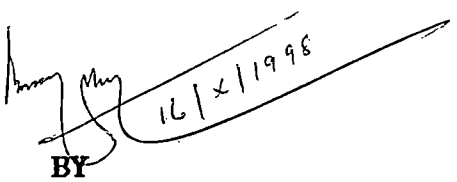
DEVELOPMENT OF PAPAYA (CARICA PAPAYA L.) BASED BLENDED PRODUCTS



BY

BEENA CHERIAN

THESIS

SUBMITTED IN PARTIAL FULFILMENT

OF THE REQUIREMENT FOR THE DEGREE

MASTER OF SCIENCE IN HOME SCIENCE

(FOOD SCIENCE AND NUTRITION)

FACULTY OF AGRICULTURE

KERALA AGRICULTURAL UNIVERSITY

DEPARTMENT OF HOME SCIENCE

COLLEGE OF AGRICULTURE

VELLAYANI, THIRUVANANTHAPURAM

1998

DECLARATION

I hereby declare that this thesis entitled "**Development of papaya (*Carica papaya* L.) based blended products**" is a bonafide record of research work done by me during the course of research and that the thesis has not previously formed the basis for the award to me of any degree, diploma, associateship, fellowship or other similar title, of any other University or Society.

Beena Cherian

Vellayani
Date: 15-10-98

BEENA CHERIAN

CERTIFICATE

Certified that this thesis entitled "**Development of papaya (*Carica papaya* L.) based blended products**" is a record of research work done independently by **Miss. Beena Cherian** 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.

Smt. SOFFI CHERIYAN
(Chairman, Advisory Committee)
Assistant Professor
Department of Home Science
College of Agriculture
Vellayani

Vellayani,
Date: 15-10-1998.

APPROVED BY

CHAIRMAN

Smt. SOFFI CHERIYAN
Assistant Professor
Department of Home Science
College of Agriculture
Vellayani

MEMBERS

Dr. (Mrs.) L. PREMA
Professor and Head
Department of Home Science
College of Agriculture
Vellayani

19/12/98

Dr. (Mrs.) MARY UKKURU. P.
Associate Professor
Department of Home Science
College of Agriculture
Vellayani

Dr. SASIKUMAR NAIR
Professor
Department of Plant Pathology
College of Agriculture
Vellayani

EXTERNAL EXAMINER

19/12/98

ACKNOWLEDGMENT

I wish to place on record my profound feeling of gratitude and indebtedness to:

'The God Almighty for Unspeakable help rendered through various hands which helped in completing this work successfully.

I express my utmost feeling of gratitude to my guide **Mrs. Soffi Cheriyan**, Assistant Professor, Department of Home Science, College of Agriculture, Vellayani for her adroit guidance and constant encouragement. I am extremely thankful for her for critically scrutinising this manuscript and for giving valuable suggestions for improvement.

With great pleasure, I express my heartfelt thanks to **Dr. (Mrs.) L. Prema**, Professor and Head, Department of Home Science for her precious suggestions whenever there was difficulties.

With ardent gratitude I acknowledge the valuable help and encouragement putforth by **Dr. (Mrs.) Mary Ukkuru. P.**, Associate Professor, Department of Home Science and **Dr. Sasikumar Nair**, Professor, Department of Plant Pathology. Their timely help is beyond all words of gratitude.

I extend my sincere gratitude to paghu chechy and her family members for their whole hearted co-operation which helped me during the period of thesis preparation.

It is my exuberant pleasure to express my deep sense of gratitude to all other staff and post graduate students of Department of Home Science especially Anna, Anitha, Byni, Jyothi and Sheena for their help during the period of study.

Now I would like to place the banquet of acknowledgement at the feet of our Dean for all the necessary help given during the whole course.

Adequate justice cannot be done in a few words to the help rendered by Mr. C.E. Ajithkumar, Junior Programmer, Department of Agricultural Statistics in the analysis of the data. The credit for neatly executing the typing, design and layout of the thesis goes to Mr. K. Chandrakumar.

Now last but not the least I owe a great deal to my beloved parents and brothers for their prayers, inspiration, constant mental support and encouragement throughout the course of this investigation. The gratitude sees no bound.

BEENA CHERIAN

CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF PLATES

INTRODUCTION

INTRODUCTION

India is uniquely placed to produce horticultural crops and it occupies a prominent position among the horticulturally rich countries of the world due to its wide range of agroclimatic conditions. Horticultural crops are the reservoir of wealth of India. Our country abounds in a variety of fruit trees which could cater to every whim and fancy of taste.

