Formulation and Evaluation Of Ready-To-Serve Beverages From Vegetable and Fruit Blends

By

S. Manjula

A THESIS SUBMITTED TO THE AVINASHILINGAM INSTITUTE FOR HOME SCIENCE AND HIGHER EDUCATION FOR WOMEN (DEEMED UNIVERSITY), COIMBATORE - 641 043

IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF

MASTER OF SCIENCE

IN FOOD SCIENCE AND NUTRITION

MAY 1997

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Certified as bonafide research work

Signature of the Head of the Department	Signature of the Dean of the Faculty	Signature of the Guide

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Introduction

INTRODUCTION

India is a hot country and the people require thirst quenching drinks throughout the year. At present artificial mineral waters and sherbets having no food value except some calories are slowly getting replaced everywhere with fresh and preserved fruit juice beverages (Das, 1984-85). They form the chief source of refreshing and exhilarating cold drinks all over the country. The people of big cities and towns have become quite conscious of the nutritive and prophylactic values of real fruit juices.

Fruit juices are convenient to prepare requiring minimum hard labour and the consumer gets maximum food values at minimum cost. They are nutritious thirst quenchers and find increasing commercial use (Tandon et al., 1984).

The fruit juice industry is undergoing considerable change as the market reacts to the highly competitive environment and the consumer demand for an ever increasing range of premium quality products (APV Enquiry, 1996).

Now the fresh and processed fruit juices and their beverages manufactured locally are the chief source of cold drinks throughout the country especially in big cities. The fruit juice beverage industry was started in India in the early thirties, and before that there was an import of these products from Europe worth several crores of rupees (Das, 1984-85)

Most of the processed products are in the form of juice and pulp and other beverages (Khurdiya, 1986). Indian domestic market has registered a steady growth in demand for fruit juices. Soft drink industry with a growth rate currently estimated at 21 per cent is expected to generate a demand for about 10,400 million bottles of which 20 per cent will be shared by fruit based drinks. Based on these estimates, the requirement of fruit juice by the Ready-to-Serve (RTS) beverage industry would be about 41,600 tonnes (Food and Allied Industry News, 1992).

RTS fruit beverages have been increasingly gaining popularity throughout the country. These beverages have largely been prepared from common fruits such as mango, orange, grape, lime, etc., (Chakraborty et al., 1993).

A number of juices could be prepared by blending more than one or two types of fruits (Anonymous, 1994). Presently the fruit juices, which are marketed do not contain a large percentage of pulps when compared with the home made juices. The present need is to prepare and market fruit juices in their natural forms at economical prices.

Mixed blends are increasingly being put into the retail market by the fruit beverage industries. Also due to the high value and wide appeal to consumers, along with fruits, vegetables have always been of interest to food scientists as raw materials for processed products (Alzamora et al., 1996).

Vegetables, as well as fruits are rich and comparatively cheaper sources of vitamins such as ascorbic acid, beta carotene and minerals like calcium, iron and phosphorus. They not only adorn the table but also enrich health. Consumption of these items helps in increasing the appetite and preventing constipation. These are currently reckoned as important adjuncts for maintenance of good health and beneficial in protecting against some degenerative diseases. They also play a key role in neutralizing the acids produced during digestion of proteinous and fatty foods (Patil et al, 1991).

The incidence of nutritional blindness, anaemia and angular stomatitis can be reduced in the country by the consumption of fruits and vegetables (Mukherjee, 1989). Fruits also possess the ability to prevent and cure scurvy which occurs due to a lack of vitamin C (Maini et al., 1984). Bhakru (1991) points out that persons subsisting on the natural diet always enjoyed good health.

Since fruits and vegetables are the only natural sources of protective nutrients like vitamins and minerals and, due to increased income, people are slowly shifting to the use of more fruits and vegetables. The perishable nature of vegetables and fruits demand comprehensive planning for movement, storage, processing and distribution (Patil et al., 1991).

India is an agriculture based country. By virtue of variable climate, geographical nature and different types of temperature, many varieties of tropical and subtropical fruits and vegetables are grown (Khurdiya, 1986). However the percapita consumption of fruits and vegetables in India is only around 130g against a minimum of about 300g recommended by dietitians (Singh, 1993).

India ranks second in the World to China in the production of vegetables and next to Brazil in fruits (Kuchroo, 1994). Vegetables and fruits are perishable products with active metabolism during the post harvest period (Weichmann, 1987). Post harvest decay causes heavy losses in quality and quantity at any time after harvest or during transit, storage and marketing (Mathur, 1995).

About 20-40 per cent of these perishable produce goes as waste in India due to improper post harvest operations (Khurdiya, 1986). As per Nanjundaswamy (1993), this leads to a colossal loss of Rs.67,500 million. Most of the fruits and vegetables are consumed fresh and processing industry produces hardly one lakh tonnes of fruit and vegetable products, which is very negligible (Khurdiya, 1986).

Processing of fruits and vegetables is carried out by sun drying, fermentation, pickling, chemical preservation, preparation of sugar concentrates, canning, freezing and irradiation (Roy, 1989). These methods include both traditional and improved methods of processing.

Sethi and Maini (1989) recommend low cost processing technology to keep the processed products available to a wider section of the population. This necessitates the food technologists to find out ways and means to reduce the cost and to increase the consumption of processed items.

Fruit blends and nectars have been developed recently and are in good demand among the public. Possibilities of blending various fruit juices and pulps for preparation of preserved items may improve their nutritional contribution (Tripathi et al., 1992).

RTS beverages based on fruits are nutritious and convenient to prepare. But the incorporation of vegetables may introduce many varieties, reduce cost and may improve nutritional value.

Hence, this study was undertaken with the following objectives to :

1. Develop Ready-to-Serve beverages from vegetable and fruit blends using ratios identified by sensory evaluation

2. Evaluate the acceptability of the beverages developed

3. Analyse the beverages for selected nutrients and other parameters

4. Study the changes in the nutritional and other qualities after a storage period of three months and

5. Calculate the cost of beverages for comparison with commercial products.

Review of Literature

II REVIEW OF LITERATURE

The available literature pertaining to the study on the "Formulation and Evaluation of Ready-to-Serve Beverages from Vegetable and Fruit Blends" is reviewed under the following headings.

A. Conservation of Fruits and Vegetables

B. Scope of Fruit Juice Beverages and

C. Studies Conducted on the Selected vegetables and Fruits

A. Conservation of Fruits and Vegetables

Fruits have been man's food from time immemorial. Fruits are especially important in the diet for the vitamins and minerals they contain. The yellow fruits such as papaya and peaches are high in vitamin A value. Fruits supply minerals like iron and calcium essential for the formation of bone and blood (Bakhru, 1991).

The contents of vitamin C and provitamin A are very high in several vegetables and in combination with fruits contribute almost all the vitamin C needed per day in the human diet. The amount of B vitamins are relatively small, however the ICMR Recommended Dietary Allowances values are also equally small. Weichmann (1987) puts forth that a 100g serving of some of the vegetables can supply a sufficient amount of vitamin C, A and B.

According to Prasad (1981), a generous intake of fruits in the diet will enable a person to lead a healthy life. Fruits have been part of our dietary and intricately woven into the eating pattern of people in various parts of the country.

Eipeson *et al.*, (1992) state that vegetables, fruits and their products have gained considerable importance by contributing significantly to the nutrition and economy of many countries in the world.

According to Kuchroo (1994), India ranks second in the world to China in the production of vegetables accounting for about 48,716 million tonnes and next to Brazil in fruits accounting for about 25,529 million tonnes. The production constitute eight per cent of the total global production (Sharma and Joshi, 1990).

Post harvest losses of horticultural products may account for as high as 50 per cent as per FAO (1985). In India nearly 20 to 40 per cent of fruits and vegetables are spoilt annually leading to a loss of Rs.3000 crores (Pandey, 1990). Most of the seasonal items go waste in thousands of tonnes and are discarded because of failure to meet the fresh market standards (Khan *et al.*, 1988).

Narasinga Rao (1992) expresses his worry that the country can ill-afford the enormous losses of fruits and vegetables during storage, transportation and marketing.

Factors that affect shelf life of fresh perishables include processing conditions like pasteurization time and temperature, oxygen content, oxygen barrier, properties and type of container and home storage temperatures and type of product either concentrate, single strength, chilled or non pasteurized (Charalambous, 1993).

In the warm and humid atmosphere, food spoilage is very rapid and hence development of food preservation techniques acquired atmost importance (Sethi and Maini, 1989). Some of the simple and low cost techniques should be adopted in our country for proper management of fresh fruits at pre and post-harvest stages of marketing and processing as suggested by Mukherjee (1989).

Alzamora et al., (1996) state that the food consumption patterns change in modern society in response to demands in the market place, the availability of certain foods, the consumer's purchasing power, consumer's tastes, needs and life styles, media publicity, consumer's safety perception and concern over food borne hazards.

Also life styles of consumers have now changed greatly due to rapid urbanization, growth of female education, emergence of working women, growth of convenience foods, spread of mass media education and the tremendous growth of foreign travel (Kejriwal, 1992).

According to Singh and Nagargoje (1986), the main objectives of preservation are to make available the seasonal glut throughout the year, to retain maximum nutrients, texture and flavour of fresh food and to prevent spoilage leading to increased percapita consumption

Shaw *et al.*, (1993) defined food processing as treatment between harvest and consumption. Foods are processed commercially to improve their nutritional value and to transport to other regions or countries from the place of surplus regions (Geetha and Shivaleela, 1982).

The objective of processing may include improvement in apperance, flavour or nutritive value or consumer accreditation (Begum *et al.*, 1983). Food Processing may also include creating a commercial outlet for excess indigenous fruits and vegetables (Annual Report, Central Food Technological Research Institute (CFTRI), 1985-86).

Processing plays an important role in the preservation and effective utilization of the available food supply (The Indian Export Trade Journal, 1985). This necessitates the determination of nutrient losses during currently used food processing operations under Indian conditions and the optimisation of processes for maximum nutrient retention.

