficient of concordance

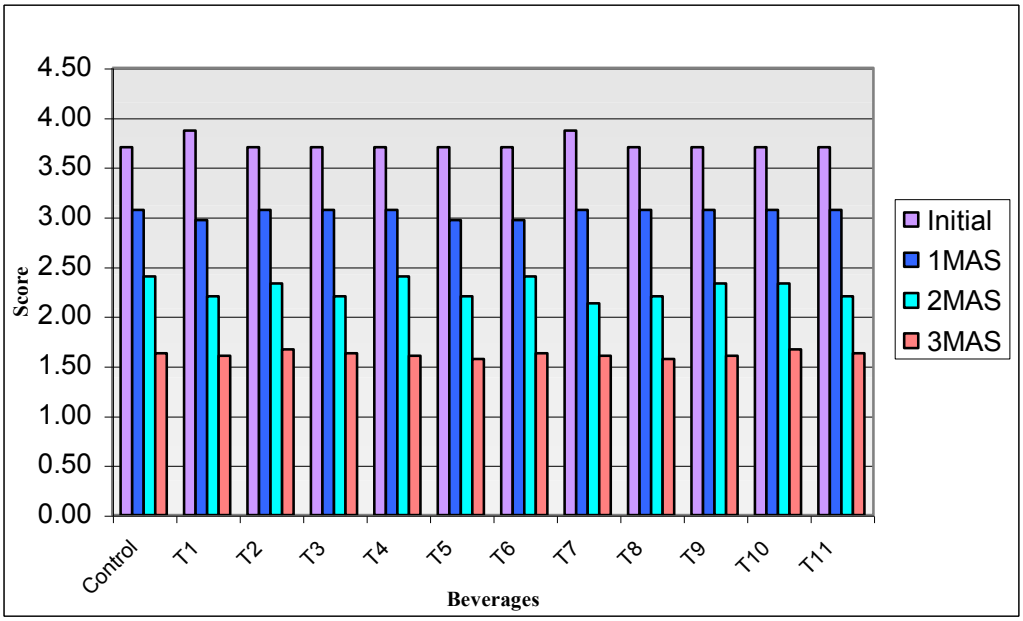

Fig 21. Score for taste of RTS beverages stored under ambient condition

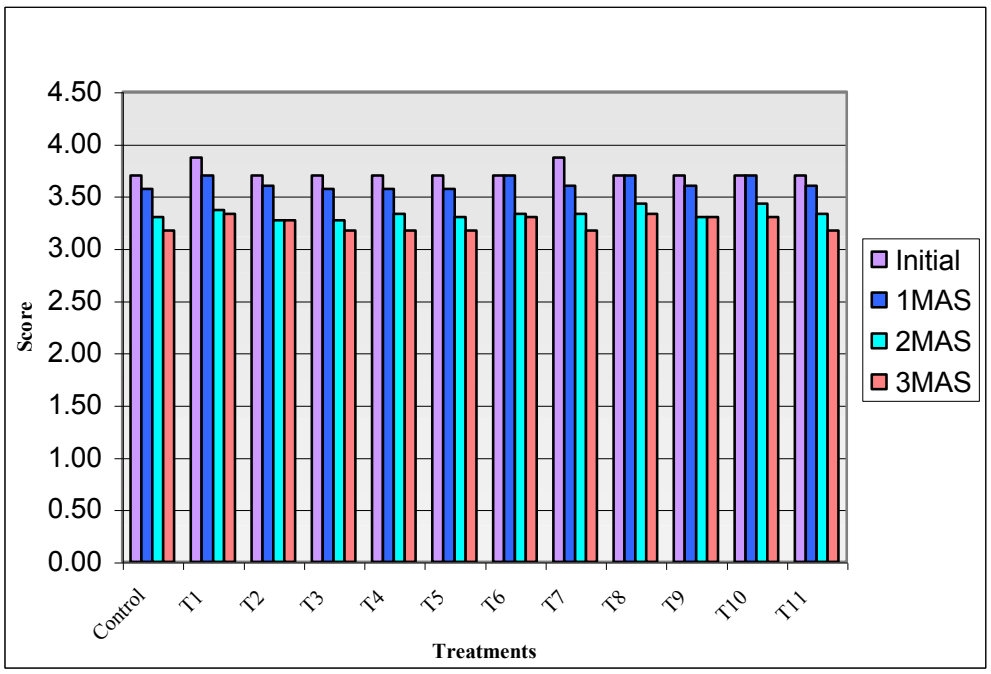

Fig 22. Score for taste of RTS beverages stored under refrigerated condition

Kendall's coefficient of concordance (W) registered for taste was worked out and it was found to be insignificant during initial period. But, after first, second, and third months of storage the W was found to be significant at 0.01 per cent level.

Effect of storage on taste of RTS beverages stored under ambient and refrigerated conditions is illustrated in Figure 21 and 22 respectively.

4.2.2.5. Overall acceptability

The overall acceptability score of RTS beverages during different storage periods under ambient and refrigerated conditions are furnished in Table 17.

The initial score for overall acceptability of RTS beverages varied from 3.70 to 3.87 with the highest score in T_8 and T_{11} and lowest in all other beverages. Under ambient storage condition, there was a gradual decrease in the score for overall acceptability in all the beverages with the advancement of storage period. The scores varied from 2.13 to 2.40 and 1.57 to 1.67 respectively after second and third months of storage. All beverages recorded an overall acceptability score of less than 2.5 after second month of storage and were found to be least acceptable after third month of storage under ambient conditions.

Under refrigerated storage conditions all RTS beverages registered an overall acceptability score of above three during the different storage periods. After third month of storage the score for overall acceptability varied from 3.17 to 3.33 with the highest score in beverages T_1 and T_8 followed by T_6, T_9 and T_{10}.

The mean rank scores registered for overall acceptability was found to be high in beverages stored under refrigerated storage conditions throughout the storage period. After third month of storage, the mean rank scores varied between

.

Table 17. Effect of storage on the mean score for overall acceptability of RTS beverages

Beverages	Initial	Storage period in months					
		Ambient temperature			Refrigeration temperature		
		1MAS	2MAS	3MAS	1MAS	2MAS	3MAS
Control	3.70 (12.17)	3.07 (9.32)	2.20 (6.9)	1.63 (6.6)	3.57 (15.22)	3.30 (17)	3.17 (18.08)
T_1	3.70 (12.17)	3.07 (9.32)	2.33 (8.27)	1.60 (6.4)	3.70 (16.87)	3.30 (17.18)	3.33 (19.08)
T_2	3.70 (12.17)	3.07 (9.32)	2.20 (6.77)	1.67 (6.8)	3.60 (15.67)	3.43 (18)	3.27 (18.68)
T_3	3.70 (12.17)	2.97 (8.38)	2.33 (8.27)	1.63 (6.6)	3.57 (15.22)	3.33 (17.15)	3.17 (18.08)
T_4	3.70 (12.17)	3.07 (9.32)	2.13 (6.27)	1.60 (6.4)	3.57 (15.22)	3.27 (17.13)	3.17 (18.08)
T_5	3.70 (12.17)	3.07 (9.32)	2.40 (8.77)	1.57 (6.2)	3.57 (15.22)	3.33 (17.4)	3.17 (18.08)
T_6	3.70 (12.17)	3.07 (9.32)	2.20 (6.77)	1.63 (6.6)	3.70 (16.87)	3.30 (17.08)	3.30 (18.88)
T_7	3.70 (12.17)	3.07 (9.32)	2.40 (8.9)	1.60 (6.4)	3.60 (15.67)	3.37 (17.75)	3.17 (18.08)
T_8	3.87 (14.17)	2.97 (8.38)	2.40 (8.77)	1.57 (6.2)	3.70 (16.87)	3.27 (16.88)	3.33 (19.08)
T_9	3.70 (12.17)	3.07 (9.32)	2.13 (6.27)	1.60 (6.4)	3.60 (15.67)	3.33 (17.35)	3.30 (18.88)
T_{10}	3.70 (12.17)	2.97 (8.38)	2.40 (8.9)	1.67 (6.8)	3.70 (16.87)	3.33 (17.48)	3.30 (18.88)
T_{11}	3.87 (14.17)	3.07 (9.32)	2.13 (6.27)	1.63 (6.6)	3.60 (15.67)	3.43 (18.13)	3.17 (18.08)
W	0.027^{NS}	0.409**	0.67**	0.851**	0.409**	0.67**	0.851**
Probability of significance (%)	72.7	0.01	0.01	0.01	0.01	0.01	0.01

MAS- Months After Storage
Figures in parenthesis are mean rank scores
W-Kendall's coefficient of concordance

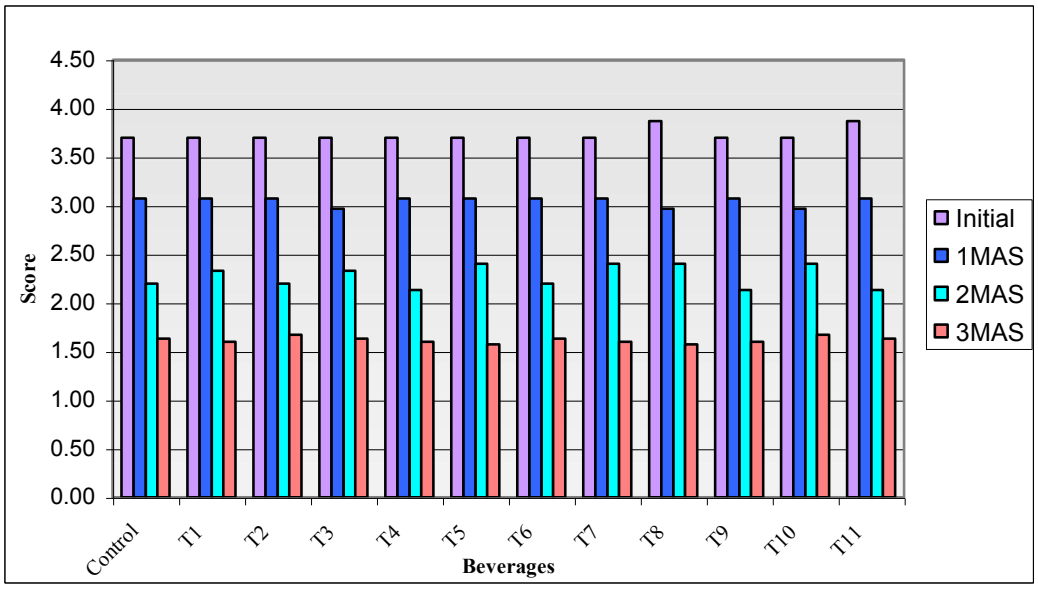

Fig 23. Score for overall acceptability of RTS beverages stored under ambient condition