Papaya (*Carica papaya* L) is an important fruit crop of our country, covering almost all the tropical and sub-tropical states. India's production accounts for about 7.03 per cent of the world's papaya production. Hence India is rated as the largest papaya producer of the world. In Asia papaya accounted for less than one per cent of the total fruit production and in India 3.09 per cent of the total fruit yield was covered by papaya (FAO, 1991). Tajuddin *et al*. (1996) reported that in India the estimated area under papaya cultivation is 45,000 hectare with a production of 0.81 million tonnes. In our state 13,157 hectares is under papaya cultivation with a production of 58,155 tonnes.

Papaya is considered as one of the most nutritious, the fastest growing, the quickest yielding crops (Jayaprakash *et al*. 1989). It is a very wholesome fruit As a source of

vitamin A (carotene) it is unrivalled by any other fruit except mango (Raghuvanshi, 1995).

According to Sheela *et al*. (1995) papaya, the nutritious fruit crop is a common component of the homestead farming systems of Kerala. It is the ideal fruit for the processing sector with year round production and availability of fruits at cheaper rates. Papaya was earlier a fruit crop of homestead and backyard gardens, but has now emerged as a commercial fruit crop in the country (Irulappan, 1992).

Papaya crop is found to be a promising fruit crop for our country, both as a potential foreign exchange earner and as a profitable crop to the farmer. Unfortunately there is much wastage of the nutritious fruit in our country. The fresh papaya fruit does not catch good price as other table fruits somehow it has not caught the fancy of our people as much as it deserves, mainly because the odour of papaya is not highly appealing (Malathi *et al*. 1986). This causes hinderance in the commercial exploitation of this fruit for processing also.

According to Rao (1991) processing of fruit can be derived as adding value to conventional and innovative food item through various formulation and combination providing protection, preservation, packaging, convenience, carriage and disposability. The outstanding qualities of papaya fruit with high pulp yield, low cost, availability throughout the year and

quick growing nature makes it form the basis for the thriving fruit processing industry.

The blending of fruit products could be an economic requisite to utilize profitably some fruit varieties for processing which may not have otherwise favourable characteristics and cost for product preparation. Secondly the objective could be to supplement appearance, nutrition and flavour. Thirdly one could simply think of developing a new product. The possibility of enhancing the flavour and acceptability of papaya products by diversification have been suggested by Kalra *et al*. (1991).

Developing such processing technologies on blended products with papaya may result not only in better utilisation of this locally available raw materials but also the production of value added products and gainful employment opportunities. Sethi (1996) reported that all future thrusts in research should be aimed at developing simple technologies which could be easily adapted to conserve and preserve perishable commodities and minimise both their qualitative and quantitative losses, so that the gap between the production and availability of horticultural crops is slowed down.

Therefore the present investigation was undertaken with an objective to develop four papaya products with higher acceptability by blending with mango and to envisage the consumer preference and shelf stability.

REVIEW OF LITERATURE

REVIEW OF LITERATURE

For any research study a knowledge of the past research work is absolutely essential. Investigator has made an attempt to review relevant literature to cover the works done by other researchers in the field of investigation. The available literature was pursued and the review is presented under the following headings.

2.1 Scope of underutilised fruits for processing.
2.2 Need for new techniques in fruit processing.
2.3 Nutritional significance and profile of papaya.
2.4 Development of innovative products from fruits.
2.5 Diversification of fruit based products.
2.6 Storage qualities of fruit based products.

2.1 Scope of underutilised fruits for processing

According to Subrahmanyam (1993) India gifted with a variety of agroclimatic conditions is the second largest producer of fruits and vegetables accounting for about 8 and 13 per cent of the total world production. Food Industry (1994) reports that India annually produces about fifty four million tonnes of fruits and vegetables valued at about Rs.10,000/- crores and is one of largest producers of fruits and vegetables in the world. In addition to the major fruits, a large number

of minor fruits, accounting for about 5.53 million tonnes are also produced in the country.

Sarain (1992) opined that apart from minor fruits, the rare ones like pomegranate, custard apple, lychees, chikkoos, ber, plums kinnows, lemon, jamun, strawberries etc. have tremendous marketing potential.

Under exploited fruits may be defined as several less known fruit species which have the potential for commercial exploitation and are yet to be utilised for their potential (Pareek, 1993). Kumar (1993) reported that considerable efforts are needed to make a new product from under exploited fruits and vegetables competitive in the world market with respect to nutritional and microbial quantity as well as zero level chemical residues. He also pointed that the export of processed products from underexploited indigenous fruits is negligible.

Some of the products from bael, ber, jamun, jack fruit, karonda aonla, lasoda and other similar fruits can be popularized by technical innovations as HEALTH FOODS having nutritional and medicinal properties, delicate flavour and attractive colour in some. Techniques of processing now standardised in the country are mainly related to major fruits. Bhowmik (1992) has stated that there is a vast potential to tap the under exploited minor fruits in the country. There is a

need to make some new products from indigenous raw material having nutritional and medicinal values to open new channel for export market.