We have some 3500 fruit and vegetable processing units spread all over the country. Most of these units are highly export oriented and will continue to remain so. The country produces some 75 million tonnes of fruits, vegetables and tubers like potato and tapioca and processing accounts for a meagre 1.5 per cent of the horticultural produce. The capacity utilization is around 40 per cent of the installed capacity of industries. Of course, fruit and vegetable processing is necessarily a seasonal activity (Venkataraman, 1939).

According to Singh (1984) preserved foods are convenience foods which can be used in therapeutic diets where a low protein, low fat and high calorie diet is required.

Sethi (1993) suggests that a new product with better colour and flavour may offer consumer acceptance and large scale potential to give support to export market. Some of the new products will have medicinal and therapeutic values apart from providing vitamins, minerals and polyphenols, forming a part of nutritious foods.

Lal et al., (1986), indicate that the techniques of food preservation include physical methods such as removal of or addition of heat, removal of water, irradiation, chemical methods such as addition of acid, salt, addition of chemical preservative, addition of sugar and heating, fermentation and combination of one or more of the above methods.

Kalra and Tandon (1986) point out that aseptic processing technology and packaging has been taken up in advanced countries and recently it is being introduced in India. The development of heat treated, aspetically packed fruit-based drinks are stable at room temperature. This requires inactivation of ascospores of Byssochdamys (Varnam and Sutherland, 1994). These is a increasing demand for clarified juices in the market (Khan et al, 1988).

Sumathi et al., (1987) suggest methods like drying, pickling with salt, spices and or oil, jams, jellies, marmalades, murabbas and preserves using sugar, bottling of squashes and juices and freezing to be effective

Even the simple use of preservative such as sulphur-di-oxide generated from sulphur to decontaminate fruits came prior to fermentation (Gould, 1989). Modern methods of processing and preservation came into use over the last hundred years (Shaw et al., 1993).

Regarding chemical preservation, the two preservatives potassium meta bisulphite and sodium benzoate may be used to advantage in combination with each other. Where sulfurous acid retards oxidative changes and benzoic acid chiefly checks spoilage organisms. Recent trends are to avoid use of chemical preservatives (Woodroof et al., 1986).

Since the cost of industrial production is very high, home scale processing is highly recommended (Anand and Maini, 1981). Venkataraman (1981) pointed out that we are no longer fresh fruit eaters alone. But we have begun to gulp packaged fruit juice in gallons and this makes a sea change as far as the industry is concerned.

Several investigations were carried out to study the effect of processing on physico-chemical and sensory quality of juice and to elaborate possibility of its conversion into beverage (Ranote et al., 1993).

B. Scope of Fruit Juice Beverages

The fruit drink market is rapidly growing and is reported to be taking a share away from synthetic carbonated beverages. The sale of fruit juice based product is expected to grow by 150 per cent in the next three years from the level of 70 million packages in 1987-'88 (Venkataraman, 1989).

There are many changes in fruit juices and drinks industry since 1980. In Ready-to-Serve Drinks and Nectars, there are several developments in the field of mixed and tropical fruit drinks which are readily gaining importance in our market (Hooper, 1984).

Soft drink sales are found to have increased due to ready-to-drink, single - serve cartons,natural and healthy pure juice products and many varieties (Euromonitor, 1990).

Considering the vastness of our country and bounty of nature, as regards the quantity and quality of fruits and vegetables there is surely an unfathomed wealth in the fruit juice and beverage line. It is desirable therefore to establish fruit-juice extracting units in specific fruit growing areas or the cities with big supply markets (Das, 1984-85).

Venkataraman (1989) pointed out that there is also a nutritional necessity to open up the flood gates for packed fruit juices for vegetables and fruits which are unique in providing vitamin A and C at prices the common man can afford.

There is a shift from consumption of alcoholic beverages to natural fruit based beverages (Vande, 1991). When the consumer preferences for non-alcoholic beverages in the 1990s were discussed, it is likely that consumption of vegetable juices will increase in the 1990s in parallel with the increased number of vegetarians (Gledhill, 1992).

According to Food and Allied Industries News (1987), Indian domestic market has recognised a steady growth in demand for fruit juices. Fruit juices have been processed into various forms such as cocktail, juice cordial, squashes, juice concentrates and in recent years there is increased production of fruit based RTS beverages, which are increasingly gaining popularity throughout the country (Chakraborty et al., 1993).

Varnam and Sutherland (1994) suggest blending of two or more fruit juices as common, together with sugar or intense sweeteners, flavourings and acidulants. Mixed fruit punch or blends are increasingly being put into the retail market by the fruit beverage industry (Anonymous, 1994).

Presently, the fruit juices which are marketed do not contain the large percentage of pulp when compared with the home made juices. The need is to prepare and market fruit juices in their natural forms at economical prices. Newer product development (1988) is of the opinion that a number of juices could be prepared by blending more than one or two types of fruits.

Samaddar (1993) viewed that the introduction of convenient package like Tetrapack, RTS beverages production recorded 49 per cent annual growth over the past few years. The fruit and vegetable preservation industry is interested in making products from well known fruits (Sethi and Maini, 1989).

Khurdiya (1986) suggested that the development of suitable mixed fruit juices and other beverages that are attractive and acceptable and the formulation of fruit based nutritional drinks to replace the synthetic and sometimes harmful drinks, can help to further improve the prospects of the juice and beverage industry in India.

Though vegetables are equally nutritious, serious attempts have not been made to develop and market vegetable juice beverages in the industry and there is great scope for producing vegetable juices on commercial scale since these can be produced without much difficulty (Khurdiya, 1988).

Das (1984-85) revealed that the blends and nectars have also developed a good demand. Tomato juice blended with many other vegetable juices add to the flavour and nutritional value of the product. Mostly carrot is used in the blends.

According to Kalala (1989), a calcium fortified food product in the form of a RTS beverage was found to have a pleasant fruit taste, no harsh off-notes, no effervescence and no bitter after taste. Also if the proper percentage of juice content in the beverage is enforced this could avoid the need for artificial colour and flavour to a great extent (Khurdiya, 1988).

C. Studies Conducted on the Selected Vegetables and Fruits

Various enriched beverages can be prepared from the combinations of vegetables and fruits so that they can be well accepted by consumers (Khan *et al*., 1988)

Carrot (*Daucus carota*)

Carrot is a most important root crop and is grown all over India. It is a rich source of beta carotene, a precursor of vitamin A and has medicinal properties also. The colour of carrot juice is dependent on its carotene content. A milk based carrot juice beverage was prepared by blending 20 per cent carrot juice into skim milk. Preparation of carrot and passion fruit juice blends have also been reported (Kulkarni, 1987).

A carrot based RTS beverage prepared by Malathi *et al*., (1992) was found to be acceptable in terms of quality factors such as colour, appearance, flavour, taste and consistency. It had a shelf life of six months in glass bottles and during storage, the total soluble solids (TSS), total sugar and pH decreased while reducing sugars and acidity increased. Acceptability was good even after six months storage.

Although preparation and evaluation of RTS beverages from black carrot is known to possess cooling and soothing properties besides its good nutritive value, it has not been commercially exploited as a RTS beverage (Shah, 1986).

Carrot juice beverage and carrot juice beverage with added orange essence were found to be highly acceptable. Carrot juice blended with lime juice was least acceptable. Other blends with orange juice and pineapple juice were moderately acceptable (Nanjundaswamy, 1988-89).

Studies with carrot juice beverage and beverage blends showed that to facilitate bottling, carrot juice beverage showed should have not more than 50 per cent carrot juice and among the blends, orange flavoured carrot beverage and carrot pineapple blend obtained higly acceptable scores. Also to imprve acceptability of carrot juice beverage, incorporation of spice extracts were also studied (Annual Report, CFTRI, 1990-91)

Beet root (<u>Beta vulgaris</u>)

According to Gudapati (1988), next to carrot, beet root is the vegetable which has the potential to give a good beverage because of its attractive red colour and sweet taste.

Beverage prepared from beet root juice as such or after blending with grape juice was found to be acceptable. However, beet root cocktail formulation and beet root and tomato juice soup formulation were quite acceptable (Annual Report, CFTRI, 1989-90).

Papaya (<u>Carica papaya</u>)

Nearly every part of the papaya tree including the fruit is said to have some medicinal value due to the presence of a substance called papain, which is an excellent enzyme used to digest the food proteins. Papaya has the property of tenderizing meat and so used in meat cookery. Traditional systems of medicine consider this as milk laxative. Papaya is used in the preparation of jam, soft drinks, crystallised fruits and are canned in syrup (Gopalan and Mohan Ram, 1990).

The fruit of papaya is very nutritious. It contains high quantities of vitamin A, fair quantities of vitamin C, some riboflavin and niacin and is a good source of calcium, phosphorus and iron. Its calorific value is quite suitable for inclusion in a non fattening diet (Singh, 1990).

According to Murali (1991), papaya contains a high amount of vitamin D. It is also used to cure sores, weeping eczema, bruises, leucoderma, chronic constipation, dysentry and piles.

The annual production of papaya in the world has been estimated at approximately 16,00,000 metric tonnes (Singh, 1990) and it is a popular tropical fruit. Papaya ranks second to mango as a source of the precursor of vitamin A (Muthukirshnan and Irulappan, 1990).

Kalra et al., (1996) and Ranote et al., (1993) reported that reducing sugars increased progressively in mango, papaya and their blends during 12 months of storage. It may be due to breakdown of sucrose and other non-reducing sugars during storage. However there were also significant increase in total sugar during storage which could be due to degradation of insoluble polysaccharide like hemicellulose oligosaccharides etc.

In a study conducted by kalra et al., (1991), Mango varieties of Totapuri, Banganpalli, Deshehari and Chausa were blended with papaya in five ratios 1:0, 1:1, 2:1,3:1 and 0:1. which was preserved for one year in glass bottles under ambient conditions (20-36 ^{o}C). The TSS did not change appreciably during storage. All the three blends had slightly better storability as compared to pure mango and papaya beverages.