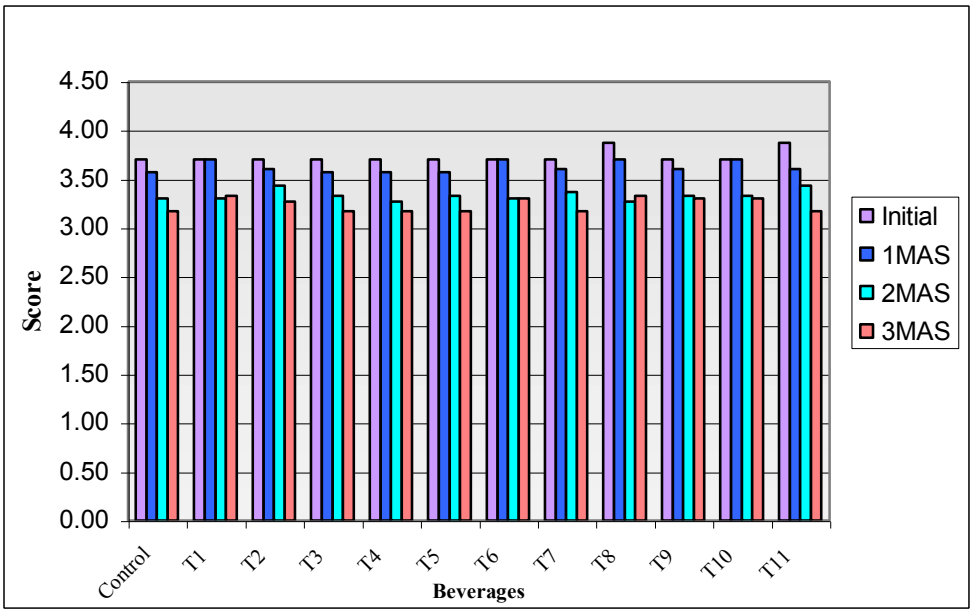

Fig 24. Score for overall acceptability of RTS beverages stored under refrigerated condition

18.08 to 19.08 under refrigerated condition and 6.2 to 6.8 under ambient storage conditions. The highest score of 19.08 was observed in T_1 and T_8 followed by T_6, T_9 and T_{10} (18.88) indicating that the beverages stored under refrigerated condition were acceptable even after three months of storage.

Kendall's coefficient of concordance (W) was worked out during different storage periods and it was found to be insignificant during initial period. But, after first, second and third months of storage the W was found to be significant. (Table 17) indicating significant agreement among judges.

Effect of storage on overall acceptability of RTS beverages stored under ambient and refrigerated conditions is shown in Figure 23 and 24 respectively

4.2.3. Enumeration of microbial count of beverages and changes during storage

The cashew apple RTS beverages were evaluated for bacteria, yeast, fungi and *E-coli* initially and at the end of the storage period. Yeast, fungi and *E-coli* were not detected in any of the beverages throughout the storage period.

4.2.3.1. Bacteria

Initially, the bacterial count was observed in beverages prepared with 100 per cent cashew apple juice (control) and in blended beverages prepared with orange (50:50), pineapple (50:50) and lime (75:25). The bacterial count in these three beverages varied between $0.30x10^{-6}$ cfu ml^{-1} to $0.41x10^{-6}$cfu ml^{-1} with the highest count in T_5 and lowest in T_3 and T_4 (Table 18).

After third month of storage, the bacterial growth was detected in all beverages both under ambient and refrigerated storage conditions. Under ambient condition the count varied from 2.5 to 6.6 $x10^{-6}$cfu ml^{-1} with the highest count in

Table 18. Bacterial population of fruit beverages during ambient and refrigerated storage.

Beverages	Bacteria $x10^{-6}$ $cfuml^{-1}$		
	Storage period in months		
	Initial	Ambient temperature (Final)	Refrigeration temperature (Final)
Control	0.38 (7)	6.4 (32.5)	3.16 (27.17)
T_1	ND	3.33 (13.67)	2.9 (13.83)
T_2	ND	3.1 (10.5)	3 (15.17)
T_3	0.30 (3)	6.6 (33)	5.3 (34)
T_4	0.30 (7.83)	5.3 (27.17)	4.3 (27.5)
T_5	0.41 (8.17)	5.9 (29.33)	4.9 (32.33)
T_6	ND	3.8 (19.17)	3.6 (22.17)
T_7	ND	3.2 (13.33)	3 (18.33)
T_8	ND	3.63 (17.33)	2.73 (10.33)
T_9	ND	3.1 (12.17)	2.7 (10.5)
T_{10}	ND	2.5 (4.67)	2.4 (7.17)
T_{11}	ND	2.93 (9.17)	2.2 (3.5)
Kruskal wallis test $p<0.05$	0.265	0.001**	

Significant at 5 % level
Figures in parenthesis are mean rank scores
ND- Not Detected

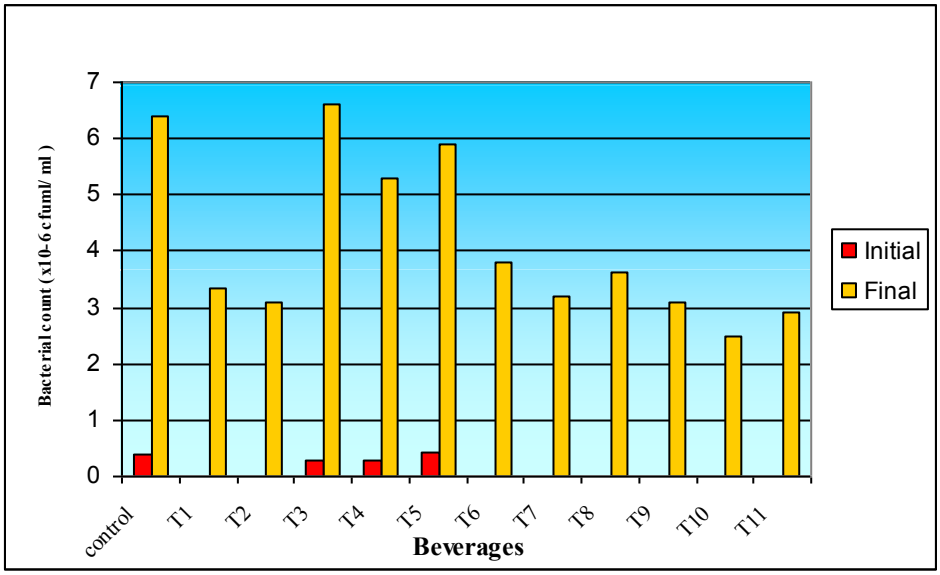

Fig 25. Bacterial population of RTS beverages stored under ambient condition (x10^{-6} $cfuml^{-1}$)

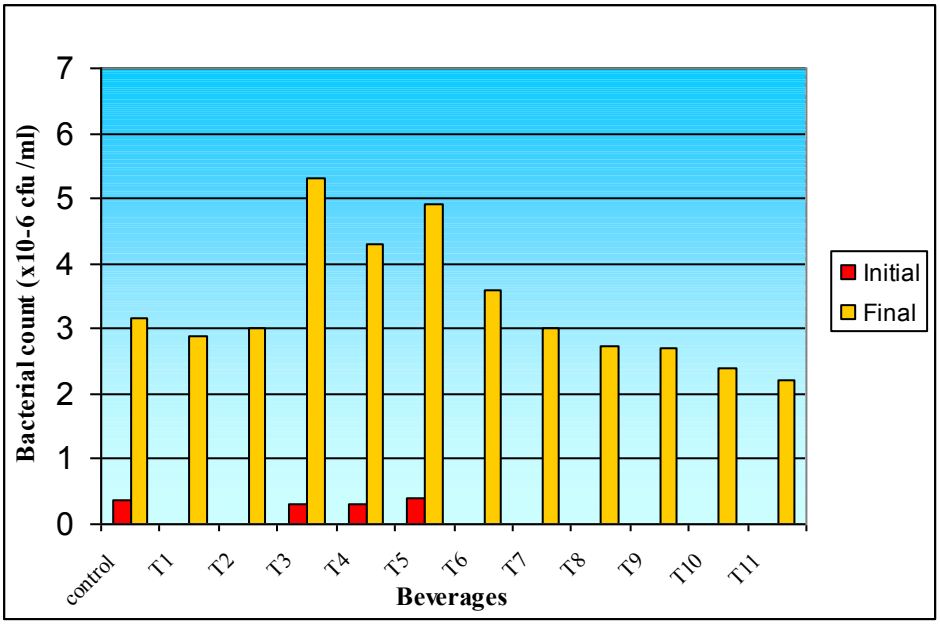

Fig 26. Bacterial population of RTS beverages stored under refrigerated condition (x10^{-6} $cfuml^{-1}$)

T_3 followed by control and T_5l. The lowest bacterial count was observed in the beverage prepared by blending cashew apple and lime juice with one drop of ginger extract (T_{10}).

In the beverages stored under refrigerated condition bacterial count at the end of the storage varied from 2.2 to 5.3 $x10^{-6}$cfu ml^{-1}. The lowest bacterial growth was observed in T_{11} and highest in T_3.

The variation observed in the bacterial count of beverages at the end of the storage was found to be statistically significant. The effect of storage on the bacterial population of different beverages is illustrated in Figure 25 and 26 respectively.

4.3.Availability – Acceptability ratio (A-A ratio) of the beverages

The Availability –Acceptability ratio was computed as the ratio of the sum of the respective content of vitamin C, β carotene and overall acceptability in different beverages to the tannin content. Since, a lower tannin content in beverages is more preferable, the higher the A-A ratio, more preferred is the beverage.