Singh (1979) pointed out that karonda fruit with speakable nutritive value and acidic taste are suitable for the production of many processed products. Roy *et al*. (1979) noticed that ripe bael fruit is not consumed freely because of eating difficulty, but it may become popular if properly processed.

Studies on processing and utilisation of kumkaut conducted by Bawa and Saini (1988) revealed that the high acidity of the juice (5.5 per cent) sweet nature of peel and consumer acceptance of various products indicated the potentiality of kumkaut for processing. Kulkarni (1994) has ascertained the west Indian cherry fruits are highly perishable and acidic were processed into different products such as squash, jam, chikki (toffee), ketchup, pickle and wine.

Dan (1985) had stated that sapodilla or chiku fruit, which has very low acid and high sugar content can be utilised for the preparation of dehydrated product. CFTRI (1987) reported that the mature papaya fruit at various stages of ripening was suggested for the preparation of jam, jelly, canned papaya, canned papaya beverage, nectar puree, concentrates, slab, powder, cereal flakes, baby foods and toffee and the raw papaya was suggested for pickle and candy.

2.2 Need for new techniques in fruit processing

Bourne (1986) has classified the causes of post harvest loss of perishable crops as primary losses due to insects microbes and mechanical damages and secondary losses due to poor storage and inadequate transport facilities. In India, inspite of these high production of fruits 20-30 per cent of the produce are not utilised due to post harvest problems as reported by Sethi (1993).

Nwanekezi *et al*. (1994) suggested that the search for alternative uses of these tropical fruits to maximize their utilization and reduce losses is therefore vitally important. Sethi (1996) had pointed out that wastage of horticultural crops at post harvest stage can be prevented by developing and using low cost, low energy, appropriate processing new and viable simple technologies for sustainable horticulture.

Shaw *et al*. (1993) remarked that owing to rich horticultural potential that exist in our country, fruit processing industry can play an important role in salvaging prices during glut seasons, generating employment opportunity, meeting the requirements of defence forces and earning foreign exchange for the country. The also remarked that it ensures fair returns to the growers and improve their economic conditions. Yadav (1995) highlighted that since commercial processing plays a very important role in marketing of fruits

and vegetables, there is a big potential for this sector. He also opined that a lot of wastage can be avoided by organizing proper processing facilities.

2.3 Nutritional significance and profile of papaya

Papaya (*Carica papaya* L) belongs to the family caricaceae is a native of Tropical America and originated in Mexico. According to Ram (1982) now papaya is grown in almost all the tropical and subtropical countries of the world.

Hayes (1960) had pointed out that from the botanical as well as the horticultural point of view, the papaya is an unusually interesting plant. He further opined that its importance among the fruits of India is great and seems to be increasing. Singh (1990) reported that papaya is produced in over 30 countries of the world, while intensive production of papaya is concentrated in rather limited areas. According to the above author India stands out as by far the most important producer of the commodity producing 15.62 per cent of all the world's papaya.

Ranganna *et al*. (1997) indicated that India's share of papaya production is about 34,000 metric tonnes. He also pointed out that the seasonal nature of many of the fruits makes the food industry nonperforming except in seasons, thus making them non-viable in many instances, which is not the case with papaya.

Papaya is a wholesome dessert fruit and Aykroyd (1951) ranks it second only to the mango as the source of precursor of vitamin A. According to Jeans (1972) the fresh papaya fruit is also a source of natural sugars, vitamin A and Vitamin C. The B vitamins niacin riboflavin and thiamine are present in small quantities and there is a fair amount of calcium. Geetha (1982) expressed that cheaper fruits also carry high nutritious food value and comprise a rich diet, as they contain large store of essential vitamins and mineral salts.

Almost every part of the papaya plant has some medicinal values. The value of papaya as a medicinal fruit has been reviewed by Quisumbig (1951) and Chopra (1958). As stated by them papaya is said to possess antihelminthic, abortifacient and emmennagogue properties. According to Jeans (1972) the alkaloid carpaine found in the leaves is also an antihelminthic. For its reducing properties papain ie valuable in cases where the liver and spleen becomes enlarged. Irulappan (1992) stated the papaya is one of the rare fruits recommended even for the diabetics. He had also reported that the fruits are prescribed in piles dyspepsia, liver, spleen and several digestive disorders.

2.4 Development of innovative products from fruits

Swami *et al*. (1977) pointed out that cultivation of new fruits and development of products from many of the notable

fruits could bring benefit nutritionally and economically. According to Anvilla (1993) the consumption of processed foods likely to increase in the future. Subrahmanyan (1993) has ascertained that for increasing the exports there is need to develop new products for exports based on the domestic capabilities and large international demand.