Tomato (Lycopersicon esculentum)

As customarily used, the tomato is a vegetable. Botanically speaking, however, it is a fruit based on its plant parts (Gould, 1992). Tomato is one of the most important vegetable in the world and in recent years tomato has gained much importance on account of its popularity and liking by people. It is said to prevent the occurrence of cancer and sourness of mouth. It is one of the richest vegetables which keeps our stomach and intestine in good condition (Joshi et al., 1994 and Patil et al., 1991).

Vitamin C, the antiscorbutic vitamin necessary for normal metabolism, wound healing and collagen synthesis, is correctly associated by consumers with tomato juice and other tomato products. The nutritive value of processed tomato products depends both on the initial nutrient concentration in the fresh tomato and on the effects of processing and storage of the finished product (Gould, 1933).

Das (1984-85) stated that tomato juice can be blended with many other vegetable juices which add to the flavour and nutritional value of the product. Mostly carrot and samkraft juices are used in the blends.

Orange (citrus aurantium)

Nutritional foods especially citrus products have always been highly regarded as excellent sources of human nutrition (Kimball,1991) and the commercial products produced are citric acid and pectin which are made primarily from cull and unmarketable fruits.

The citrus fruits are used to improve appetite. They are also useful in scurvy, bilious affections and bilious diarrhoea because of their high ascorbic acid content (Mankad, 1994).

Citrus fruits are among the most important horticultural products enjoyed universally. Citrus is the World's leading tree fruit crop and world's production in 1980 totalled 56.5 million metric tonnes (Bose and Mirta, 1990).

Multifruit RTS beverages of high organoleptic acceptability could be produced from orange by blending other juices of good palatability (Sandu et al., 1992). Selected brands of orange juice is widely used in menu items of hospitals for selected patients (Rita et al., 1980).

Lime (Citrus aurantifolia)

The citrus fruits are primarily grown for the fresh fruit market. They are in great demand for dessert fruits and also as preserves in the form of squash, cordial, marmalade and pickle (Mankad, 1994).

Numerous blended diluted fruit juice drinks have been introduced, several of which have proved quite popular. These blended juice utilize a large quantity of citrus fruits in their manufacture (Tressler et al., 1980).

An attempt was made by Bhatia et al., (1992) to produce citrus beverages especially with lime, at the farm level whereas the cost of 200ml bottle of RTS drink was only Rs.0.42-0.47. Avoidance of middlemen, change in cultivation methods according to processing needs and ultimate reduction in cost are some of the advantages claimed for farm level processing.

Experimental Procedure

III EXPERIMENTAL PROCEDURE

The experimental procedure followed for the study on the "Formulation and Evaluation of Ready-to-Serve Beverages from Vegetable and Fruit Blends" is discussed under the following headings:

A. Selection of Vegetables and Fruits

B. Identification of Best Ratios for Blends of Selected Fruits and Vegetables

C. Preparation of Ready-to-Serve (RTS) Beverages following the Best Ratios

D. Conduct of Acceptability Tests

E. Selection of Nutrients, Other Parameters and Methods of Analysis

F. Calculation of Cost of Processed Items and

G. Analysis of the Data.

A. Selection of Vegetables and Fruits

RTS beverages are commonly prepared with fruits. An attempt was made in this study to prepare RTS beverages with blends of vegetables and fruits in order to reduce the cost and increase the nutritional value of fruit based beverages. Among the vegetables, Carrot (Daucus carota) was selected for its high beta carotene and Beet Root (Beta vulgaris) for its total sugar content. Juices of both the vegetables are attractive in colour which may provide pleasant colours to beverages. The fruits selected include Lime (Citrus aurantifolia) and Orange (Citrus aurantium) for their high ascorbic acid content, Papaya (Carica papaya) for its high beta carotene content and Tomato (<u>Lycopersicon esculentum</u>) for its general nutritional value and wide use among the public.

For beverage preparation the selected fruits and vegetables were purchased fresh without spoilage and of optimum maturity from the market at one time and used appropriately.

B. Identification of Best Ratios for Blends of Selected Fruits and Vegetables

The vegetables such as carrot and beet root were cleaned and the skin was peeled off. They were cut into bigger pieces and cooked with adequate amount of water separately for about 10 minutes. They were then cooled and the pulp was obtained using an electric blender with out discarding the little amount of cooked water.

Lime was cut into halves and the juice was extracted. With regard to orange, the outer skin, albedo portion and the seeds were removed and the juice segments were put in a blender to get the pulp. Papaya was peeled, seeds removed, cut into pieces and the pulp was obtained using a blender. In case of tomato, the fruit was blanched in order to remove the skin and then pulp was extracted. The pulp of the vegetables and fruits were diluted with adequate amount of water to get the juice.

In the laboratory, juices of the respective vegetables and fruits were mixed without any other ingredient to get twenty four ratios from two vegetables and four fruits. These 24 combinations of blended juices were given to the taste panel members after adding uniform amount of sugar to all the samples and the 24 combinations were evaluated using a five point scale score card. The mean scores are given in Appendix IA and IB.

Vegetable juices without fruit blending were also done separately to serve as control for fruit blended vegetable juices. The list of ten best ratios are as follows :

Carrot based		Beet root based	
1. Carrot	(1:0)	6. Beet root	(1:0)
2. Carrot, Lime	(10:1)	7. Beet root, Lime	(10:1)
3. Carrot, Orange	(1:1)	8. Beet root, Orange	(1:1)
4. Carrot, Papaya	(1:1)	9. Beet root, Papaya	(2:1)
5. Carrot, Tomato	(2:1)	10. Beet root, Tomato	(2:1)

C. Preparation of Ready-to-Serve (RTS) Beverages following the Best Ratios

The RTS beverages were prepared for the best ten ratios using the following recipe.

Ingredients

Vegetable or fruit pulp	-	200g
Sugar	-	100 - 130g (15^{o} Brix)
Citric acid	-	2.5 - 3.5g
Water	-	650ml
Potassium metabisulphite	-	100mg per 1000ml

Method

1. Extracted the juices of the selected vegetables and fruits and mixed in the ratios which are judged as best. The mixing was done thoroughly.
2. Using a pocket refractometer, the sugar content of the blends was noted. Then added the required amount of sugar to get 15^{o} Brix.
3. After the sugar was thoroughly dissolved, the juice was filtered using a stainless steel sieve.
4. Required amount of citric acid was added.
5. Heated the juice to a temperature of $90^{o}C$
6. After a period of 5 minutes, added the weighed amount of potassium metabisulphite by dissolving in little amount of juice and then adding to the rest of the juice which was still hot.
7. The RTS beverages were filled into previously sterilized 200 ml narrow mouthed juice bottles in the hot condition, corked and then air cooled.

The formulated vegetable based RTS beverages are shown in Plate I and II.

D. Conduct of Acceptability Tests

The organoleptic scoring is the single most important criterion to determine the consumer acceptability (Kalra *et al.*, 1983). According to Peckham (1987) sensory analysis is more precise, reliable and reproducible.

PLATE I - CARROT BASED RTS BEVERAGES

PLATE II - BEET ROOT BASED RTS BEVERAGES

Therefore the processed RTS beverages were finally evaluated by sensory analysis for appearance, colour, texture, flavour and taste by selected ten trained panel members. A five point scale score card was prepared and used for this purpose (Appendix IIA and IIB). All the required norms were followed during evaluation. RTS beverages were also evaluated after a storage period of three months.

E. Selection of Nutrients, other Parameters and Methods of Analysis

Nutrients

The RTS beverages prepared using carrot and beet root blended with lime, orange, papaya and tomato were analysed for their nutrients in both processed as well as three months stored samples. The nutrients for analysis included beta carotene, ascorbic acid, calcium, phosphorus, iron and reducing sugars.

The beta carotene content was determined using High Performance Liquid Chromatography (Appendix III). The ascorbic acid present in the processed items were determined by 2,6 dichlorophenol indophenol dye method (Ranganna, 1986). Estimations of calcium, phosphorus and iron were carried out using AOAC method (1985). Reducing sugar was estimated by Benedict's Quantitative Method.

Other parameters such as the percentage of Total soluble Solids (TSS) was found out with the help of a pocket refractometer. The pH values of the RTS beverages were determined using a pH meter.

The acid content of the processed beverages was determined by titrating 10 ml of the made up juice against 0.1 N sodium hydroxide with phenolphthalein as indicator.

Sulphur-di-oxide present in the processed items was estimated by the Modified Ripper's Titration method (Ranganna, 1986).

Determination of all the above components and parameters was also done for the RTS beverages after three months of storage.

F. Calculation of Cost of Processed Items

The cost of RTS beverages was calculated taking into account of raw material cost including preservatives and fuel. Finally the cost was calculated for the total number of bottles produced from which the cost per bottle was found out. This will provide information on the cost of processing the selected vegetables and fruits and the scope for commercial application.

G. Analysis of the Data

The values obtained for the nutrients and other parameters for the RTS beverages before and after storage were statistically analysed using paired or dependent t-test (Appendix IV).