During the initial period of storage, the A-A ratio of the beverages varied from 726.06 to 1357.35 (Table 19). Highest A-A ratio was observed in the control beverage prepared with equal proportions of cashew apple juice and orange juice and one drop of ginger (T_6). The RTS beverages prepared with cashew apple juice and orange juice (50:50) (T_3), and cashew apple juice (50%) and pineapple juice (50%) with one drop of ginger (T_8) and also with one drop of cardamom (T_9) had an A-A ratio of 1300.20, 1277.44 and 1170.28 respectively. Lowest ratio was observed in the beverage prepared with 100 per cent cashew apple juice (control).

Table 19 Availability- Acceptability ratio of RTS beverages during the initial period of storage

Beverages	Vitamin C (mg/100ml)	β-carotene (μg/100ml)	Overall accepta-bility	Tannin (mg/100 ml)	A-A ratio	Rank
Control	22.9	21.32	3.70	0.066	726.06	12
T_1	23.08	26.60	3.70	0.059	904.80	10
T_2	21.92	15.24	3.70	0.052	785.77	11
T_3	17.14	23.37	3.70	0.034	1300.20	2
T_4	17.4	14.66	3.70	0.036	977.06	9
T_5	20	22.99	3.70	0.046	1007.77	8
T_6	17.14	25.31	3.70	0.034	1357.35	1
T_7	20.93	16.91	3.70	0.033	1143.84	6
T_8	17.14	13.91	3.87	0.027	1277.44	3
T_9	17.14	20.51	3.70	0.031	1170.28	4
T_{10}	20	19.37	3.70	0.041	1050.41	7
T_{11}	20	20.72	3.87	0.039	1153.10	5

After first month of storage under ambient condition, the A-A ratio varied from 677.48 to 1234.50 (Table 20). The highest ratio was found to be in beverage prepared with cashew apple juice and pineapple juice (50:50 + one drop of cardamom) (T_9) followed by cashew apple juice and lime juice (75:25) (T_5) and cashew apple juice and lime juice (85:15+one drop of cardamom) (T_{11}). The lowest A-A ratio was observed in beverage prepared with 100 per cent cashew apple juice with the addition of one drop of cardamom extract (T_2)

All the beverages were found to be unacceptable with particular reference to taste and flavour after second and third months of storage under ambient condition. So A-A ratio was not calculated during these periods. But, under refrigerated storage condition all the beverages were found to be acceptable even after third month of storage. The A-A ratios of beverages during different storage periods under refrigerated condition are given in Tables 21-23. After first month of storage the A-A ratio varied from 765.39 to 1500.15 (Table 21). The highest ratio was observed in beverage prepared with cashew apple juice and pineapple juice (50:50+ginger extract) (T_8) followed by cashew apple juice and pineapple juice (50:50+cardamom extract) (T_9) and cashew apple juice and lime juice (75:25+ginger extract) (T_{10}). The lowest A-A ratio of 765.39 was observed in beverages prepared with 100 per cent cashew apple juice with the addition of one drop of ginger extract (T_1).

After second month of storage under refrigerated condition the A-A ratio of RTS beverages varied from 873 to 1511.31 (Table 22). The lowest ratio was observed in control (100 % cashew apple juice) and highest in T_8 (cashew apple juice and pineapple juice (50:50) +ginger extract).

After third month of storage the A-A ratio in the beverages varied from 925.08 to 1707.34 (Table 23). The highest ratio was observed in T_5 (cashew apple juice and lime juice 75:25) followed by T_6 (1623.05) (cashew apple juice and orange juice 50:50 +ginger extract) and T_7 (1544.92) (cashew apple juice and

Table 20 Availability- Acceptability ratio of RTS beverages after first month of storage under ambient storage condition

Beverages	Vitamin C (mg/100 ml)	β-carotene (μg/100 ml)	Overall aceceptability	Tannin (mg/100 ml)	A-A ratio	Rank
Control	9.81	20.25	3.07	0.044	752.80	9
T_1	16.66	20.43	3.07	0.054	748.32	10
T_2	13.06	12.55	3.07	0.042	677.48	12
T_3	12.54	16.37	2.97	0.03	1062.44	7
T_4	10.41	10.66	3.07	0.034	710.00	11
T_5	14.5	17.36	3.07	0.029	1218.26	2
T_6	12.54	18.63	3.07	0.032	1081.26	5
T_7	12.66	14.57	3.07	0.031	908.80	8
T_8	12.72	12.54	2.97	0.026	1085.64	4
T_9	14.5	15.35	3.07	0.027	1234.50	1
T_{10}	14.5	16.73	2.97	0.032	1068.65	6
T_{11}	14.5	18.64	3.07	0.033	1108.47	3

Table 21 Availability- Acceptability ratio of RTS beverages after first month of storage under refrigerated storage condition

Beverages	Vitamin C (mg/100ml)	β-carotene (μg/100 ml)	Overall aceceptability	Tannin (mg/100 ml)	A-A ratio	Rank
Control	18.98	21.10	3.57	0.054	808.33	11
T_1	18.09	24.13	3.70	0.060	765.39	12
T_2	17.75	13.60	3.60	0.042	832.14	10
T_3	15.2	20.46	3.57	0.032	1213.09	4
T_4	15.09	13.88	3.57	0.032	956.86	9
T_5	18.18	20.3	3.57	0.036	1157.25	7
T_6	15.09	19.6	3.70	0.032	1199.69	5
T_7	17.69	16.26	3.60	0.033	1126.50	8
T_8	16.36	13.44	3.70	0.022	1500.15	1
T_9	16.36	18.42	3.60	0.029	1308.52	2
T_{10}	18.18	17.54	3.70	0.032	1244.95	3
T_{11}	17.04	18.46	3.60	0.033	1173.10	6

Table 22 Availability- Acceptability ratio of RTS beverages after second month of storage under refrigerated storage condition

Beverages	Vitamin C (mg/100 ml)	β-carotene (μg/100ml)	Overall acecepta bility	Tannin (mg/100 ml)	A-A ratio	Rank
Control	17.14	20.3	3.30	0.047	873.00	12
T_1	16.36	21.27	3.30	0.037	1116.18	9
T_2	17.18	12.87	3.43	0.034	975.34	11
T_3	14.09	18.42.	3.33	0.031	1156.34	8
T_4	14.5	12.91	3.27	0.031	1000.22	10
T_5	16.36	19.36	3.33	0.032	1207.84	6
T_6	14.5	16.1	3.30	0.026	1287.34	5
T_7	16.63	15.48	3.37	0.026	1347.47	4
T_8	15.09	12.37	3.27	0.021	1511.31	1
T_9	15.14	15.48	3.33	0.025	1376.62	2
T_{10}	16.36	16.46	3.33	0.026	1372.78	3
T_{11}	16.36	16.33	3.43	0.030	1190.88	7

Table 23 Availability- Acceptability ratio of RTS beverages after third month of storage under refrigerated storage condition

Beverages	Vitamin C (mg/100 ml)	β-carotene (μg/100ml)	Overall aceceptability	Tannin (mg/100 ml)	A-A ratio	Rank
Control	16.18	18.89	3.17	0.041	925.08	12
T_1	15.14	18.69	3.33	0.028	1343.25	6
T_2	15.16	12.25	3.27	0.031	1000.22	11
T_3	13.2	14.43	3.17	0.029	1074.30	10
T_4	13.2	12.35	3.17	0.026	1104.62	9
T_5	14.5	18.76	3.17	0.021	1707.34	1
T_6	13.2	15.42	3.30	0.020	1623.05	2
T_7	14.21	14.03	3.17	0.020	1544.92	3
T_8	12.72	11.49	3.33	0.20	1271.08	8
T_9	14.5	14.53	3.30	0.022	1469.55	4
T_{10}	15.14	15.32	3.30	0.024	1426.48	5
T_{11}	15.09	15.16	3.17	0.024	1319.21	7

orange juice 50:50 +cardamom extract). The lowest ratio of 925.08 was obtained in beverage prepared with 100per cent cashew apple juice (control).

The Availability-Acceptability ratio computed for the beverages during each storage period was ranked in the descending order so as to find out the most preferred beverage up to the end of storage in terms of nutritional quality and acceptability with less tannin content (Table 24). Among the twelve beverages, the beverage prepared by mixing 75 per cent cashew apple and 25 per cent lime juice without any spice extract (T_5), though secured eighth rank during the initial period with an A-A ratio of 1007.77, under ambient condition was ranked as the second best after first month of storage (A-A ratio 1218.26). Under refrigerated condition also A-A ratio of T_5 improved during each storage period and secured seventh, sixth and first ranks after first, second and third months of storage respectively. So, the beverage prepared by blending 75 per cent cashew apple and 25 per cent lime juice without any spice extracts can be ranked as the best when stored for a month under ambient condition and up to three months under refrigerated condition.

The beverage prepared by mixing equal proportions of cashew apple and pineapple juices and one drop of cardamom extract (T_9) though secured fourth rank during the initial period of storage was ranked as the best after first month of storage under ambient condition. At refrigerated condition also the rank of this beverage improved up to the second month of storage and was ranked as the second best after first and second months of storage. However, after third month of storage T_9 obtained fourth rank on the basis of A-A ratio. So, T_9 also can be considered best when stored for a month under ambient condition and up to two months under refrigerated condition.

The beverages prepared with equal quantity of cashew apple and pineapple juices with one drop of ginger extract (T_8) improved the A-A rank under refrigerated condition and was found to be the best both after first and second

Table 24. Ranks of beverages on the basis of Availability-Acceptability ratio

Beverages	Initial	Ambient condition	Refrigeration condition		
		1MAS	1MAS	2MAS	3MAS
Control	12	9	11	12	12
T_1	10	10	12	9	6
T_2	11	12	10	11	11
T_3	2	7	4	8	10
T_4	9	11	9	10	9
T_5	8	2	7	6	1
T_6	1	5	5	5	2
T_7	6	8	8	4	3
T_8	3	4	1	1	8
T_9	4	1	2	2	4
T_{10}	7	6	3	3	5
T_{11}	5	3	6	7	7

MAS- Months After Storage

months of storage. They secured the highest A-A scores of 1500.15 and 1511.31 respectively after first and second months of storage. However, after third month T_8 secured eighth rank with an A-A ratio of 1271.08.

The beverage prepared by blending cashew apple juice and lime juice in the proportion 75:25 (T_{10}) with ginger extract with the initial A-A rank of seven improved the rank order after first and second months of storage under refrigerated condition and secured third rank during both storage periods. So T_8 and T_{10} can be considered best up to two months when stored under refrigerated condition.