CFTRI (1990) stated that Nectar is a ready to serve beverage like juice. It is a thin pulp of the fruit blended with sugar and citric acid to obtain a product of 15-20° brix and mild acid taste. Only limited studies are available on papaya nectar and in these studies priority was given to factors such as temperature and tin uptake (Brekke *et al*. 1976) and heat transfer (Luna *et al*. 1987). Bael fruit nectar standardised by Susanta and Singh (1978) of composition 25 per cent pulp, 25°brix and 0.3 per cent acidity produced highly acceptable products. Aruna *et al*. (1997) prepared nectar from papaya was highly acceptable.

Fruit leather is a well established product, particularly in the North American market. It is manufactured by dehydrating a fruit puree into leathery sheet (Raab and Oehler, 1976). Mango bar is prepared by drying the pulp of ripe fruits. Addition of ingredients like sugar, citric acid, pectin and potassium metabisulphite to pulp facilitates drying

and improves the product quality (Heikal *et al*. 1972., Mathur *et al*. 1972., Nanjundaswamy *et al*. 1976., Rao and Roy, 1980, Jayaraman 1988). The preservation of dried papaya and jackfruit was established by Jayaraman and Gupta (1991) Cheman and Taufik (1993) developed jack fruit leather from blanched puree and puree soaked in 0.1 per cent sodium metabisulphite. Sensory evaluation showed that both were acceptable.

The fruit slab, from bael fruit pulp were standardised by Susanta and Singh (1978). Dan (1985) has ascertain that dehydrated products prepared from sapodilla was highly acceptable.

William (1964) noticed that candied fruits have maintained their popularity as a sweet meat delicacy throughout the centuries ever since sugar was extracted from cane. He also reported that candied fruits are almost devoid of the characteristic flavour of the natural fruits owing to the high percentage of sugar absorbed.

Ronald (1956) prepared candy from figs, pears and peaches and observed considerable decrease in weight of the fruit. Shiro (1971) patented a method of preparation of candy from juicy fruits like cherries plums and apricots to sugar concentration of 72 per cent without shrinking. Thirumaran *et al*. (1985) standardised a simple processing technique for

papaya candy and was found acceptable. Mohammed *et al*. (1993) developed a recipe for candy using pineapple which was organoleptically acceptable.

Mango sauce manufactured by Kaur and Khurdiya (1993) from mature unripe mango scored maximum results with 2:1 ratio of mango and canesugar. For the sauce from ripe fruit in the ratio 4:1 and 2:1 were found best. Sharma and Kumar (1995) standardised ketchup using four varieties of pumpkin. The products were found to be above average where organoleptically assessed in comparison with tomato ketchup and vegetable ketchup.

Wine is a natural, nontoxic healthful fermented beverage from fruits rich in calories, vitamins and minerals (Adsule 1992). According to Vyas (1993) wines of pleasing flavour could be made from fruits containing tannin.

Wine prepared from the combination of more than two varieties of Apple by Dang (1979) was found to be quite acceptable. Khurdiya *et al*. (1984) developed a recipe for wine using jamun which was organoleptically acceptable. Rarrales (1985) has described the design and development of suitable cashew apple juice expeller for the manufacture of cashewapple wine. Purushothaman (1996) formulated wine from papaya after removing the latex and skin, of the papaya through a process standardised by them, wine with 7.9 per cent alcohol could be

obtained. Kadam *et al* (1991) has standardised the formula for the preparation of wine from ber which was organoleptically acceptable.

Alian and Muringe (1980) developed a recipe for wine using pineapple canning waste and was organoleptically accepted. Joshi (1990) standardised the method for wine from pomegranate. The sensory evaluation studies showed that pomegranate wine had better flavour and colour than grape wine.

2.5 Diversification of fruit based products

According to Woodroof (1974) the manufacture of blended juice, traditional or popular juice has been used as a base and others are used to built up the beverage qualities. Begum *et al*. (1983) reported that mixed fruit juice has great consumer appeal and improved the nutritional quality of the drink.

Nanjundaswamy *et al*. (1964) reported that the plain juice of papaya has to be blended with the other fruit juices to make it a highly acceptable beverage. Woodroof (1975) observed that the purees and juice of orange, banana, papaya and guava can be successfully blended with passion fruit juice into tropical fruit drinks, punches and syrups. Pruthi and Sondhi (1978) reported the development of interesting products like cashew apple RTS beverage from blends with carotene rich fruit pulps of mango and papaya.