Results and Discussion

TABLE I

BETA CAROTENE CONTENT OF PROCESSED AND STORED RTS BEVERAGES (in 100 grams)

S.No.	RTS Beverage (Vegetable, fruit ratio)		Soon after processing (mg)	After 3 months (mg)	Storage loss or gain %
1.	Ca	1:0	1.292	1.205	- 7
2.	Ca:Li	10:1	1.294	1.182	- 9
3.	Ca:Or	1:1	0.665	0.615	- 8
4.	Ca:Pa	1:1	0.734	0.693	- 6
5.	Ca:To	2:1	0.899	0.835	- 7
6.	Be	1:0	-	-	-
7.	Be:Li	10:1	-	-	-
8.	Be:Or	1:1	0.018	0.015	- 17
9.	Be:Pa	2:1	0.059	0.050	- 15
10.	Be:To	2:1	0.039	0.030	- 23

Ca - Carrot, Li - Lime, Or- Orange, Pa-Papaya, To-Tomato, Be - Beet root

EFFECT OF STORAGE ON BETA CAROTENE CONTENT

Particulars	Mean	Standard Error	't' Value
Before storage	0.625		
		0.04	2.95*
After storage	0.578		

* Significant at five per cent level

The beta carotene content was found more among carrot based beverages (0.615 mg to 1.205mg per 100g) when compared to the beet root based beverages (0.015 mg to 0.05

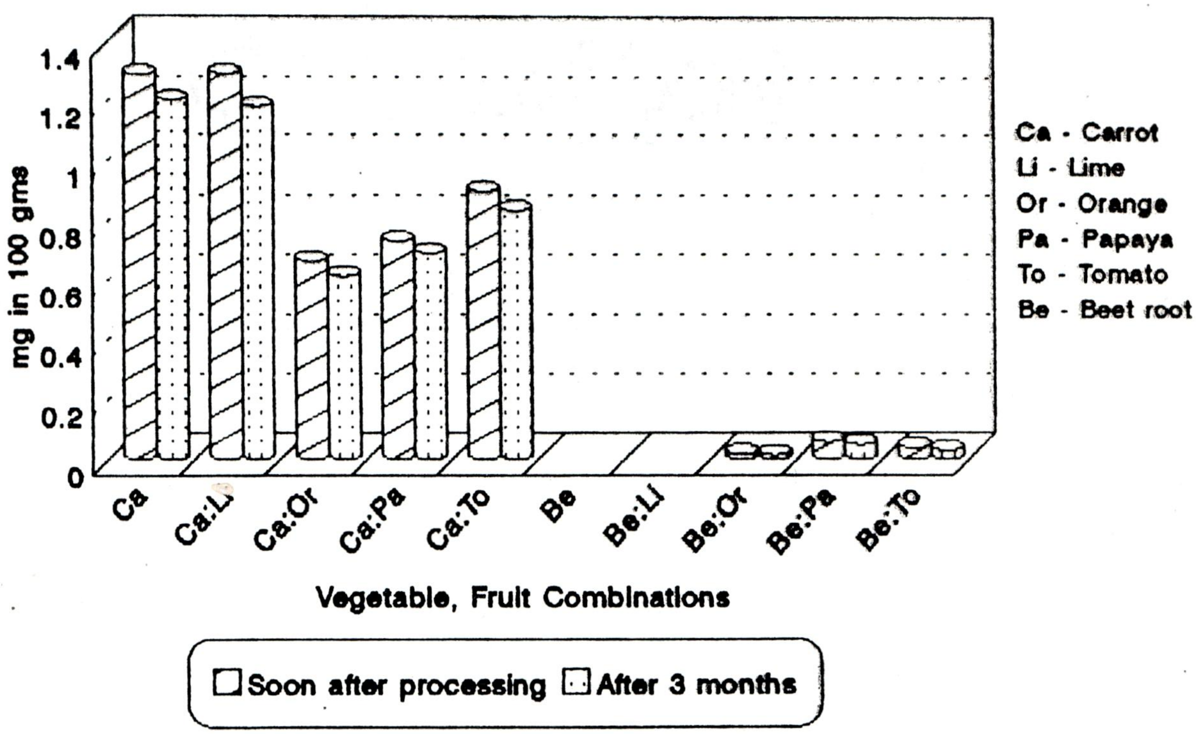

FIGURE I

BETA CAROTENE CONTENT OF PROCESSED AND STORED RTS BEVERAGES

mg per 100g). All the RTS beverages showed a decrease in the beta carotene content on storage. The reduction varied from 6 to 23 per cent. The combination containing carrot and papaya in the ratio of 1:1 showed a lower reduction of six per cent revealing the maximum retention of beta carotene. The combination containing beet root and tomato in the ratio of 2:1 showed a higher reduction of 23 per cent revealing a minimum retention.

The RTS beverages prepared from only beet root and beet root blended with lime were found to have no beta carotene. Very less amount of beta carotene was found among beverages containing beet root with orange,papaya and tomato.

The RTS beverages prepared from beet root based indicated a higher reduction of beta carotene content ranging from 15 to 23 per cent when compared to the RTS beverages prepared from carrot based which showed a lesser reduction ranging from 6 to 9 per cent.

In a study on kinnow-RTS beverages carried out by Ranote et al., (1992), the absorbance for carotenoid extracts was found to be too low (0.05-0.08) and remained constant throughout the storage under ambient conditions. Ranote et al., (1993) further reported that storage of kinnow orange juice in bottles indicated a reduction of total carotenoids from 0.4 to 0.2 Optical Density at 440 nm. The retention of carotenoids might be due to increase in the moisture level as in RTS beverages which exerts a protective effect on carotenoids (Sudhakar and Maini, 1994).

Kalra and Tandon (1996) observed that pure mango and papaya juice had better retention of carotenoid contents throughout the experimental period as compared to their blends. Statistical analysis revealed a significant reduction in the beta carotene content during the three months storage at five per cent level.

2. Ascorbic acid

Table II highlights the ascorbic acid content of RTS beverages in fresh and stored forms (Figure II).

TABLE II

ASCORBIC ACID CONTENT OF PROCESSED AND STORED RTS BEVERAGES (in 100 gms)

S.No.	RTS Beverage (Vegetable, fruit ratio)		Soon after processing (mg)	After 3 months (mg)	Storage loss or gain %
1.	Ca	1:0	0.416	0.393	- 6
2.	Ca:Li	10:1	1.664	1.220	- 26
3.	Ca:Or	1:1	6.240	5.304	- 15
4.	Ca:Pa	1:1	0.832	0.476	- 42
5.	Ca:To	2:1	2.080	1.224	- 41
6.	Be	1:0	2.800	1.428	- 31
7.	Be:Li	10:1	2.912	2.040	- 29
8.	Be:Or	1:1	4.160	3.260	- 13
9.	Be:Pa	2:1	0.832	0.476	- 43
10.	Be:To	2:1	2.496	2.040	- 18

Ca-Carrot, Li-Lime, Or-Orange, Pa-Papaya, To-Tomato, Be-Beet root

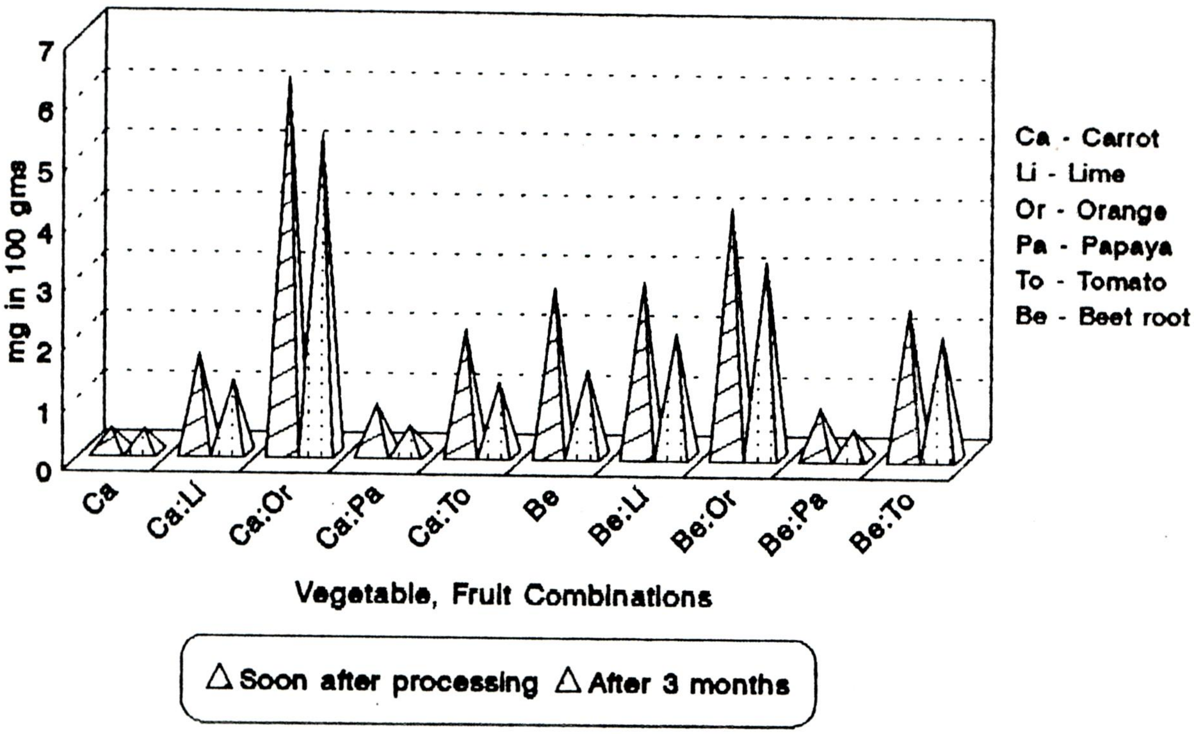

FIGURE II

ASCORBIC ACID CONTENT OF PROCESSED AND STORED RTS BEVERAGES

EFFECT OF STORAGE ON ASCORBIC ACID CONTENT

Particulars	Mean	Standard Error	't' Value
Before Storage	2.371		
		0.29	6.53**
After storage	1.736		

** Significant at one per cent level

Among the various samples, ascorbic acid content was found more among orange blended carrot and beet root RTS beverages whereas it was least among RTS beverages with carrot alone, carrot with papaya and beet root with papaya.

Calculation of storage loss by comparing the values obtained between samples stored for three months and soon after processing, indicated that, there was maximum loss of ascorbic acid ranging from 6 to 43 per cent.

The RTS beverages prepared from beet root and papaya in the ratio of 2:1 showed a maximum loss of about 43 per cent whereas the RTS beverages prepared from carrot alone had a minimum loss of about six per cent only. The RTS beverages containing orange showed a loss of ascorbic acid which varied from 13 to 15 per cent. The loss of ascorbic acid might be attributed to oxidation of the vitamin during storage.

Gould (1993) observed that the shelf life of tomato juice fortified with ascorbic acid was dependent not only on temperature and length of storage, but also upon the ascorbic acid concentration.

Ranote *et al*., (1993) conducted a study on thermal process and shelf-life of Kinnow juice and revealed that there was decrease in ascorbic acid content from 22.2 to 12.0 mg per 100g of the samples.