The beverage prepared with 100 per cent cashew apple juice secured the lowest rank order initially (12^{th}), after second and third months of storage under refrigerated condition. The beverage prepared with 100 per cent cashew apple juice with ginger (T_1) and cardamom extracts (T_2) also did not improve the rank order during storage at ambient condition and during the first two months of storage under refrigerated conditions.

The beverages prepared by blending cashew apple and orange juice with and without spice extracts also did not show any improvement in the rank under ambient storage condition (T_3, T_6 and T_7). Under refrigerated condition the rank order of T_3 also deteriorated up to the end of storage. In T_6 and T_7 after third month of storage under refrigerated condition slight improvement was noticed.

The beverages prepared with cashew apple juice and pineapple juice without spice extracts (T_4) which secured ninth rank initially also did not show any improvement in the rank during storage under both storage conditions.

The beverage prepared with 85 per cent cashew apple and 15 per cent lime juice with cardamom extract also did not improve the rank order during storage under refrigerated conditions. This beverage secured fifth rank initially and sixth

and seventh ranks during different periods of storage under refrigerated conditions.

Computation of the cost of RTS beverages

The production cost of cashew apple RTS beverages was computed for one bottle of 200ml capacity including cost of bottle,cap and fuel charges. The details are presented in Appendix II.

Cost of production of RTS beverages varied from Rs.3.17 to Rs. 4.21.The lowest cost of production was found to be in the beverage prepared exclusively with cashew apple without any flavouring agent and the highest cost was found to be in beverage prepared with equal proportion of cashew apple juice and orange juice with the addition of one drop of ginger extract.

Discussion

5. DISCUSSION

The results of the study entitled "Standardisation of blended cashew apple RTS beverages" are discussed in this chapter.

5.1.Organoleptic evaluation of blended RTS beverages

Thirty four RTS beverages were prepared using cashew apple juice as the base and mixing with pineapple, orange and lime juices at 50, 25 and 15 per cent levels with and without volatile ginger and cardamom extracts at different combinations. Organoleptic evaluation of the beverages was carried out using score cards by a panel of ten judges.

Among the 34 treatments, all beverages except B_6 and B_{31} secured a score of above three for all quality attributes like appearance, colour, flavour, taste and overall acceptability (Table 4). The RTS beverages prepared with 100 per cent cashew apple juice with three drops of cardamom extract (B_6) and cashew apple and lime juice at equal proportions with one drop of cardamom extract (B_{31}) had an overall acceptability score of 2.78 and 2.92 respectively. The treatment B_6 had a score in the range of 2.50 to 2.80 for different quality attributes and lowest rank scores for mean and overall acceptability. B_{31} also had a lesser score for flavour and colour. Hence, from the thirty four beverages, all beverages except B_6 and B_{31} could be considered as acceptable to the judges.

Among the twelve different groups of beverages studied for organoleptic qualities along with the control prepared with 100 per cent cashew apple juice, one beverage from each group was selected for storage study on the basis of the highest scores obtained for different quality attributes, mean acceptability and overall

acceptability as well as the rank scores obtained for mean and overall acceptability. Thus, twelve beverages including control were selected for storage study.

Though, beverages were prepared with 100 per cent cashew apple juice with addition of 1, 2 and 3 drops of ginger extract (Group 2) and cardamom extract (Group 3), the beverages prepared by adding one drop of ginger as well as cardamom extract were selected for storage study based upon the highest scores obtained for almost all quality attributes and overall acceptability. These two beverages also secured the highest mean rank scores. Among the three different concentrations of ginger and cardamom extracts the addition of lowest concentration of spice extracts was found to be acceptable to the judges. Similar to the present finding, in a study conducted by Nath *et al*. (2005), highest scores for sensory attributes was observed in beverages prepared with lowest proportion of ginger juice.

Among the different beverages prepared by blending cashew apple juice with orange juice at three different proportions without any spice extracts (Group 4) and also by adding one drop of ginger (Group 7) and one drop of cardamom (Group 8) extracts, the beverages prepared with equal proportions of cashew apple and orange juice without any spice extracts (B_7) in group 4 and with one drop of ginger extract (B_{16})in group 7 secured the highest scores for all sensory attributes as well as rank scores. However, in group 8, the beverage prepared using 75 per cent cashew apple juice, 25 per cent orange juice and one drop of cardamom extract (B_{20}) obtained the highest score for various quality attributes, over all acceptability and mean and over all acceptability rank scores. In these three groups of beverages prepared by blending cashew apple juice and orange juice at different proportions, higher proportion of cashew apple juice was found to be more acceptable to the judges when cardamom extract was added and equal proportion of two juices were more acceptable when ginger extract was added and also without any spice extracts. In a

study conducted in blended cashew apple and orange beverages, Inyang and Abah (1997) also observed higher proportion of cashew apple juice (60%) as highly acceptable.

Among the blended beverages prepared using cashew apple and pineapple juice at different proportions without adding spice extracts (Group 5) and by adding ginger extract (Group 9) and cardamom extract (Group 10), the beverages with equal proportions of cashew apple and pineapple juices were found to be highly acceptable to the judges from all the three groups. Contrary to this, Tripathy *et al*. (1992) observed better acceptability in blended beverages prepared with higher proportion of pineapple (90%) juice and lower proportions of (10%) guava juice, thus indicating that cashew apple juice is better accepted by the judges when blended at equal proportions with pineapple juice with and without spice extracts.

Among the blended beverages prepared with cashew apple and lime juice at three different proportions of 50:50, 75:25 and 85:15 without adding any spice extracts (Group 6), with one drop of ginger extract (Group 11) and one drop of cardamom extract (Group 12) higher percentage of cashew apple juice was preferred by the judges in all the three combinations. The proportions of 75 per cent cashew apple juice and 25 per cent lime juice without any spice extract (B_{14}) and with one drop of ginger extract (B_{29}) in group 6 and 11 respectively secured the highest score for different quality attributes, over all acceptability and mean and overall acceptability rank scores. From group 12, still higher per cent of cashew apple juice (85%) and 15 per cent lime juice with one drop of cardamom extract was preferred by the judges for various sensory attributes.

When the scores obtained for the blended beverages selected for storage study were compared with the beverage prepared with 100 per cent cashew apple

juice (control) almost all beverages secured a higher score either for mean acceptability or for overall acceptability or for both. All blended beverages secured higher rank scores for mean and overall acceptability also than the beverages prepared with 100 per cent cashew apple juice with and without adding spice extracts. In a study conducted by Vaidya *et al*. (1998) blended beverages prepared with guava and pomegranate as well as guava and ber secured the highest scores for sensory attributes than the beverages prepared either with 100 per cent pomegranate or 100 per cent ber juice.

5.2.Chemical composition of RTS beverages during storage

The RTS beverages selected from each group were prepared again as per the FPO specifications and stored under ambient and refrigerated storage conditions for a period of three months. Each beverage was evaluated for chemical constituents and organoleptic qualities at monthly intervals. The growth of bacteria, fungi and yeast was also evaluated initially and at the end of storage.

The acidity of all RTS beverages was found to be 0.32 per cent during the initial period of the experiment, and no change in the acidity was observed after one month of storage irrespective of storage conditions (Table 6). However, in RTS beverages stored under ambient conditions an increase in the acidity was observed after second month of storage. The acidity of beverages increased up to 0.64 per cent after second month of storage and at the end of storage further increase in the acidity was also observed in almost all beverages except T_1, T_2 and T_{10}. The maximum increase in acidity was observed in T_3 and T_4 followed by control and T_5 at the end of storage. The increase in acidity of beverages observed under ambient conditions may be due to the interaction of organic acids present in the beverages. Sogi and Singh (2001) also observed an increase in the acidity from 0.39 to 0.51 per cent in kinnow

RTS beverages during storage at ambient temperature due to the release of organic acids. Sahu *et al.* (2005) also noticed an increase in the acidity in mango beverages with the progress of storage period due to the formation of other organic acids by ascorbic acid inherently present in mango pulp. Palaniswamy and Muthukrishnan (1974), Hema (1997), Sudhagar (2001), Saikia and Saikia (2002), Joy (2003), Shere *et al*. (2003), Naik *et al*. (2003) and Lakshmi and Begum (2004) also observed an increase in the acidity of fruit beverages prepared with lemon, jamun, pear, ou-tenga, roseapple, amla, cherry and *Optuntia dilleni* during storage at ambient conditions.

However, contrary to the present finding, a decreasing trend in acidity was observed in kinnow mandarin juice (Sarmah *et al*., 1981 and (Ghorai and Khurdiya, 1998), mandarin, sweet orange and lemon juices (Mehta and Bajaj, 1983), spiced tamarind RTS beverages (Manjula *et al*., 2003) jamun beverage (Kannan and Thirumaran, 2004) and lime-aonla spiced beverages (Deka *et al*., 2004) during storage at ambient storage conditions. Nath *et al*. (2005) also observed a gradual and consistent decrease in the acidity of ginger-kinnow squash during storage at room temperature and indicated that the decrease occurred due to the interaction with the organic constituents of juices induced by temperature and action of enzymes. Barwal *et al*. (2005) also reported a decrease in the acidity of bitter gourd RTS beverages during storage under ambient storage conditions due to the co-polymerisation of organic acids during storage .

Under ambient storage conditions the rate of increase in acidity was found to be lower in RTS beverages prepared by adding spice extracts. This might be due to the inhibitory action of spices in the release of organic acids.

In the RTS beverages stored under refrigerated conditions, a gradual decrease in the acidity of almost all beverages except T_2, T_3 and T_{11} was observed. In

T_2, T_3 and T_{11} acidity remained stable till the end of storage period. This decrease in acidity might be due to the conversion of some amount of acids to sugar (Babsky *et al*., 1986). Deka *et al*. (2004) also reported a decrease in acidity in lime-aonla spiced beverage during six months of storage at cool chamber (10-29.6°C) and at low temperature (4±1°C). A decrease in the acidity of heat processed kinnow mandarin juice stored at low temperature was reported by Ghorai and Khurdiya (1998) with the increase in storage period.

The TSS content of RTS beverages varied from 14-15°brix initially and the content increased up to 15.2°brix (T_8) at ambient temperature and 15°brix (T_8) at refrigerated temperature by the end of storage period (Table 7).