Begum (1983) claimed encouraging results from squash of pineapple and mango pulp mixture in the ratio of 25:75, 50:50 and 75:25. Kalra and Tandon (1984) observed that blends of guava and mango nectar was found to be superior to guava or mango nectar. Studies by Kalra *et al*. (1991) revealed that 25-33 per cent papaya pulp could be incorporated in mango without affecting the quality and acceptability of mango beverage. Teotia *et al*. (1992) tried to develop a muskmelon-mango beverage blend and the beverage made from 50:50 blend was adjudged the best because of its balanced flavour. Manimegalai (1995) conducted studies on mango papaya blended squashes at the proportion of 75:25, 50:50 and 25:25. Organoleptic evaluation indicated that blends with 50:50 and 75:25 had high consumer acceptability than other one.

Blended fruit slabs were made by Krishnamurty and Varma (1978) incorporating 10 per cent badami mango pulp as banana pulp. Studies by Muthukrishnan and Palaniswami (1972) resulted in acceptable quality squash by blending lime and pineapple juices with west Indian cherry at 1:1 ratio. According to Chakraborthy *et al*. (1993) clarified watermelon juice blended with lime juice or pineapple juice yielded RTS beverage of acceptable quality. Saini and Wani (1993) opined that overall scoring improved when plum juices from three varieties were blended uniformly prior to the preparation of RTS drinks.

2.6 Storage qualities of fruit based products

Seow *et al*. (1991) pointed out that properly processed fruit products can be stored for more than one year and keeps sound organoleptically.

Mukherjee *et al*. (1963) developed pear juice with good appearance and possessed natural flavour and taste of the fruit, but lacked shelf stability.

Tripathi *et al*. (1988) developed a recipe for amla juice which was found organoleptically acceptable evenafter six months. Seow *et al*. (1991) investigated that processed jack fruit juice kept for more than seventeen days at a storage temperature of 30°C.

Papaya Ready to serve beverage standardised by Thirumaran *et al*. (1993) consisted of 25 per cent 9.5 per cent sugar (15°brix) and 65 per cent water. The RTS was found to be highly acceptable organoleptically with a shelf life of more than six months.

Manan *et al*. (1992) developed an RTS with acceptable sensory attributes from nine months stored apricot pulp. Thirumaran *et al*. (1992) has standardised the formula for the preparation of fermented carrot based RTS which was acceptable even after six months.

Manan *et al*. (1992) reported that squash prepared from apricot pulp had a good shelf life period of about six months and was also found to be highly acceptable.

Thirumaran *et al*. (1990) standardised a recipe for tomato concentrates with a good shelf life period. Similarly Sethi (1994) developed a method for whole tomato concentrate using chemical preservatives with a shelf life of eight months.

Thirumaran *et al* (1986) had standardised the formula for papaya jam and found that it had a shelf life of 8 months with an over all acceptability score of 3.75. Tripathi *et al*. (1988) revealed that the organoleptic evaluation of stored amla jam showed an increase in the acceptability with storage. Joshi (1991) revealed that karonda jam was organoleptically acceptable with a shelf life of about one year under ambient conditions. Bhat nagar (1991) conducted studies on the preparation of jam from watermelon rind was reasonably good under ambient storage conditions for a period of six months.

Singaravelu and Arumugam (1993) prepared dried sapota flakes which showed a shelf life of 120 days with pretreatments and 39-40 days without pretreatments.

The kinnow RTS stored showed negligible changes in pH when evaluated for quality (Renote *et al*. 1992). The analysis of pH on grape juice by perlette (1992) failed to reflect any

change in pH during 24 week storage. According to Shah and Bains (1992) canned peach and apricot pulp stored well over 24 weeks produced negligible changes in pH.

Kalra *et al*. (1991) had reported that acidity did not change significantly during the twelve month storage of mango papaya blended beverage. Shelf life studies on whole tomato concentrate stored for eight months showed an increase of 2.08 per cent in titrable acidity (Sethi 1994).

A gradual increase in reducing sugar was observed by Mehta and Bajaj (1983) in citrus juice during the storage period of eight months and the increase being 50-88 per cent. Analysis on the shelf life quality of amla juice by Tripathi *et al*. (1988) had indicated an increase of 0.19 per ent in reducing sugar during storage. Particularly no changes in reducing sugar was observed by Sandhu *et al*. (1988) during 24 weeks storage of grape juice. They concluded that storage period had no effect on the concentration of reducing sugar while in a study conducted by perlette (1992) only a slight change in reducing sugars was obtained during the 24 week storage in grape juice.

Shelf life studies in amla juice by Tripathi *et al*. (1988) produced a one per cent increase on total sugar during 135 days. During storage of carrot juice the total sugar was found to decline by 0.14 per cent at room temperature by Bawa and Saini (1987).

Kinnow juice RTS stored at ambient condition over 24 weeks (Shah and Baini 1992) and kennow juice over a period of six months (Renote *et al* 1993) had indicated negligible changes in TSS. In the storage studies by Thirumaran *et al*. (1990) and (1992) they had observed a decline in TSS on storage in tomato juice concentrates and in fermented carrots based RTS.