Roig *et al*., (1994) viewed that exposure of fruit juice to high temperature (>60 ^{0}C) during pasteurization resulted in a considerable loss of this labile vitamin.

Ghosh *et al*., (1981) pointed out that, on pasteurization of fruit juices in flexible pouches, there was a drastic reduction of ascorbic acid in pineapple juice stored upto 30 days from 1.0 to 0.1 mg per 100g of the sample.

Statistical analysis of the data in the study revealed a highly significant loss in ascorbic acid content at one per cent level on storage among the RTS beverages prepared from vegetable and fruit blends.

3. Calcium

The calcium content of fresh and stored RTS beverages is shown in Table III.

TABLE III

CALCIUM CONTENT OF PROCESSED AND STORED RTS BEVERAGES (in 100 gms)

S.No.	RTS Beverage (Vegetable, fruit ratio		Soon after processing (mg)	After 3 months (mg)	Storage loss or gain %
1.	Ca	1:0	18.0	17.6	- 2
2.	Ca:Li	10:1	19.8	19.2	- 3
3.	Ca:Or	1:1	9.0	8.7	- 3
4.	Ca:Pa	1:1	10.8	10.5	- 3
5.	Ca:To	2:1	14.4	14.0	- 3
6.	Be	1:0	3.6	3.5	- 3
7.	Be:Li	10:1	5.4	5.2	- 3
8.	Be:Or	1:1	1.8	1.8	-
9.	Be:Pa	2:1	3.6	3.6	-
10.	Be:To	2:1	7.2	7.0	- 3

Ca - Carrot, Li-Lime, Or-Orange, Pa-Papaya, To-Tomato, Be-Beet root

EFFECT OF STORAGE ON CALCIUM CONTENT

Particular	Mean	Standard Error	't' Value
Before Storage	9.350	0.99	0.79NS
After storage	9.110		

NS- Not significant

The calcium content was found to be more among carrot based RTS beverages (8.7 to 19.2mg per 100g) than beet root based samples (1.3 to 7 mg per 100g). The maximum was for carrot and lime blended (19.8mg) and minimum for beet root and orange samples (1.8 mg).

The storage loss of calcium ranged from 2 to 3 per cent revealing the maximum retention of calcium during the storage period. The RTS beverages prepared from carrot alone showed a minimum reduction of two per cent. The combinations containing carrot with lime, orange, papaya and tomato and beet root with orange and tomato and beet root alone showed a maximum loss of three per cent. The RTS beverages containing beet root with papaya and beet root with orange showed no change in the calcium content on storage.

The difference in calcium content between the fresh and stored samples revealed no significant difference through statistical analysis.

4. Phosphorus

The phosphorus content of RTS beverages immediately after processing and after the storage period is depicted in the Table IV.

TABLE IV

PHOSPHORUS CONTENT OF PROCESSED AND STORED RTS BEVERAGES (in 100 gms)

S.No.	RTS Beverage (Vegetable, fruit ratio)		Soon after processing (mg)	After 3 months (mg)	Storage loss or gain %
1.	Ca	1:0	115.2	115.0	-
2.	Ca:Li	10:1	118.4	118.4	-
3.	Ca:Or	1:1	54.4	53.3	- 2
4.	Ca:Pa	1:1	60.8	59.8	- 2
5.	Ca:To	2:1	80.0	80.0	-
6.	Be	1:0	12.2	12.1	- 1
7.	Be:Li	10:1	12.8	12.8	-
8.	Be:Or	1:1	6.9	6.7	- 3
9.	Be:Pa	2:1	9.1	8.8	- 3
10.	Be:To	2:1	9.6	9.6	-

Ca-Carrot, Li-Lime, Or-Orange, Pa-Papaya, To-Tomato
Be-Beet root

EFFECT OF STORAGE ON PHOSPHORUS CONTENT

Particulars	Mean	Standard Error	't' Value
Before storage	47.940	0.41	2.21NS
After storage	47.650		

NS-Not significant

The phosphorus content was found to be greater among the carrot based beverages (54.4 to 118.4 mg per 100g) when compared to beet root based beverages (6.9 to 12.8 mg per 100g). The maximum was for carrot and lime blend (118.4 mg) and minimum for beet root and orange samples (6.9mg).

The storage loss of phosphorus ranged from 0 to 3 per cent revealing a greater retention during storage. The RTS beverages prepared from carrot alone, carrot with lime, carrot with tomato, beet root with lime and beet root with tomato showed no change in the phosphorus content after storage.

The RTS beverages prepared from beet root alone showed a minimum loss of one per cent phosphorus. The RTS beverages prepared from beet root with orange and beet root with papaya showed a maximum loss of three per cent phosphorus content on storage.

The statistical analysis of the study revealed no significant difference in the phosphorus content during three months storage.

5. Iron

The values of iron for processed and stored RTS beverages are presented in Table V.

TABLE V

IRON CONTENT OF PROCESSED AND STORED RTS BEVERAGES

(in 100 gms)

S.No.	RTS beverages (Vegetable, ruit ratio)		Soon after processing (mg)	After 3 months (mg)	Storage loss or gain %
1.	Ca	1:0	0.220	0.215	3
2.	Ca:Li	10:1	0.220	0.220	-
3.	Ca:Or	1:1	0.180	0.175	3
4.	Ca:Pa	1:1	0.160	0.155	3
5.	Ca:To	2:1	0.190	0.190	-
6.	Be	1:0	0.260	0.255	2
7.	Be:Li	10:1	0.260	0.260	-
8.	Be:Or	1:1	0.200	0.185	3
9.	Be:Pa	2:1	0.210	0.205	2
10.	Be:To	2:1	0.220	0.220	-

Ca-Carrot, Li-Lime, Or-Orange, Pa-Papaya, To-Tomato, Be-Beet root

EFFECT OF STORAGE ON IRON CONTENT

Particulars	Mean	Standard Error	't' Value
Before storage	0.212	0.05	0.25 NS
After storage	0.208		

NS-Not significant

The iron content of all the samples ranged within 0.18 to 0.26 mg in the fresh beverages. Beet root with lime and beet root alone had the highest iron content namely 0.26mg per 100g.

The storage loss of iron was found to be in the range of 2 to 3 per cent. The combinations containing carrot and lime, beet root and lime; carrot and tomato and beet root and tomato did not show any change in the iron content after the storage period.

The combinations containing beet root alone and beet root with papaya showed a minimum loss of two per cent iron content. The RTS beverages prepared from carrot alone, carrot with papaya and beet root with orange showed a maximum loss of three per cent iron content.

Statistical analysis revealed no significant difference in the iron content during the three months storage.

The findings of the study revealed that calcium, iron and phosphorus being more stable, did not reduce much on storage in contrast to the vitamins like ascorbic acid and beta carotene present in the RTS beverages.

6. Reducing sugars

The reducing sugar content of RTS beverages immediately after processing and after three months of storage is given in Table VI and Figure III.

TABLE VI

REDUCING SUGAR CONTENT OF PROCESSED AND STORED RTS BEVERAGES (in 100 gms)

S.No.	RTS Beverage (Vegetable, fruit ratio)		Soon after processing (g)	After 3 months (g)	Storage loss or gain %
1.	Ca	1:0	5.304	5.609	+ 6
2.	Ca:Li	10:1	5.422	5.810	+ 7
3.	Ca:Or	1:1	5.674	5.951	+ 5
4.	Ca:Pa	1:1	6.972	7.394	+ 6
5.	Ca:To	2:1	4.880	5.304	+ 9
6.	Be	1:0	2.568	2.742	+ 7
7.	Be:Li	10:1	2.939	3.089	+ 5
8.	Be:Or	1:1	3.012	3.275	+ 7
9.	Be:Pa	2:1	4.979	5.222	+ 5
10.	Be:To	2:1	2.624	2.870	+ 9

Ca-Carrot, Li-Lime, Or-Orange, Pa-Papaya, To-Tomato, Be-Beet root

EFFECT OF STORAGE ON REDUCING SUGAR CONTENT

Particulars	Mean	Standard Error	't' Value
Before storage	4.437	0.09	9.51**
After storage	4.727		

** Significant at one per cent level

Though carrot and beet root are sweeter, the reducing sugar content was found to be more among carrot based RTS beverages. The reducing sugar content was maximum

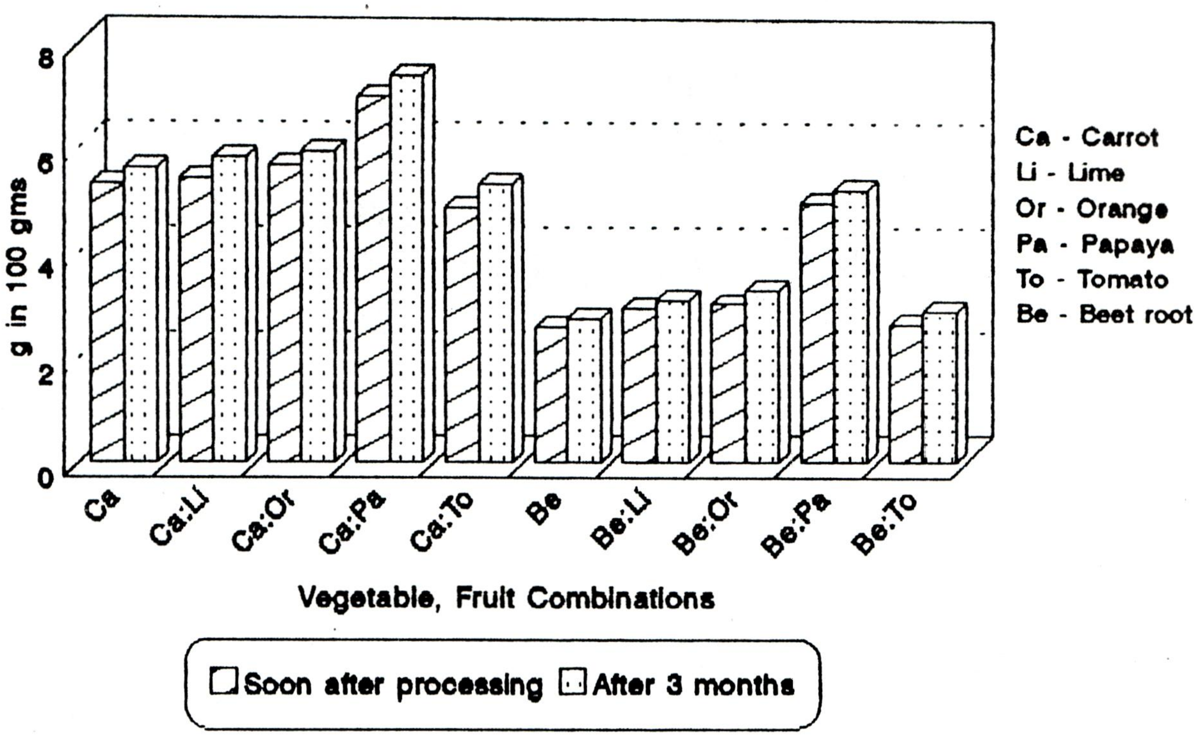

FIGURE III

REDUCING SUGAR CONTENT OF PROCESSED AND STORED RTS BEVERAGES

for carrot and papaya blended beverage (6.972g) and minimum for the beverage prepared from beet root alone (2.568g).