After first month of storage under ambient conditions, an increase in the TSS content was observed except in control, T_1 and T_9. The increase in the TSS content might be due to the hydrolysis of polysaccharides into mono and disaccharides. An increase in the TSS content was also reported by Wasker and Khurdiya (1987), Mehta and Bajaj (1983), Jain *et al*. (2003), Garaude *et al*. (1995), Attri *et al*. (1998), Pande and Singh (1999), Saikia and Saikia (2002), Joy (2003) and Kotecha and Kadam (2003), Manjula *et al*. (2003) Naik *et al.* (2003) and Shere *et al*. (2003) in citrus juice, phalsa squash, jamun squash and juice, sand pear blended juice, guava beverages, Ou-tenga squash, sweet orange juice, rose apple squash, tamarind syrup, spiced tamarind RTS beverages, cherry squash, amla RTS beverages under ambient storage conditions.

TSS content remained constant throughout the storage period in T_1 and control. Stability in TSS content in papaya-mango blended beverages (Kalra *et al*., 1991), Jamun squash (Hema, 1997), jack fruit RTS beverage (Krishnaveni *et al*., 2001), Palmyra RTS beverage (Daniel *et al*., 2003) and in passion fruit RTS beverage

(Hegazi, 1985) was also reported. After second and third months of storage under ambient conditions, a slight decrease in the TSS content was observed in almost all beverages. In T_8 and T_9 the TSS remained constant during the rest of the storage periods. This slight decrease in TSS could be due to the chemical interaction of the organic constituents induced by temperature as suggested by Mehta and Bajaj (1983)., Lotha (1992) and Ghorai and Khurdiya (1998). Marginal decrease in the TSS content of RTS mango beverages was also reported by Saini *et al*. (1996) under ambient storage conditions.

Under refrigerated storage condition, no change in TSS content of the beverages was noticed after first month of storage, but during the later part of the storage a slight increase in the TSS content of most of the beverages occurred. This slight increase in TSS during storage might be due to the hydrolysis of polysaccharides into mono and soluble disaccharides as reported by Meyer (1960) or due to the conversion of some amount of acids to sugars (Babsky *et al*., 1986). In control, T_1, T_4, T_6, T_7 and T_9 the TSS content remained constant till the end of the storage period.

Kotecha and Kadam (2003) also observed an increase in the TSS content in tamarind syrup and concentrates during the storage period of 180 days both at ambient and at lower temperature. An increase in the TSS content was also observed in lime-aonla spiced beverages (Deka *et al*., 2004), mango-pineapple spiced beverages (Deka *et al*., 2005) and in ginger-kinnow squash (Nath *et al*., 2005) during storage under low temperature.

The reducing sugar content of the RTS beverages varied from 6.76 to 9.8 per cent initially and an increase in the reducing sugar content of the beverages was observed with the advancement of the storage period up to three months under

ambient storage conditions (Table 8). After first month of storage, the reducing sugar content in almost all beverages increased up to 10.2 to 12.1 per cent. After second and third months of storage also gradual increase in the reducing sugar content of the beverages was observed and at the end of the storage period the reducing sugar content varied from 12.2 to 14.28 per cent. The increase in reducing sugar could be due to the inversion of sucrose to glucose and fructose (Lotha, 1992 and Pruthi *et al*., 1984) or due to the breakdown of polysaccharides into simple sugars.

Saini *et al*. (1996), Jain *et al*. (1988), Dhaliwal and Hira (2001), Sogi and Singh (2001), Saikia and Saikia (2002) and Joy (2003) also observed an increase in reducing sugar content in mango beverage, litchi squash, carrot-beet root juice, kinnow RTS beverage, Ou-tenga squash and rose apple squash during storage at room temperature. Similar findings of increase in reducing sugar were also reported by Khurdiya and Roy (1985), Wasker and Khurdiya (1987), Hilda and Manimegalai (1996), Hema (1997), Sudhagar (2001), Manjula *et al*. (2003), Naik *et al.* (2003), Kannan and Thirumaran (2004), Deka *et al*. (2004), Barwal *et al*. (2005) and Deka *et al*. (2005) jamun nectar, phalsa, amla and jamun beverages, pear squash, spiced tamarind RTS beverages, cherry squash, lime-aonla spiced beverages, bitter gourd RTS beverage and mango-pineapple spiced beverages during storage under ambient storage conditions.

At refrigerated storage conditions also a gradual increase in the reducing sugar content was observed in control and T_1 throughout the storage period. Though there was a gradual decrease in the reducing sugar content after first month of storage, a gradual increase in the reducing sugar content was observed up to the end of the storage period from second month onwards in all the beverages. At the end of the storage period the reducing sugar content varied from 7.14 to 12.2 per cent. Deka *et al*. (2004) and Deka *et al*. (2005) also reported an increase in the reducing sugar

content in lime-aonla and mango-pineapple spiced beverages during storage at cool chamber and at low temperature.

The rate of increase in the reducing sugar content was found to be higher in the beverages stored under ambient condition. This might be due to the faster hydrolysis of sucrose in beverages stored under ambient conditions. Ghorai and Khurdiya (1998) also observed an increase in the reducing sugar content of kinnow mandarin juice during storage both at ambient and at low temperature and an increased rate of changes in beverages stored at ambient temperature.

Initially, the total sugar content of the RTS beverages varied from 11.11 per cent to 13.16 per cent (Table 9). After first month of storage a decrease in the total sugar content of all the beverages stored at ambient condition was noticed which varied from 10.2 to 12.1 per cent. This decrease in total sugar content might be due to the reactions of sugars with aminoacids. Beerh *et al*. (1989), Saini *et al*. (1996), Manjula *et al*. (2003) and Kannan and Thirumaran (2004) also observed a decrease in the total sugar content in mango beverages, spiced tamarind RTS beverages and jamun beverages. However, during the later part of storage, the total sugar content of beverages increased gradually and at the end of the storage period the total sugar content of all beverages was found to be higher than the initial value. This increase in the total sugar content might be due to the conversion of some amount of acids to sugars (Babsky *et al*., 1986).

Jain *et al*. (1988), Attri *et al*. (1998), Joy (2003) and Kotecha and Kadam (2003) reported an increase in the total sugar content of litchi squash, sand pear juice, rose apple squash and tamarind syrup under ambient storage conditions. Deka *et al*. (2004) and Deka *et al*. (2005) also observed an increase in the total sugar content in

lime-aonla and mango-pineapple spiced beverages respectively under ambient storage conditions.

Under refrigerated storage conditions, a gradual decrease in the total sugar content of the beverages was noticed after second and third months of storage. At the end of storage, the total sugar content of all beverages except T_{11} was found to be lower than the initial value and it varied from 11.09 to 11.9 per cent. Contrary to the present findings Deka *et al*. (2004) and Deka *et al*. (2005) observed an increase in the total sugar content in lime-aonla and mango-pineapple spiced beverage during storage under low temperature.

At the end of storage, the total sugar content of the beverage stored at ambient conditions was found to be higher than those stored at low temperature. This higher total sugar content of the beverages stored at room temperature might due to rapid hydrolysis of polysaccharides at higher temperature and subsequent inversion to reducing sugar.

A gradual decrease in the vitamin C content was observed in all beverages with the advancement of storage period both at ambient and refrigerated storage conditions (Table 10). However, higher percentage of vitamin C was retained in beverages stored under low temperature.

The vitamin C content of the beverages varied from 17.14 to 23.08 mg 100 ml^{-1} initially and it decreased to 5.6 and 12.72 mg 100 ml^{-1} under ambient and refrigerated storage conditions respectively at the end of storage. The rate of decrease was found to be high during the initial period of storage at ambient condition. The decrease in vitamin C during storage is due to its thermo labile nature and due to exposure to light, air and length of storage period. The decrease in vitamin C with

storage may also be due to increase in acidity of the stored product leading to degradation of ascorbic acid to carbolic acid as suggested by Sahu *et al*. (2005).

A decrease in the vitamin C content of papaya-mango blended beverages (Manimegalai *et al.,* 1994), muskmelon RTS beverage (Teotia *et al*., 1997), kinnow mandarin juice (Ghorai and Khurdiya,1998), kinnow RTS beverage (Sogi and Singh, 2001), tamarind syrup (Kotecha and Kadam, 2003), spiced tamarind RTS beverage (Manjula *et al*. 2003), papaya and mango spiced RTS beverage (Ramakrishnan and Anuruby, 2003), musambi and orange blended squash (Bobby and Sri, 2003) and bittergourd RTS beverage (Barwal *et al*., 2005) were also observed during storage. Ladaniya *et al*. (2004) also observed a decrease in the ascorbic acid content of orange juice stored both at ambient and low temperature and indicated that this could be due to the oxidation of ascorbic acid to dehydro-ascorbic acid or some other biochemical reactions like browning.

At refrigerated storage conditions, the rate of decrease in vitamin C was found to be low compared to ambient storage conditions. The decrease in vitamin C content was found to be high during the initial period of storage. From second month onwards there was a linear decrease in the vitamin C content in almost all beverages. Higher percentage of vitamin C was retained in all beverages stored under refrigerated conditions. About 66 (T_1) to 85 per cent (T_9) of vitamin C was retained in the beverages stored under refrigerated conditions in contrast to a retention of 32 (control) to 47 per cent (T_{10} and T_{11}) under ambient storage conditions. Ghorai and Khurdiya (1998) and Kotecha and Kadam (2003) and Shere *et al.* (2003) also observed increased loss in ascorbic acid in beverages stored under ambient condition. Deka *et al*. (2004) and Deka *et al*. (2005) observed maximum retention of vitamin C in lime-aonla and mango-pineapple spiced beverages stored under low temperature.

A significant decrease in the ß carotene content was observed in the RTS beverages with the advancement of the storage period under ambient and refrigerated conditions, but the rate of decrease was found to be high in beverages stored under ambient conditions (Table 11).

The ß carotene content of RTS beverages varied from 13.91-26.60 µg 100 ml^{-1} initially and it decreased to 7.75-14.29 µg and 11.49-18.89 µg 100 ml^{-1} under ambient and refrigerated storage conditions respectively at the end of the storage period. Krishnaveni *et al*. (2001) also noticed a decrease in the ß-carotene content of the jack fruit RTS beverages during ambient storage condition. Similar findings of decrease in ß-carotene content in mango RTS beverages and papaya and mango spiced RTS beverages during storage was observed by Beerh *et al*. (1989) and Ramakrishnan and Anuruby (2003). The decrease in ß-carotene content may be due to the exposure of juices to light as reported by Lotha (1992) or may also be due to non-oxidative or oxidative changes which alter the colour and lower the flavour and nutritive value of the product.