Storage studies conducted by Mehta and Bajaj (1983) had revealed that colour retention was better in samples preserved with potassium metabisulphate when compared to pasteurized and sodium benzoate preserved samples.

Analysis of the spoiled samples of tomato concentrate revealed that spoilage was either by yeast or *Aspergillus* (Sethi, 1994).

MATERIALS AND METHODS

MATERIALS AND METHODS

The present study entitled 'Development of papaya (*Carica papaya* L) based blended products is aimed at developing blended products of papaya and mango by assessing the optimum proportions of these fruits for blending. The advantages of diversifying the different papaya products, its organoleptic, nutritional, shelf life qualities and consumer acceptance were also ascertained in this investigation.

The methodology of the study is presented under the following headings.

3.1 Selection of fruits for the study

3.2 Physico-chemical and sensory characteristics of papaya fruit

3.3 Selection of the products proposed

3.4 Standardisation of blended products of papaya and mango

3.5 Selection of the best blend on different products

3.6 Detailed study on the selected blended papaya products

3.6.1 Observations carried out on fresh products

3.6.1.1 Comparative acceptability by panelists

3.6.1.2 Chemical and nutritional composition

3.6.1.3 Confirmation with FPO requirements

3.6.1.4 Cost benefit analysis of the products

3.6.1.5 Fruit product yield ratio

3.6.1.6 Consumer acceptance and preference

3.7 Shelf life assessment of products

3.7.1 Assessment of changes in the nutritional and chemical qualities

3.7.2 Changes in sensory qualities

3.7.3 Microbiological profile

3.8 Statistical analysis of the data

3.1 Selection of fruits for the study

The papaya (*Carica papaya* L.) is an important fruit of the tropical and subtropical regions of the country, deserving greater attention due to its high productivity and multipurpose uses (Ghanta, 1994). This fruit was selected for the present experiment on product development based on the following aspects.

1. Papaya is the ideal fruit for the processing sector with year round production and availability of fruits at cheaper rates (Sheela *et al*. 1995).

2. Being a quick growing fruit papaya can form the basis for a thriving fruit processing industry.

3. The richness in carotenoids, its significant high pulp yield, low cost and availability are also outstanding qualities for its utilisation by the processing industry.

4. According to Singh (1990) Ripe papaya is one of the best refreshing fruits rich in vitamin A and a good source of vitamin B and C.

5. It is a nutritive fruit containing 0.5 per cent protein and an equivalent amount of minerals consisting mainly of iron, calcium and phosphorus (Singh, 1969).

6. Jayaprakash (1989) stated that it is rich in vitamin A and in the present context of global vitamin deficiency, its importance is recognised more than ever before.

The papaya variety CO-2 was selected for this experiment considering its processing qualities and availabiltiy in large quantity at the Instructional Farm, Vellayani.

3.1.2 Selection of fruit for blending

Reuniting flavour, eliminating undesirable component of the same of different juices becomes the basis for blending of a wide variety of flavour, colour and consistency (Annapurna 1977). Rao *et al*. (1979) reported that blends may go a long way in reducing cost of juice used in making beverages. Inorder to contribute a highly acceptable flavour of papaya products, mango Neelum was selected for blending with papaya fruit in the present investigation. This fruit was identified as a carrier fruit due to the following reasons.

1. Mango has got a lot of nourishment packed in it and is found to blend well with other fruits (Kalra *et al*. 1991).

2. According to Jain (1961) it is relished for its succulence, exotic flavour and delicious taste.

3. No fruit quite compares in flavour with the best mangoes when ripe (Berry, 1979).

4. The mango is one of the choicest and most appreciated of all fruits because of its aromatic flavour and tastes (Raghuvanshi, 1995).

Mango fruits that were required for the study were procured from the local markets of Thiruvananthapuram.

3.2 Physico-chemical and sensory characteristics of papaya CO-2 variety

3.2.1 Physico-chemical characteristics

Physico-chemical characteristics are the qualitative indices of any edible fruit (Bhuyan *et al*. 1992). Physical characteristics of the fruit are very important for identification of the cultivar. Inorder to assess the processing qualities of papaya CO-2 variety its physico-chemical characteristics were analysed using metric, visual and standard chemical procedures as detailed below.

Sl.No.	Constituents	Methods adopted
1.	Size of the fruit (LxB)	Metric
2.	Fruit weight	Weighing balance
3.	Wastage	
4.	Pulp content	
5.	pH	Digital pH meter
6.	Total soluble solids	Refractometer
7.	Acidity	A.O.A.C. (1965)
8.	Reducing sugar	A.O.A.C. (1965)
9.	Total sugar	A.O.A.C. (1965)
10.	Vitamin C	A.O.A.C. (1965)
11.	Moisture	A.O.A.C. (1965)
12.	Pectin	Lal *et al*.(1986)
13.	Carotenoids (Betacarotene)	Srivastava & kumar (1994)

3.2.2 Sensory characteristics of fresh fruit

According to stone and sidel (1993) sensory evaluation involves the measurement and evaluation of the sensory properties of foods and other materials. Sensory evaluation is the most suitable criterion for judging the quality of papaya in respect of colour, flavour, appearance, texture/consistency and taste.