During storage the RTS beverages showed an increased reducing sugar content ranging from 5 to 9 per cent. A maximum increase of nine per cent had been observed among the combinations of carrot with tomato and beet root with tomato. On the contrary, a minimum increase of five per cent reducing sugar content was seen among the combinations of carrot with orange, beet root with lime and beet root with papaya.

Both the RTS beverages prepared from carrot alone and the combination of carrot with papaya showed an increase of six per cent reducing sugar content. The combinations containing beet root with orange and beet root alone showed an increase of seven per cent in the reducing sugar content.

Beerh et al., (1989) observed that during storage there was a substantial increase in reducing sugar content in all the beverages prepared from mango varieties which may be due to the hydrolysis of non-reducing sugar on storage. Also they reasoned out that the increase was due to inversion of non-reducing sugar during hot filling and processing under prevalent acidic conditions. An increased reducing sugar content on storage was also reported among carrot based RTS beverages by Malathi et al., (1992).

Statistical analysis of the data revealed a highly significant increase in the reducing sugar content during three months storage at one per cent level.

B. Other Parameters

7. pH values

Table VII highlights the pH values of processed and stored RTS beverages

TABLE VII

pH VALUES FOR PROCESSED AND STORED RTS BEVERAGES (in 100 grams)

S.No.	RTS Beverage (Vegetable, fruit ratio		Soon after processing	After 3 months	Storage loss or gain %
1.	Ca	1:0	3.4	3.3	- 3
2.	Ca:Li	10.1	3.1	3.0	- 3
3.	Ca:Or	1:1	3.2	3.1	- 3
4.	Ca:Pa	1:1	3.3	3.2	- 3
5.	Ca:To	2:1	3.3	3.3	-
6.	Be	1:0	3.5	3.4	- 3
7.	Be:Li	10:1	3.1	3.0	- 3
8.	Be:Or	1:1	3.2	3.2	-
9.	Be:Pa	2:1	3.2	3.1	- 3
10.	Be:To	2:1	3.3	3.2	- 3

Ca- Carrot, Li-Lime, Or-Orange, Pa-Papaya, To-Tomato
Be-Beet root

EFFECT OF STORAGE ON pH VALUES

Particulars	Mean	Standard Error	't' Value
Before storage	3.260	0.74	0.34NS
After storage	3.180		

NS-Not significant

The initial pH values of all the samples ranged from 3.1 to 3.5. The changes in the pH values of RTS beverages ranged within three per cent. The RTS beverages prepared from the combination of carrot with tomato and beet root with orange showed no change in the pH values on storage.

The combinations containing carrot alone, carrot with lime, carrot with papaya and carrot with tomato and the combinations containing beet root alone, beet root with lime, beet root with papaya and beet root with tamato showed a maximum change of three per cent in pH values. The changes in pH values were very neglibible.

Chakraborty et al., (1993) studied the chemical changes in RTS beverages during storage at room temperature and revealed that the beverages containing clarified water-melon juice, clarified watermelon-lime juice and clarified watermelon-pineapple juice showed reduction in the pH values from 3.55 to 3.45, 3.48 to 3.40 and 3.56 to 3.45 respectively. No major changes in pH values were noticed in

RTS beverages prepared from mango by Beerh et al., (1989). Similar observations of slight reduction in pH of RTS beverages were also reported by Malathi et al., (1992).

Statistical analysis of the data in the study revealed no significant difference in the pH value among the RTS beverages from vegetable and fruit blends.

8. TSS Content

The Total Soluble Solids content of processed and stored RTS beverages are compared in Table VIII.

TABLE VIII

TSS OF PROCESSED AND STORED RTS BEVERAGES
(in 100 gms)

S.No.	RTS Beverage (Vegetable, fruit ratio)		Soon after processing (Brix)	After 3 months (Brix)	Storage loss or gain %
1.	Ca	1:0	15.0	16.0	+ 7
2.	Ca:Li	10:1	15.0	15.0	-
3.	Ca:Or	1:1	15.0	16.0	+ 7
4.	Ca:Pa	1.1	15.0	16.0	+ 7
5.	Ca:To	2:1	15.0	15.5	+ 3
6.	Be	1:0	15.0	15.5	+ 3
7.	Be:Li	10:1	15.0	15.0	-
8.	Be:Or	1:1	15.0	16.0	+ 7
9.	Be:Pa	2:1	15.0	16.0	+ 7
10.	Be:To	2:1	15.0	15.5	+ 3

Ca-Carrot, Li-Lime, Or-Orange, Pa-Papaya, To-Tomato, Be-Beet root

EFFECT OF STORAGE ON TSS CONTENT

Particulars	Mean	Standard Error	't' Value
Before storage	15.000	0.35	6.32**
After storage	15.700		

** Significant at one per cent level

All the RTS beverages prepared had 15^{o} Brix at the start of the experiment The TSS content of the RTS beverages increased from 3 to 7 per cent on storage. The combinations containing lime showed no change in the TSS content. A minimum change of three per cent in TSS was observed among the RTS beverages prepared from beet root alone and the combination of beet root with tomato and carrot with tomato. Among RTS beverages of carrot alone, carrot/beet root with orange and papaya showed a maximum increase of seven per cent in TSS.

In the thermal process of Kinnow orange into RTS beverage, Ranote et al., (1992) observed no change in the TSS after a storage period of 24 weeks whereas they observed an increase in sugar content after prolonged storage. Similarly Kalra et al., (1991) showed that there was no change seen in the RTS beverages of papaya and mango blends on storage . The slight increase in TSS in the present study might be due to hydrolysis of carbohydrate during storage.

In another study by Kalra and Tandon (1996) with papaya and mango blends, a slight increase in TSS during the 12 months storage was observed.

Statistical analysis revealed a significant difference in the TSS content during three months storage at one per cent level.

9. Acidity

The acid content present in the processed and stored RTS beverages is presented in Table IX.

TABLE IX

ACID CONTENT OF PROCESSED AND STORED RTS BEVERAGES

(in 100 gms)

S.No.	RTS Beverage (Vegetable, fruit ratio)	Soon after processing (mg)	After 3 months (mg)	Storage loss or gain %
1.	Ca 1:0	0.24	0.25	+ 4
2.	Ca:Li 10:1	0.30	0.32	+ 7
3.	Ca:Or 1:1	0.29	0.30	+ 3
4.	Ca:Pa 1:1	0.29	0.30	+ 3
5.	Ca:To 2:1	0.29	0.29	-
6.	Be 1:0	0.24	0.25	+ 4
7.	Be:Li 10:1	0.30	0.32	+ 7
8.	Be:Or 1:1	0.29	0.29	-
9.	Be:Pa 2:1	0.29	0.30	+ 3
10.	Be:To 2:1	0.29	0.30	+ 3

Ca - Carrot, Li-Lime, Or-Orange, Pa-Papaya, To-Tomato,
Be - Beet root

EFFECT OF STORAGE ON ACID CONTENT

Particulars	Mean	Standard Error	't' Value
Before storage	0.282	0.04	6.01**
After storage	0.292		

** Significant at one per cent level

The acid content of all the fresh RTS beverages ranged from 0.24 to 0.30.The RTS beverages prepared with the combination of lime had more acid content whereas those from carrot and beet root alone contained less acid content. On storage, the acid content of RTS beverages was found to increase in the range of 3 to 7 per cent. RTS beverages prepared from the combination of carrot with tomato and beet root with orange showed no change in the acid content.

The combinations containing lime showed a maximum increase of seven per cent of acid content on storage RTS beverages prepared from the combination of carrot with orange and carrot with papaya for both showed a minimum increase of three per cent in the acid content. The combinations containing lime showed a maximum increase of seven per cent acid content on three months storage.

Kalra et al., (1988) reported that mango based market beverages with a 18 per cent TSS had 0.23 to 0.24mg per cent acidity.

Statistical analysis revealed a significant difference at one per cent level in the acid content of samples on storage.

10. Sulphur-di-oxide

The sulphur-di-oxide content of processed RTS beverages are tabulated in Table X.

TABLE X

SULPHUR-DI-OXIDE CONTENT OF PROCESSED RTS BEVERAGES
(mg in 100 gms)

S.No.	RTS Beverages Vegetable, fruit ratio		After processing
1.	Ca	1:0	395
2.	Ca:Li	10:1	385
3.	Ca:Or	1:1	400
4.	Ca:Pa	1:1	390
5.	Ca:To	2:1	410
6.	Be	1:0	395
7.	Be:Li	10:1	400
8.	Be:On	1:1	405
9.	Be:Pa	2:1	390
10.	Be:To	2:1	405

Ca- Carrot, Li: Lime, Or-Orange, Pa-Papaya,
To- Tomato, Be- Beet root

The residual sulphur-di-oxide content of RTS beverages ranged from 385 to 410 ppm. The combination containing carrot with tomato in the ratio of 2:1 contained a maximum residual amount of 410 ppm of sulphur-di-oxide. The RTS beverages prepared by combining carrot and lime contained a minimum of 385 ppm sulphur -di-oxide.