Srivastava (1998) also reported a decrease in the ß-carotene content in RTS beverages prepared using Dashehari and Banganpalli mangoes during six months of storage at ambient temperature.

At refrigerated storage condition the rate of decrease in ß-carotene content was found to be low compared to ambient storage condition indicating higher retention of ß-carotene in RTS beverages stored at refrigerated condition. About 60.9 (T_6) to 88.60 (control) per cent of ß-carotene was retained in the beverages at the end of storage under low temperature in contrast to 46.8 (T_3) to 73.86 (T_7) per cent under ambient conditions. There was a linear decrease in the ß-carotene content throughout the storage period.

Initially, the tannin content of RTS beverages varied from 0.027-0.066 mg 100 ml^{-1} (Table 12). The tannin content was high in all beverages prepared with 100 per cent cashew apple juice (control, T_1 and T_2) and with higher percentage of cashew apple juice (T_5, T_{10} and T_{11}). After third month of storage, the tannin content varied between 0.009-0.036 mg 100 ml^{-1} under ambient conditions and 0.020 to 0.041 mg 100 ml^{-1} at refrigerated conditions. Thus, a decrease in the tannin content was noted during the entire storage period both at ambient and at refrigerated conditions, but the decrease was found to be high during ambient conditions. Deka *et al*. (2005) also observed a similar decrease in the tannin content of mango-pineapple spiced beverages during ambient and at low temperature storage with higher retention of tannin at low temperature as observed in the present study. The loss of tannin during storage might be due to the oxidation of tannins.

Srivastava *et al*. (1985) and Deka (2000) also reported a linear decrease in the tannin content in mango juice and grape-mango and grape-pineapple spiced RTS beverages respectively.

5.3 Organoleptic qualities of RTS beverages during storage

The initial score for appearance of RTS beverages varied from 4.13 to 4.23 (Table 13). During storage a gradual decrease in the appearance was noticed in the beverages stored both under ambient and refrigerated conditions. However, maximum decrease was found in beverages stored under ambient conditions. The mean rank score of the beverages during different storage periods were also found to be lower in beverages stored under ambient condition.

Initially, the mean score for all blended beverages were found to be either on par or higher than the score obtained for the beverages prepared with 100 per cent cashew apple juice (control). During different storage periods also the same trend was maintained by almost all beverages both under ambient and refrigerated storage conditions. At the end of the storage the score varied from 2.73 to 3.10 (ambient) and 3.77 to 3.80 (refrigeration). Under refrigerated storage all beverages secured a mean score of above 3.7 during the entire storage periods. The decrease in the score for appearance of the beverages may be due to the deterioration of pigment present in beverages.

Krishnaveni *et al*. (2001), Joy (2003), Kannan and Thirumaran (2004) also observed a decrease in appearance of jack fruit RTS beverages, roseapple squash and jamun beverages respectively under ambient storage condition. Jain *et al*. (2003) observed that sweet orange juice when stored under low temperature maintained the appearance score within the highly acceptable range during the entire storage period and observed lower deterioration in quality attributes of beverages stored under refrigerated condition.

Initially, the score for colour of RTS beverages varied from 4.13-4.23 and at the end of storage the scores varied from 2.73 to 3.10 under ambient condition and to 3.77 to 3.80 under refrigerated condition (Table 14). The beverages prepared with cashew apple juice and one drop of ginger (T_1), cashew apple and lime(T_5) and cashew apple, pineapple and one drop of ginger (T_7) maintained the highest mean score and rank scores for colour after second month of storage under ambient condition. The mean score and rank scores for colour were lower in beverages stored under ambient conditions. The decrease in the score for colour might be due to the bleaching of the pigment by exposure to light or may be due to the degradation of β-carotene which also decreased the appearance score of the beverages.

Hema (1997), Krishnaveni *et al*. (2001) Sogi and Singh (2001) and Ladaniya *et al*. (2004) also observed a decrease in colour of various fruit beverages like jamun squash, jack fruit RTS beverages, kinnow fruit beverages and orange juice during storage under ambient storage conditions.

While comparing the scores for colour of different blended beverages with the scores obtained for the beverages prepared with 100 per cent cashew apple juice, almost all beverages had a score on par or higher than the scores obtained for control during different storage periods both under ambient and refrigerated conditions. However, lowest mean and rank score for colour was recorded for control beverage during the initial period and after one month of storage under ambient conditions.

Initially, the score for flavour varied between 3.70-3.87 with the highest score in T_2 and T_4 (Table 15). Under ambient storage conditions the score for flavour decreased gradually and after first and second months of storage the scores varied from 2.97-3.07 and 2.13-2.40 respectively. During the third month of storage a drastic decrease in the scores for flavour was noticed and the scores of all beverages were found to be below two at the end of the storage under ambient conditions. This loss of flavour might be due to the fermentation occurred in the beverages when stored under ambient storage condition.

In contract to these observations all beverages maintained a score of above 3 till the end of storage under refrigerated conditions. Though, there is a decrease in the scores with advancement of storage periods under both conditions, the rate of decrease in flavour score was more in beverages stored under ambient conditions. The mean rank scores during different storage periods was also found to be low under ambient storage conditions. Thus, the findings indicated better acceptability in

beverages stored under refrigerated conditions till the end of storage with respect to flavour.

Takur and Barwal (1998), Krishnaveni *et al*. (2001), Sogi and Singh (2001) Barwal *et al*. (2005) also observed a decrease in the flavour of kiwi fruit squash, jack fruit RTS beverage, kinnow squash and bittergourd RTS beverage respectively when stored under ambient storage conditions.

Nath *et al*. (2005) also observed a decrease in the flavour of ginger-kinnow squash during storage at room temperature due to the degradation of flavour constituents upon storage at high temperature.

The initial score for taste of RTS beverages varied from 3.70-3.87 (Table 16). The highest score was found in T_1 and T_7 and lowest in all other beverages including control. Under ambient storage condition, a gradual decrease in the scores was noticed in beverages after first month of storage. After second and third months of storage also drastic decrease in the score was observed in all beverages. At the end of storage under ambient conditions all beverages had a score of less than 2 indicating that the taste of beverages deteriorated after first month of storage and were found to be unacceptable. This decrease in taste might be due to the fermentation of beverages induced by temperature or due to changes in the chemical constituents and loss of volatile aromatic substances. Takur and Barwal (1998), Joy (2003), Jain *et al*. (2003) and Nath *et al*. (2005) also observed a decrease in taste during storage in kiwi fruit squash, rose apple squash, orange juice and ginger-kinnow squash respectively under ambient conditions.

Under refrigerated storage conditions, though a slight decrease in the score was observed in all beverages, a score of above three was maintained during the

entire storage periods. It indicated that all beverages are acceptable even after third month of storage under refrigerated condition. Jain *et al*. (2003) also observed a slight decrease in taste in orange juice when stored under low temperature. The rank scores also were found to be high in all beverages stored at refrigerated temperature during different storage periods till the end of storage.

The initial score for overall acceptability of RTS beverages varied from 3.70 to 3.8 and scores of most of the beverages were found to be on par with the control (Table 17).

Under ambient storage condition, there was a gradual decrease in the score for overall acceptability in all beverages. The score varied from 2.13-2.40 and 1.57-1.67 respectively after second and third months of storage indicating that all beverages are unacceptable after first month of storage. This decrease in the overall acceptability score is due to the decreasing trend observed in the quality attributes during storage. Sogi and Singh (2001), Krishnaveni *et al*. (2001), Nath *et al*. (2005) also observed a decrease in the overall acceptability score in kinnow fruit beverages, jack fruit RTS beverages and ginger-kinnow squash respectively during storage under ambient conditions. However, Tiwari (2000) observed better acceptability in guava-papaya blended RTS beverage even after six months of storage at room temperature.

Under refrigerated storage conditions all the RTS beverages registered an overall acceptability score of above 3 during the entire storage period. After third month of storage the score for overall acceptability varied from 3.17-3.33 with the highest score in T_1 and T_8 followed by T_6, T_9 and T_{10}. Under refrigerated condition also a slight decrease in the scores for overall acceptability was observed in all beverages. Lakshmi *et al*. (2005) also observed a slight decrease in the overall

acceptability scores in tamarind beverages when stored under refrigerated temperature.

All the beverages stored under refrigerated conditions were acceptable even after three months of storage. Highest mean and rank scores were observed in beverages stored under refrigerated conditions throughout the storage period.

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5.4. **Changes in the microbial count of beverages during storage**

The bacterial count was detected in beverages prepared with 100 per cent cashew apple juice (control) and in blended beverages prepared with orange (50:50), pineapple (50:50) and lime (75:25) even at the time of storage (Table 18). However, no bacterial growth was detected in other beverages in which spice extracts were added indicating that ginger and cardamom extracts added to the beverages might have inhibited the growth of bacteria initially due to the antimicrobial properties of spices. Ejechi *et al*. (1998) also reported inhibition of microbial growth in mango juice when nutmeg and ginger were supplemented. Meena and Sethi (1994) and Ji *et al*. (1997) also indicated antimicrobial activity of ginger.

After third month of storage, the bacterial growth was detected in all beverages both under ambient and refrigerated storage conditions, but the rate of increase was found to be low at refrigerated condition indicating growth suppression of bacteria under low temperature. Maximum increase in bacterial count was detected in beverages prepared without spice extracts (control, T_3, T_4 and T_5). During storage also spices inhibited the growth of bacteria.

After third month of storage under ambient storage condition the bacterial growth varied from 2.5 to 6.6 cfu ml^{-1}. The highest count was observed in the

beverages prepared with cashew apple and orange juice (T_3) followed by the beverage prepared with 100 per cent cashew apple (control) and cashew apple and lime juice (T_5).