The organoleptic qualities of the fruit and the products were evaluated by a taste panel. The panel is the

analytical tool in sensory evaluation. The value of this tool depends on the objectivity, precision and reproductability of the judgement of the panelists (Pal *et al*. 1995). A panel of 10 expert judges were chartered for conducting sensory evaluation. The panel members were selected after initial screening through a simple triangle test as suggested by Jellink (1985). From the 20 scientists working in the University who participated in the triangle test, ten were selected as judges. The evaluation card for triangle test is presented in Appendix I.

Colour in the most important characteristics by which quality of food is judged (Aparnathi and Bindal, 1995). According to Tejinder (1994) flavour is the unique character of odour and taste. He also pointed out that appearance of the food is important but it is the flavour that ultimately determines the quality and acceptability of food. Jack *et al*. (1995) reported that texture is a percept resulting from interaction between food and its consumer.

Colour, flavour, appearance, texture and taste characteristics were the quality attributes evaluated. These qualities were evaluated on a five point scale by scoring method. A suitable score card was formulated and was used for evaluating the sensory qualities (Appendix II).

3.3 Selection of products

Papaya is marketed chiefly as fresh fruit, however its processed products are becoming increasingly popular (Nath and Ranganna, 1981). At present only few processed items that are standardised and made popular to consumers based on papaya fruit The need for the formulation of new products, from this year round available, quick growing fruit bearing high pulp content have been felt by many workers (Singh, 1990; Irulappan, 1992). To meet this requirement four novel products are identified for development from papaya fruit namely nectar, fruit butter, fruit leather and sauce.

3.3.1 Nectar

Nectar is a ready to serve beverage like juice. CFTRI (1990) defines Nectar as a thin pulp of the fruit blended with sugar and citric acid to obtain a product of 15-20° brix and mild acid taste. Lal *et al*. (1986) remarked that fruit beverages are delicious and have universal appeal like any other beverages. The marginal increase in production of fruit products in recent years is based chiefly on fruit juice and beverages (Maini and Anand, 1985). Recently lot of interest has been evinced in papaya drinks because of its comparitively good nutritional value and attractive colour. Thus as an initial attempt nectar was choosen in the study.

3.3.2 Fruit butter

Fruit butter is practically similar to jam except that it is made from finely sieved pulp to which small quantities of spices consisting of nutmeg, cinnamon, clove etc. are added (Siddappa, 1986). Fruit butter can be made by using a combination of fruits with 1 per cent or more pectin content. According to Sudhakar and Maini (1995) pectin plays a significant role in the manufacture of fruit product like fam, jellies, marmalades, preserves etc. and thus are indispensable to the fruit processing industry. Hence butter was considered to process papaya.

3.3.3 Fruit leather

Preparation of fruit slabs or fruit leather is one of the cheap method of preservation of fruit pulp (CFTRI, 1978). Maini and Anand (1985) reported that to bring down the cost of production, it is necessary to adopt preservation techniques which are not capital intensive, have minimum conversion costs and involve cheaper packaging. These techniques should be based on drying, pickling and preservation by sugar and chemicals.

Maini *et al*. (1982) reported that more fruits preserved by drying than by any other methods have major advantages of greater concentration in dry form, production

with minimal labour, less expensive and economic equipment for processing and storage. Nowadays there may be a good market for fruit leather, depending on price, packaging, marketing and distribution. Hence fruit leather was included in the study.

3.3.4 Sauce

Sauces are liquid or semi liquid mixtures which are added to meat, poultry, fish, vegetables and desserts to garnish or to enhance the appearance and the flavour (Swaminathan, 1974). It improves digestion and are good appetisers. Sauce is an important food product prepared both in homes as well as commercially in India. Nowadays the market value of sauces have increased tremendously. In the present trial sauce based on papaya fruit which could be cheaper than sauces from other fruits was considered for development.

3.4 Standardisation of plain and blended papaya products

Standardisation of recipe is an essential strive for high quality products. (Crusius, 1984). According to Tolule (1984) the procedure for recipe standardisation begin with the process of recipe modification or adjustment.

Plain products of papaya viz. nectar, fruit butter, fruit leather and sauce were first standardised at the laboratory by repeated trials and organoleptic assessment.