Kalra and Tandon (1996) observed that among the mango and papaya blends at different ratios, the total sulphur-di-oxide level dropped significantly in almost all the samples after 12 months storage under ambient conditions.

C. Acceptability Tests

The mean scores obtained for acceptability tests of the different RTS beverages soon after processing and after three months of storage as evaluated by the taste panel members are depicted in Table XI.

TABLE XI

MEAN SCORES OF PROCESSED AND STORED RTS BEVERAGES

(Maximum scores : 25)

S.No.	RTS Beverage (Vegetable fruit ratio		Soon after processing	After 3 months	Diffference
1.	Ca	1:0	19.9	20.3	0.4*
2.	Ca:Li	10:1	18.5	13.8	- 4.7
3.	Ca:Or	1:1	19.6	18.9	- 0.7
4.	Ca:Pa	1:1	16.3	15.2	- 1.1
5.	Ca:TO	2:1	18.1	17.4	- 0.7
6.	Be	1:0	18.5	17.6	- 0.9
7.	Be:Li	10:1	18.6	15.1	- 3.5
8.	Be:Or	1:1	21.0	16.2	- 4.8
9.	Be:Pa	2:1	17.2	16.4	- 0.8
10.	Be:To	2:1	20.3	16.4	- 3.9

Ca-Carrot, Li-Lime, Or-Orange, Pa-Papaya, To-Tomato, Be-Beet root

* Increase

Among all the beverages beet root with orange, beet root with tomato, carrot alone and carrot with orange were found to be highly acceptable as revealed through the highest scores obtained. The beverages containing papaya in combination with carrot and beet root got [illegible] scores because the strong flavour of papaya did not [illegible] well with the flavourful vegetables namely carrot and beet root.

On three months storage, the RTS beverages prepared from carrot alone showed slight increase in scores. The lime blended carrot and beet root beverages got lowest scores after three months storage. Nanjundaswamy (1988-89) also reported that among RTS beverages, carrot juice blended with lime was least acceptable. All the other beverages were acceptable within limits after storage. With regard to the rest of the samples a significant difference in scores was not observed.

Sensory evaluation results indicated that the fruit blended vegetable beverages were acceptable immediately after processing to a great extent, compared to three months stored samples where slight quality changes were observed. This proves the scope of preparing fruit blended vegetable based RTS beverages for immediate and short term exploitation in the commercial markets.

D. Cost of Processed RTS Beverages

The cost of processing RTS beverages is given in Table XII.

TABLE XII

PROCESSING COST OF RTS BEVERAGES

(In Rupees)

S. No	Vegetable and fruit in grams		Ratio	Vegeta-bles	Sugar	Preserva-tive	Citric acid	Gas	Bottle* (4)	Corks (4)	Total	One bottle of RTS
1.	Ca	200:0	1:0	3.00	1.45	0.05	0.30	0.10	4.00	0.55	9.45	2.35
2.	Ca:Li	200.20	10:1	3.50	1.45	0.05	0.30	0.10	4.00	0.55	9.95	2.50
3.	Ca:Or	100:1 0	1:1	2.00	1.45	0.05	0.35	0.10	4.00	0.55	8.50	2.10
4.	Ca:Pa	100:100	1:1	1.90	1.45	0.05	0.35	0.10	4.00	0.55	8.40	2.10
5.	Ca:To	133:3: 66.7	2:1	2.50	1.45	0.05	0.35	0.10	4.00	0.55	9.00	2.25
6.	Be	200:0	1:0	2.00	1.35	0.05	0.30	0.10	4.00	0.55	8.35	2.10
7.	Be:Li	200:20	10:1	2.50	1.35	0.05	0.30	0.10	4.00	0.55	8.85	2.20
8.	Be:Or	100:100	1:1	1.50	1.35	0.05	0.35	0.10	4.00	0.55	7.90	2.00
9.	Be:Pa	133.3: 66.7	2:1	1.60	1.35	0.05	0.35	0.10	4.00	0.55	8.00	2.00
10.	Be:to	133.3: 66.7	2:1	1.85	1.35	0.05	0.35	0.10	4.00	0.55	8.25	2.05

* - 200 ml capacity
Ca- Carrot, Li-Lime, Or-Orange, Pa-Papaya, To-Tomato, Be-Beet root

Summary and Conclusion

V. SUMMARY AND CONCLUSION

Ready-to-Serve beverage have gained popularity in the country since it is easy to consume and there is no other treatment carried out after the processing as the name suggests. Currently, the beverages which are marketed do not contain a large percentage of fruit pulp when compared with the home made juices. There is a need to prepare and sell vegetable and fruit juices in their natural forms at economical prices. A number of juices could be prepared by blending one or two fruits and vegetables.

Fruits and vegetables provide appreciable amounts of vitamins, minerals and essential nutrients to the diet. India ranks number two in the world among the fruits and vegetable producing countries and contribute eight per cent of the total global production. It is estimated that about 25 million tonnes of fruits and 48 million tonnes of vegetables are produced annually in the country. But the processing industry has the capacity to handle only about 1.5 per cent of the total output of fruits and vegetables.

Eventhough various kinds of fruits and vegetables are available almost the year round, most of the seasonal items in thousands of tonnes go waste and are discarded because of failure to meet the fresh standards. Some fruit varieties can be blended for processing to utilise profitably which might not have otherwise favourable characteristics.

Since there are inadequate studies on blending of fruit and vegetable juices and the nutritional importance of the processed items, this study was carried out to find out the best combinations of RTS beverages from fruit and vegetable blends and study the storage changes.

In this study, first a preliminary test was carried out in the laboratory by blending fruit and vegetable juice without adding any other ingredients like potassium metabisulphite and citric acid. Vegetables like carrot and beet root were selected and blended with fruits like lime, orange, papaya and tomato in order to get twenty four combinations. The vegetable juices without blending with any fruit juice were also prepared as controls. All the combinations were evaluated organoleptically by selected ten trained taste panel members and the results obtained helped to select the best ratios among the different combinations prepared.

Based on the results obtained by the preliminary test, the ten best ratios were followed up to prepare the RTS beverages. The processing method of RTS beverages included the extraction of pulp from vegetables and fruits and blending with required amount of sugar to bring the concentration to 15^{o} Brix and adding the required amount of citric acid. The juice was then boiled to 90^{o}C and weighed amount of potassium metabisulphite was added and filled hot into the narrow mouthed bottles of 200 ml capacity which were sterilised earlier. Air cooled the bottles and stored for a period of three months in a cool and dry place.

As soon as the RTS beverages were prepared, the nutrient contents like beta carotene, ascorbic acid, calcium, phosphorus, iron and reducing sugar were estimated. Other parameters like Total Soluble Solids (TSS), acidity, pH values and sulphur-di-oxide were also found out. The RTS beverages were tested for the nutrient contents and other parameters after three months storage.

A five point scale score card was formulated and the acceptability of the RTS beverages was evaluated by a group of ten trained taste panel members. The cost of processing was also computed for all the ten RTS beverages in order to compare with the commercial products.

The results obtained by the study is summarised as follows:

1. The beta carotene content was found to be higher in carrot based RTS beverages . On storage, beta carotene was lost in the range of 6 to 23 per cent. The combination containing carrot and papaya showed a minimal reduction of six per cent and the combination containing beet root and tomato showed a maximum reduction of 23 per cent. The RTS beverages prepared from only beet root and beet root blended with lime were found to have no beta carotene content.

Statistical analysis revealed a significant reduction at five per cent level in the beta carotene content during storage

2. The ascorbic acid content was found more among orange blended carrot and beet root beverages. The storage loss of ascorbic acid ranged from 6 to 43 per cent. The combination containing beet root and papaya showed a maximal loss of 43 per cent and the RTS beverage prepared from carrot alone showed a minimal loss of six per cent. The loss of ascorbic acid might be due to oxidation on storage.

   Statistical analysis revealed a highly significant loss at one per cent level in the ascorbic acid content during storage.

3. The carrot based RTS beverages were found to contain more calcium content. The storage loss of calcium ranged from 0 to 3 per cent. The RTS beverages containing beet root with papaya and beet root with orange showed no change in the calcium content. The combinations containing carrot with lime, orange, papaya and tomato and beet root with orange and tomato and beet root alone showed a three per cent loss of calcium content on storage.

   Statistically there was no significant difference in the calcium content due to storage.

4. The phosphorus content was higher among the carrot based beverages The storage loss of phosphorus ranged from 0 to 3 per cent. The RTS beverages prepared from beet root with orange and papaya showed a maximum loss of three per cent phosphorus content.

There was no significant difference in phosphorus content on storage as revealed through statistical analysis.

5. In the fresh beverages, the iron content of all the samples ranged within 0.18 to 0.26 mg per 100g. The storage loss of iron ranged from 0 to 3 per cent. The combinations containing lime and tomato showed no change in the iron content after storage. The RTS beverages prepared from carrot alone, carrot with papaya and beet root with orange showed a maximum loss of three per cent of iron.

There was no statistically significant difference in the iron content after storage.

The findings of the study revealed that calcium, iron and phosphorus being more stable, did not reduce much on storage in contrast to the vitamins like ascorbic acid and beta carotene present in the RTS beverages

6. The carrot based RTS beverages contaied higher amount of reducing sugar when compared to beet root

based samples. The maximum was in carrot and papaya blended (6.927g) and minimum was in the RTS beverage prepared from beet root alone (2.568g). All the RTS beverages showed an increase in the reducing sugar content during storage ranging from 5 to 9 per cent. A maximum increase of nine per cent was observed among tomato blended beverages.

Statistically, the increase in the reducing sugar content during storage period was highly significant at one per cent level.

7. The initial pH values of all the samples ranged from 3.1 to 3.5. The changes in the pH values on storage varied from 0 to 3 per cent. The combination containing carrot with tomato and beet root with orange showed no change in the pH values. All other combinations showed a maximum change of three per cent of pH values.

The differences in the pH values on storage was not statistically significant.