The lowest bacterial count was observed in the beverage prepared using cashew apple and lime juice with 1 drop ginger extract (T_{10}). Chitra (2000) detected a bacterial count of 4 x 10^{-6} cfu g^{-1} in clarified banana squash after 300 days of storage. Sudhagar (2001) also observed a bacterial count of 5 x 10^{-6} cfu g^{-1} and 7-9 x 10^{-6} cfu g^{-1} in pear and pear-blended squash after six months of storage at ambient temperature. Khan and Malik (2002) also detected total viable count, total coliforms and faecal colifoms in fruit juices. In carrot-pineapple blended juice Dhaliwal and Hira (2004) also observed bacterial count. However, Attri *et al*. (1998) found that the blends of sand pear juice with apple, apricot and plum could be stored at room temperature for six months without any spoilage in temperate regions.

In the beverages stored under refrigerated condition bacterial count varied from 2.2 to 5.3 10^{-6} cfu ml^{-1}. The lowest bacterial growth was observed in beverage prepared with cashew apple and lime juice with the addition of one drop of cardamom extract (T_7). The highest bacterial growth was observed in beverage prepared with cashew apple and orange juice without spice drops (T_3). The bacterial count observed in control, T_3, T_4 and T_5 initially is higher than the count of 100 per ml at 20-22 ^{0}C suggested by BIS (2006) in beverages. The contamination of juice with bacteria might have occurred from wide spread presence in the air as well as contamination from the extracting machines or utensils. Another desirable characteristic noticed in the beverages was the absence of yeast, fungi and *E.coli* till the end of the storage period as suggested by BIS (2006).

5.5. Availability-Acceptability ratio

The Availability - Acceptability ratio (A-A ratio) computed as the ratio of the sum of the respective content of vitamin C, β-carotene and overall acceptability in different beverages to the tannin content indicated that, initially the beverages prepared by blending cashew apple and orange juice with ginger extract (T_6) and cashew apple and orange juice in equal proportion without any spice extract (T_3) had the highest two A-A ratios (Table 19). This indicates that these two beverages are highly acceptable in terms of sensory and nutritional qualities with lower tannin content initially. The beverages prepared with 100 per cent cashew apple juice (control) had the lowest A-A ratio followed by the beverages prepared with cashew apple juice and spice extracts (T_2 and T_1). However, after first month of storage, the beverages prepared with cashew apple juice and pineapple juice (50:50) and 1 drop of cardamom extract (T_9) and cashew apple and lime juice (75:25) without spice extracts (T_5) secured the highest two A-A ratios due to the retention of more vitamin C and β-carotene with less tannin content compared to other beverages.

After first month of storage also the lowest A-A ratio was observed in beverages prepared with 100 per cent cashew apple juice with the addition of one drop cardamom extract and found to be least acceptable (Table 20). Lowest A-A ratio observed in the beverage might be due to the higher tannin content.

All the beverages were found to be unacceptable with particular reference to taste and flavour after second and third months of storage under ambient storage condition. However, under refrigerated storage condition all the beverages were found to be acceptable even after third month of storage.

Under refrigerated storage condition after first month of storage the A-A ratio varied from 765.39 to 1500.15 with the highest ratio in T_8 prepared with equal quantities of cashew apple juice and pineapple juice with one drop of ginger extract followed by T_9 prepared with cashew apple and pineapple juice (50:50) with one drop cardamom (Table 21). In T_8 and T_9 about 95 per cent and 90 to 97 per cent of vitamin C and β-carotene respectively were retained after first month of storage and had lower tannin content (0.022 and 0.029 mg). The lowest A-A ratio was observed in beverages prepared with 100 per cent cashew apple juice with one drop of ginger extract (T_1) followed by control and T_2 indicating lower quality attributes with respect to nutrients and acceptability with high tannin content in these beverages.

After second month of storage also T_8 and T_9 maintained the highest two ranks with respect to A-A ratio indicating better acceptability after two months of storage also (Table 22). The beverages prepared with 100 per cent cashew apple juice secured the lowest score up to the end of storage followed by the beverage prepared with cashew apple juice and cardamom extract.

After third month of storage, the highest A-A ratio was observed in T_5 prepared with cashew apple juice (75%) and lime juice (25%) followed by cashew apple juice (50%) and orange juice (50%) with one drop of ginger (T_6) and cashew apple juice (75%) and orange juice (25%) with one drop of cardamom (Table 23).

Most of the blended beverages secured the high A-A ratio when compared to the beverages prepared with 100 per cent cashew apple juice with and without spice extracts. All beverages stored under refrigerated conditions also had better A-A ratio till the end of the storage when compared to ambient storage condition.

On the basis of A-A ratio of beverages computed giving importance to nutritional and organoleptic qualities with lower tannin content, the beverage prepared by blending 75 per cent cashew apple and 25 per cent lime juice (T_5) could be considered as the best when the rank order of the beverage during each period under ambient and refrigerated conditions are taken into account. Though, this beverage was ranked as eighth initially on the basis of A-A ratio during storage the rank order showed fast improvement under both storage conditions.

Under ambient and refrigerated storage conditions T_5 secured second and first ranks respectively at the end of storage. The improvement noticed in the beverage is mainly due to the better retention of vitamin C and β-carotene and also due to the loss of tannin occurred during storage. Nearly 73 per cent of vitamin C (Table 25) and 76 to 82 per cent of β-carotene (Table 26) were retained in T_5 during storage. The tannin content of the beverage also decreased during storage both under ambient and refrigerated conditions from the initial content of 0.046 mg100ml^{-1}. Another favourable characteristic noticed in T_5 is the improvement of rank occurred under both storage conditions (Table 24). Hence, T_5 which was prepared with 75 per cent cashew apple juice and 25 per cent lime juice without any spice extracts could be considered as the most preferred beverage when both storage conditions and different storage periods are also taken into account.

Though, the beverage prepared with equal proportion of cashew apple and orange juice with one drop of ginger extract (T6) secured the higest rank initially did not improve the rank scores during storage. This beverage also retained 73 to 77 per cent vitamin C (table 25) and 61 to 74 per cent of β-carotene (Table 26) during storage with better acceptability, the tannin content decreased only to 0.032 mg 100 ml^{-1} from the initial content of 0.034 mg 100 ml^{-1}

Table 25. Percentage retention of vitamin C in beverages during storage

Beverages	Ambient temperature	Refrigeration temperature		
	1MAS	1MAS	2MAS	3MAS
Control	**42.84**	**82.88**	**74.85**	**70.66**
T_1	**72.18**	**78.38**	**70.88**	**65.60**
T_2	**59.58**	**80.98**	**78.38**	**69.16**
T_3	**73.16**	**88.68**	**82.21**	**77.01**
T_4	**60.73**	**88.04**	**84.60**	**77.01**
T_5	**72.50**	**90.90**	**81.80**	**72.5**
T_6	**73.16**	**88.04**	**84.60**	**77.01**
T_7	**60.49**	**84.52**	**79.46**	**67.89**
T_8	**74.21**	**95.45**	**88.04**	**74.21**
T_9	**84.60**	**95.45**	**88.33**	**84.60**
T_{10}	**72.50**	**90.90**	**81.80**	**75.7**
T_{11}	**72.50**	**85.20**	**81.80**	**75.45**

MAS- Months After Storage

Table 26. Percentage retention of β carotene in beverages during storage

Beverages	Ambient temperature	Refrigeration temperature		
	1MAS	1MAS	2MAS	3MAS
Control	**94.98**	**98.97**	**95.22**	**88.60**
T_1	**76.80**	**90.71**	**79.96**	**70.26**
T_2	**82.35**	**89.24**	**84.45**	**80.38**
T_3	**70.05**	**87.55**	**78.82**	**61.75**
T_4	**72.71**	**94.68**	**88.06**	**84.24**
T_5	**75.51**	**88.30**	**84.21**	**81.60**
T_6	**73.61**	**77.44**	**63.61**	**60.92**
T_7	**86.16**	**96.16**	**91.54**	**82.96**
T_8	**90.15**	**96.62**	**88.93**	**82.60**
T_9	**74.84**	**89.81**	**75.48**	**70.84**
T_{10}	**86.37**	**90.55**	**84.98**	**79.09**
T_{11}	**89.96**	**89.09**	**78.81**	**73.17**

MAS- Months After Storage

An improvement in the rank of T_9 which was prepared with equal proportions of cashew apple and pineapple juices with one drop of cardamom extract was also noticed during both storage conditions. T_9 secured the top rank after first month of storage under ambient conditions and second best after first and second months of storage under refrigerated conditions. Here also about 85 per cent of vitamin C (Table 25) and 71 to 75 per cent of β-carotene (Table 26) were retained up to the above storage periods. The tannin content was decreased to 0.027mg100ml^{-1}(ambient) and 0.022 mg100ml^{-1} (refrigeration) from the initial value of 0.031 mg. In T_9 better ranking was noticed after first month of storage under ambient condition and up to the second month of storage under refrigerated condition, Hence, T_9 could also be considered as the preferred beverage among the twelve beverages up to one month under ambient condition and up to two months under refrigeration condition.

The beverage prepared with equal proportions of cashew apple juice and pineapple juice with one drop of ginger (T_8) secured better ranking only when stored under refrigerated condition up to second month. However, under ambient conditions the rank deteriorated. Hence, this could be considered as best up to second month of storage only under refrigerated condition. An improvement in the rank of T_{10} also was noticed during storage under refrigerated condition up to second month and could also be taken as the preferable beverage when stored under low temperature up to two months.

All the other beverages including the beverage prepared with 100 per cent cashew apple juice with (T_1 &T_2) and without spice extracts (control) either showed a lower ranking during storage or remained stable during storage under both storage conditions.

Hence, the beverage prepared with 75 per cent cashew apple and 25 per cent lime juice could be considered as the best up to the end of storage when both storage conditions are taken into account. The blends with equal proportions of cashew apple and pineapple juice with one drop of cardamom extract (T_9) could also be considered best up to one month of storage under ambient condition and up to second month of storage under refrigerated condition. T_8 and T_{10} prepared respectively with equal proportions of cashew apple and pineapple juice with one drop of ginger and 75 per cent cashew apple and 25 per cent lime juice with one drop of ginger could be considered as preferable when stored under refrigerated conditions up to two months.

Summary

SUMMARY

The present study entitled "Standardisation of blended cashew apple RTS beverages" was undertaken with the aim of developing RTS beverages by blending cashew apple juice with fruit juices like orange, pineapple and lime at different proportions with and without spice extracts and to study the shelf life qualities of the beverages.

Preliminary study was conducted by preparing 34 RTS beverages along with control prepared using 100 per cent cashew apple juice as per FPO specifications for RTS fruit beverages. Organoleptic evaluation of these beverages was carried out using score cards by a panel of 10 semi trained judges. The scores were analysed statistically. In the preliminary study all beverages except the beverage prepared with 100 per cent cashew apple juice with three drops of cardamom (B_6) and equal proportion of cashew apple and lime juices with one drop of cardamom extract (B_{31}) were found to be acceptable to the judges by securing a score of above three for various quality attributes and for mean and overall acceptability. The mean rank score and overall acceptability rank score of thirty three beverages also varied from 14.64 (B_{30}) to 24.44 (B_7) and 10.45 (B_2) to 23.18 (B_{20}) respectively. Among these 33 beverages, one beverage was selected from each group on the basis of better scores for quality attributes, mean and overall acceptability scores and mean and overall acceptability rank scores. Thus 12 beverages including control were selected for storage study.

The selected beverages were prepared as per FPO specifications and stored for three months at ambient and refrigerated storage conditions. Organoleptic qualities and analysis of chemical constituents such as acidity, TSS, reducing sugar, total sugar, vitamin C, β-carotene and tannin were conducted initially and at monthly intervals up to three months. Microbial enumeration was conducted initially and at the end of the storage period.

The acidity of all RTS beverages was found to be 0.32 per cent during the initial periods of storage. A gradual increase in the acidity was noticed in beverages stored under ambient condition and at the end of the storage it increased up to 0.70 per cent (T_3 and T_4). Under refrigerated condition a decrease in the acidity of the RTS beverages was observed during storage and it decreased to 0.22 per cent (T_4 and T_{10}) at the end of storage).

The TSS content of RTS beverages varied from 14^0 brix to 14.8^{o}brix initially and during storage an increase in the TSS content was noticed in most of the beverages stored under ambient and refrigerated condition. Under ambient condition at the end of storage period the TSS content increased up to 15.2^0 brix (T_8) and in refrigerated storage it increased up to 15^0 brix. In control and T_1 the TSS content remained stable till the end of storage under both storage conditions.

The reducing sugar content of RTS beverages varied from 6.76 to 9.80 per cent during the initial period of storage. The reducing sugar content increased up to 14.28 per cent (T_3, T_7 and T_8) and 12.22 per cent (T_{11}) under ambient and refrigerated storage conditions respectively.

Initially, the total sugar content of RTS beverages varied from 11.11 to 13.16 per cent. After third month of storage under ambient condition an increase in the total sugar content was observed in all the beverages and the content varied from 12.38 to 13.88 per cent. But, under refrigerated storage condition a decrease in the total sugar content was observed in all the beverages except T_{11} and the content varied from 11.21 to 11.9 per cent

Initially, the vitamin C content of RTS beverages varied from 17.14 to 23.08 mg $100ml^{-1}$. The highest vitamin C content was observed in T_1 followed by T_7 and control. After third month of storage a decrease in the vitamin C content

was observed in all beverages stored under ambient and refrigerated conditions. Higher percentage of vitamin C was retained in beverages stored under refrigerated condition. At the end of storage the vitamin C content varied from 5.6 to 9.43 mg $100ml^{-1}$ and 12.72 to 16.18 mg $100ml^{-1}$ under ambient and refrigerated storage conditions respectively.

Initially the β-carotene content of the beverages varied from 14.66 (T_4) to 26.60μg $100ml^{-1}$ (T_1) and it decreased to 7.75 μg$100ml^{-1}$ under ambient storage condition and 11.49 μg$100ml^{-1}$under refrigerated storage condition. The retention of β-carotene was found to be more in beverages stored under refrigerated condition. The decrease in β-carotene content of the beverages at the end of the storage was found to be statistically significant in all beverages under both storage conditions except in control.

The tannin content of RTS beverages varied from 0.027 (T_8) to 0.066 (control) mg$100ml^{-1}$ initially. A significant decrease in the tannin content was obser4ved in the beverages stored both under ambient and refrigerated conditions, but the highest decrease was observed in ambient storage condition. After third month of storage the tannin content varied from 0.009 (T_9) to 0.036mg$100ml^{-1}$(control) and 0.020 (T_8) to 0.041 mg$100ml^{-1}$ (control) respectively under ambient and refrigerated conditions.

A gradual decrease in the different quality attributes like appearance, colour, flavour, taste and overall acceptability was noticed during storage, but the highest decrease was observed in the RTS beverages stored under ambient storage condition. All the beverages stored under ambient condition were found to be unacceptable after first month of storage with respect to taste and flavour and overall acceptability, but under refrigerated storage condition all the beverages were found to be highly acceptable even after third month of storage.

Initially, the bacterial count detected only in beverages prepared without the addition of spice extracts (control, T_3, T_4 and T_5). At the end of storage, the bacterial count was detected in all the beverages stored both under ambient and refrigerated conditions, but the rate of increase in the bacterial count varied from 0.30 to 0.41x10^{-6}cfuml^{-1} and at the end of storage it increased to2.5 to6.6 x10^{-6}cfuml^{-1} and 2.2 to 5.3 x10^{-6}cfuml^{-1} respectively under ambient and refrigerated conditions. Fungi, yeast and *E.coli* were not detected through out the storage period.

The Availability-Acceptability (A-A) ratio computed on the basis of nutrient content, overall acceptability and tannin content of the beverages initially and during storage indicated that the beverages prepared with cashew apple and orange juices at equal proportions with one drop of ginger was acceptable in terms of quality and acceptability during the initial period of storage. After first month of storage under ambient condition the beverage prepared with cashew apple and pineapple juices at equal proportion with one drop of cardamom extract had the highest A-A ratio due to the retention of more nutrients and also due to the lower tannin content. Under refrigerated storage condition after third month of storage the beverage prepared with cashew apple and lime juices in the ratio of 75:25 without spice extract was found to be having the highest A-A ratio due to the retention of more nutrients and with lower tannin content.

On the basis of ranking of A-A ratio of beverages during different storage periods and two storage conditions, the beverage prepared with 75 per cent cashew apple juice and 25 per cent lime juice is considered to be the best (T_5) up to one month of storage under ambient condition and up to three months of storage under refrigerated condition. Cashew apple and pineapple juices at equal proportion with one drop of cardamom extract (T_9) could also be considered as best up to one month at ambient condition and up to two months under refrigerated conditions. However, T_8 and T_{10} with equal proportion of cashew apple and pineapple juices and one drop of ginger and cashew apple and lime

juices in the ratio of 75:25 with one drop of ginger respectively also could be considered as acceptable up to two months of storage only under refrigerated condition.

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* Originals not seen

Appendix

APPENDIX I

Score card for the organoleptic evaluation of cashew apple RTS beverages

Sl.No.	Parameters	Scores							
1	**Appearance** Excellent Good Fair Poor Very poor	5 4 3 2 1							
2	**Colour** Excellent Good Fair Poor Very poor	5 4 3 2 1							
3	**Flavour** Excellent Good Fair Poor Very poor	5 4 3 2 1							
4	**Taste** Excellent Good Fair Poor Very poor	5 4 3 2 1							
5	**Overall acceptability** Excellent Good Fair Poor Very poor	5 4 3 2 1							

Date: Name and Signature:

APPENDIX II

Cost of RTS beverages

Beverages	Cost of production (Rs/200 ml bottle)
Control	3.17
T_1	3.54
T_2	3.81
T_3	3.85
T_4	3.44
T_5	3.47
T_6	4.21
T_7	4.14
T_8	4.07
T_9	3.80
T_{10}	3.83
T_{11}	3.98

STANDARDISATION OF BLENDED CASHEW APPLE RTS BEVERAGES

By

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ABSTRACT OF THE THESIS

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ABSTRACT

The present study entitled the "Standardisation of blended cashew apple RTS beverages" was attempted to standardise cashew apple RTS beverages by blending cashew apple with other fruit juices like orange, pineapple and lime and ginger and cardamom extracts and to find out acceptable beverages with high sensory and nutritional qualities with good shelf life.

Thirty four RTS beverages were prepared using cashew apple as the base and mixing with orange, pineapple and lime juices at different combinations with and without the addition of spice extracts. Organoleptic evaluation of RTS beverages was carried out using five-point scale by semi-trained panel of ten judges and twelve most acceptable beverages were selected for storage study. Selected beverages were stored under ambient and refrigerated conditions for a period of three months and the beverages were analysed for chemical, sensory and microbial qualities.

An increase in the acidity and total sugar content of beverages was noticed during storage under ambient conditions, while a decrease was noticed under refrigerated storage condition. An increase in the TSS and reducing sugar contents was observed in almost all beverages stored both under ambient and refrigerated conditions. A decrease in the vitamin C and β-carotene contents was observed in all beverages through out the storage period in both the storage conditions. Higher percentage of vitamin C and β-carotene was retained in the beverages stored under refrigerated condition. A significant decrease in the tannin content of the beverages was also observed under both the storage conditions and the decrease was found to be more in beverages stored under ambient condition.

The sensory qualities of all beverages were found to be acceptable even after third month of storage under refrigerated condition, but the RTS beverages stored

under ambient condition was found to be unacceptable after first month of storage due to fermentation.

During the initial period of storage, no bacterial growth was observed in the spiced RTS beverages. After third month of storage the bacterial growth was observed in all beverages, but the rate of increase was found to be low under refrigerated storage conditions.

Among the different combinations evaluated the beverage prepared with 75 per cent of cashew apple and 25 per cent lime juice without any spice extract was found to be the most acceptable up to one month of storage under ambient condition and up to three months of storage under refrigerated condition with respect to nutritional quality, acceptability and lower tannin content. The beverage prepared by blending equal proportion of cashew apple and pineapple juice with one drop of cardamom extract also was found to be acceptable after one month of storage under ambient condition and up to two months under refrigerated condition. Under refrigerated condition, the beverages prepared with equal proportion of cashew apple and pineapple juices with one drop of ginger and cashew apple (75%) and lime juice (25%) with one drop of ginger also were found to be acceptable up to two months of storage.

Blending of cashew apple juice with other fruit juices and spice extracts improved the nutritional quality and acceptability of cashew apple juice in terms of taste, flavour and mouth feel. Hence, the cashew apple which is under utilised can be commercially exploited in the processing sector by preparing nutritious and acceptable blended beverages using commonly available fruits and flavouring extracts.