8. The TSS content of all the fresh beverages was 15^{o} Brix at the start of the experiment which increased by seven per cent for some combinations on storage. The combination containing lime alone showed no change in the TSS content whereas beverages prepared from carrot alone, carrot/beet

root with orange and papaya showed a maximum increase of seven per cent.

Statistically, the difference in the TSS content was found to be highly significant at one per cent level.

9. The acid content of the formulated RTS beverages ranged from 0.24 to 0.30. On storage, acidity increased by seven per cent among the combinations containing carrot/beet root with lime. The RTS beverages prepared from carrot with tomato and beet root with orange showed no change in the acid content on storage.

The change in the acid content during storage was highly significant at one per cent level.

10. The residual sulphur-di-oxide content of RTS beverages ranged from 385 - 410 ppm. The combination containing carrot and tomato contained a maximum residual amount of 410 ppm of sulphur-di-oxide and the combination containing carrot and lime had a minimum of 385 ppm.

11. Among all the beverages carrot, carrot with orange, beet root with orange and beet root with tomato were found to be highly acceptable as revealed through the highest scores obtained. The combination containing papaya got the lowest scores

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Appendices

APPENDIX IA

DIFFERENT RATIOS AND MEAN SCORES OF CARROT BASED BLENDS

S. No.	Vegetable/ Fruit	Appearance (5)	Colour (5)	Texture (5)	Flavour (5)	Taste and acceptability (5)	Total (25)
a.	Carrot :Lime						
i.	10:1	4.2	3.9	4.5	3.8	3.6	20.0
ii.	10:2	4.2	3.9	4.0	3.5	3.3	18.9
iii.	10:3	4.1	3.7	3.5	3.2	3.0	17.5
b.	Carrot :Orange						
i.	1:1	4.3	4.2	4.6	4.0	4.1	21.2
ii.	1:2	4.1	4.2	4.5	3.9	3.7	20.4
iii.	2:1	4.2	4.1	4.5	3.7	3.3	19.8
c.	Carrot:Papaya						
i.	1:1	3.7	4.0	4.1	4.8	4.4	21.0
II.	1:2	3.6	3.7	4.0	4.4	3.9	19.6
iii.	2:1	3.4	3.3	4.2	4.7	4.2	19.8
d.	Carrot : Tomato						
i.	1:1	4.3	3.8	3.6	4.3	3.5	19.5
ii.	1:2	4.8	3.5	2.9	4.0	3.2	18.4
iii.	2:1	4.5	4.0	4.1	4.6	3.9	21.1

APPENDIX IB

DIFFERENT RATIOS AND MEAN SCORES OF BEET ROOT BLENDS

S. No.	Vegetable/ fruit	Appearance (5)	Colour (5)	Texture (5)	Flavour (5)	Taste and acceptability (5)	Total (25)
a.	Beetroot:Lime						
i.	10:1	3.9	4.3	4.1	4.3	4.2	20.8
ii.	10:2	3.9	4.2	4.2	3.5	3.0	18.8
iii.	10:3	4.0	4.3	4.4	3.2	2.8	18.7
b.	Beet root:Orange						
i.	1:1	4.2	4.5	4.3	4.0	4.3	21.4
ii.	1:2	3.7	4.6	4.4	3.8	3.7	20.2
iii.	2:1	3.7	4.5	3.9	4.2	4.1	20.4
c.	Beet root:Papya						
i.	1:1	3.9	3.8	4.2	3.9	3.4	19.2
ii.	1:2	3.8	2.7	3.6	3.7	3.1	17.9
iii.	2:1	4.0	3.9	4.5	4.1	4.0	20.5
d.	Beet root:Tomato						
i.	1:1	3.0	3.4	4.5	3.8	3.5	18.2
ii.	1:2	3.6	2.9	4.1	3.9	3.1	17.6
iii.	2:1	4.2	3.8	4.7	4.4	3.9	21.0

APPENDIX IIA

SCORE CARD FOR CARROT BASED RTS BEVERAGES

S.NO.	Criteria	Score	1	2	3	4	5
1.	APPEARANCE						
	Very clear	5					
	Clear	4					
	Slightly cloudy	3					
	Cloudy	2					
	Very cloudy	1					
2.	COLOUR						
	Orange	5					
	Reddish orange	4					
	Light orange	3					
	Brownish orange	2					
	Brownish	1					
3.	TEXTURE						
	Juicy	5					
	Slightly thick	4					
	Moderately thick	3					
	Very thick	2					
	Very watery	1					
4.	FLAVOUR						
	Pleasant sweet flavour	5					
	Very strong	4					
	Slightly strong	3					
	Weak flavour	2					
	Unpleasant bitter	1					
5.	TASTE AND ACCEPTABILITY						
	Excellent	5					
	Very good	4					
	Good	3					
	Fair	2					
	Poor	1					

APPENDIX IIB

SCORE CARD FOR BEET ROOT BASED RTS BEVERAGES.

S.NO.	Criteria	Score	1	2	3	4	5
1.	APPEARANCE						
	Very clear	5					
	Clear	4					
	Slightly cloudy	3					
	Cloudy	2					
	Very cloudy	1					
2.	COLOUR						
	Medium red	5					
	Dark red	4					
	Reddish brown	3					
	Light brown	2					
	Dark brown	1					
3.	TEXTURE						
	Juicy	5					
	Slightly thick	4					
	Moderately thick	3					
	Very thick	2					
	Very watery	1					
4.	FLAVOUR						
	Pleasant sweet flavour	5					
	Very strong	4					
	Slightly strong	3					
	Weak flavour	2					
	Unpleasant bitter	1					
5.	TASTE AND ACCEPTABILITY						
	Excellent	5					
	Very good	4					
	Good	3					
	Fair	2					
	Poor	1					

APPENDIX III

ESTIMATION OF BETA COROTENE

PRINCIPLE

Only a few over 500 carotenoids found in nature have vitamin A activity. The most prevalent and active carotenoid present in foods is All trans beta carotene. HPLC is considered to be the most reliable, efficient and reproducible method for carotenoid analysis. The carotenoids in food stuffs are generally associated with the lipid fraction. Hence beta carotene in the food is saponified with lipid fraction. Hence beta carotene in the food is saponified with alcoholic potassium hydroxide and extracted with petroleum ether (60^{o}-80^{o}), filtered and carotenoid pigments separated, identified and estimated using reversed phase isoelectric solvent system. Identification and quantification are based on the retention time and peak area of the individual samples.

Reagents:-

1. 12% alcoholic potassium hydroxide
2. Petroleum ether (60^{o} - 80^{o})
3. HPLC grade solvents - methanol, acetonitrile dichloromethane
4. Calcium carbonate
5. Anhydrous sodium sulphate
6. Beta carotene standard (Sigma chemical co USA)

Procedure

1 Take a weighed amount of the sample in a mortar and pestole add a small quantity of glass powder

and a small amount of 12 per cent potassium hydroxide and macerated well.

2. Transfer into a conical flask and wash the remaining contents in the mortar and pestle by 12 per cent potassium hydroxide (Potassium hydroxide is added so that the sample is immersed in it completely.

3. Mix it well by a vortex mixer

4. Place it in a shaking water bath at 37 ^{o}C for half an hour

5. Rename the conical flask and transfer it into a separating funnel. Calcium carbonate is added previously to the separating funnel before the extract is transfered. Petroleum ether 60-80 ^{o}C is added to wash the extract and the amount depends on removing the extract. Calcium carbonate helps to remove non-carotenoids.

6. The process of washing with petroleum ether is continued till there is no colow.

7. The extract is filtered through anhydrous sodium sulphate to remove moisture. The exact volume is noted.

Determination of beta carotene by HPLC

One ml of the sample solution is filtered through 0.45 millimicron filter and 20 microlitres is used for quantification in High Performance Liquid Chromatography.

The HPLC schimadzu model is equipped with a variable wavelength and integrator. The wave-length is set at 450 nm. A stainless steel column 150x4.6 mm id prepacked with shim pack CLC ODS packing is used for carotenoid analysis. The solvent system, acetonitrile: dicholromethane : Methanol, all HPLC grade solvents (70:20:10) is pumped at a flow rate of 2 ml /minute Beta carotene standard used are of sigma chemical Co (U.S.A.) - Type IV Synthetic from carrots.

An external standard is used for quantification. Because of the variation in the concentration of compounds to be analysed in the food matrix, no internal standard is used. The HPLC was calibrated daily by injecting a full loop (20 micro litres) of each standard solution in duplicate or triplicate. Each sample is injected in duplicate. Concentration of each compound is determined from the calibration plot in which peak area was plotted against concentration (ng/ml). The detection responses are linear over the concentration charge 25-100 mg per 20 micro litres. All results are expressed as micro litre per gram of fresh weight (micro gram/gram fresh weight) of the food stuff. Peak identification is based on the retention times and comparison with standards and co-chromatography with the standards.

CALCULATION:

(a) Weight of the sample :

(b) Total Volume

(c) Optical density (O.D)

(d) Beta carotene = $\dfrac{\text{Volume x O.D mcg in 100gs}}{\text{Weight of the sample}}$

APPENDIX IV

METHOD USED FOR STATISTICAL ANALYSIS

Paired on dependent t-test was used to test the difference between means of two samples which are related to one another in any significant manner. The formula used for the analysis of before and after stages as follows :

$$t_{n-1} = \frac{\bar{d} \cdot \sqrt{n}}{S.E\ (d)}$$

Where t	=	calculated 't' value
n-1	=	degree of freedom
n	=	Sample size
d	=	mean of the difference calculated by the formula
d	=	d/n
where d	=	sum of differences
n	=	sample size
S.E. x d	=	Standard error of the mean differnce calculated by the formula

$$S.E. \times (\bar{d}) = \frac{\Sigma d^2 - n(\bar{d})^2}{n-1}$$

Where d^2	=	sum of the squares of the individual differences
d	=	sum of the differences
n	=	sample size

If the calculated value of t is greater than the table value it is concluded that the difference in sample mean is significant. On the other hand, if the calculated value of t is less than the table value, the difference is not significant