Kalra *et al*. (1991) opined that blending of fruits could be done to supplement appearance, nutrition or flavour of its products. It is also considered an economic requisite to utilise some fruit varieties for processing which may not have otherwise favourable characteristics. Thus based on the recipes formulated and standardised for plain products four blended papaya products were developed. To standardised papaya mango blended products at the laboratory, papaya and mango pulp at three different proportions were tried. The proportions experimented for standardisation of blended papaya products viz. nectar, fruit butter fruit leather and sauce were the same. The three proportions of fruits used were

T_1 papaya + Mango 55:45

T_2 papaya + Mango 60:40

T_3 papaya + Mango 65:35

3.4.1 Formulation of papaya - Mango blended nectar

The techniques followed in the standardisation of nectar using papaya and mango is as described below.

The selected varieties of both ripe papaya and mango were washed thoroughly in running water to remove the adhering dirt and was drained. After draining water, they were peeled using stainless steel knife and the seeds were discarded. The pulp was extracted by crushing the fruits seperately with the help of mixie. Papaya and mango pulp in three different

proportion viz. 55:45, 60:40 and 65:35 were mixed 1 kg fruit pulp was taken in each combination. Sugar syrup was prepared with 1 1/2 litres of water, 400 g of sugar and 10g citric acid. The mixture was filtered through a fine muslin cloth and cooled 10 ml of lime juice and sugar syrup was added to each combinaion of fruit pulp. As preservative 1 gm of potassium metabisulphite dissolved in little mixture was added and mixed well in a blender. Nectar was filled in sterilised bottles of 200 ml capacity and sealed by crown corking. These bottles were then immersed in water taken in a large vessel and heated to 85°C for pasteurisation. After this process bottles were cooled immediately and stored at ambient temperature. The high pectin content of papaya helped in proper pulp distribution in the juice. Papaya variety selected for this study (CO-2) is rich in natural colour and hence required no artificial colouring to bring attraction to the product.

3.4.2 Formulation of papaya-mango blended fruit butter

The well matured and ripened fruits of both papaya and mango were selected. The selected fruits were then thoroughly washed in running water. The skin was peeled by using a stainless steel knife and the seeds were discarded. With the help of a mixie, the fruits were blended to extract the fine pulp. To 1 kg of each combination of papaya and mango pulp 65 per cent of sugar was added. The mixture was cooked

slowly with occasional stirring till the mass was thickened. At this stage 1 gm of powdered spices (Cinnamon and cloves) along with 7 ml of lime juice was added. The end point of fruit butter was determined by sheet/flake test (CFTRI, 1990). A small portion of the product was taken out in a spoon during boiling and cooled. It was then allowed to drip from spoon. The end point was spotted when the product fell off in the form of a sheet or flakes. When the correct consistency was reached it was filled into sterilised jam bottles of 100 gm capacity leaving a headspace of 2 cm. Bottles were cooled and then closed with lids. Blended papaya butter was stored under ambient conditions.

3.4.3 Formulation of papaya-mango blended leather

Fully ripened fruits of papaya and mango were selected. Fruits were washed in running water to remove the adhering dirt. Peeled the fruits and seeds were removed. Cut into pieces and extracted the pulp using a mixie. To 1 kg of each of the three pulp combination added 75 gm of sugar, 5g of citric acid and 2.5 gm of potassium metabisulphite. Mixed well. This mixture was poured into a trays of a thickness of 1/4 cm. The tray was covered with a fine net cloth and kept for drying in the sun. When it was dried to some extent another layer was poured over it and left for drying again. This process was repeated upto a thickness of 1 cm. The fruit

sheet was properly dried turning both the sides until it attained leathery consistency. It was then cut into diagonal and rectangular pieces. These pieces were packed in polythene covers and sealed air tight using a heat sealer. The sealed covers were stored in plastic containers.

3.4.4 Formulation of papaya-mango blended sauce

Ripened papaya fruits and semiripened mango fruits were selected for the preparation of sauce. Washed the fruits, peeled and seeds were discarded. Then pulp was extracted by crushing the fruit in a mixie. Papaya and mango pulp was mixed at the different combinations selected to get 1 kg pulp each. 50 gm of sugar was added to each set at two intervals. A masala bag containing chopped onion, garlic, red chilli powder, pepper, cinnamon, cardamom and cloves was dipped in the pulp. This mixture was then heated by stirring and pressing the bag with the laddle inorder to extract the flavour of masala. After some time the masala bag was removed and 40 ml of vinegar, 9 ml of lime juice, 3 gm of salt and remaining sugar was added to it. Salt was added only at the end of cooking process to prevent bleaching colour of the product (Srivastava and Kumar (1994). Removed from the flame, when the mixture was sufficiently thickened and attained the sauce consistency. Then added 0.7 gm of sodium benzoate and tomato red colour to the sauce. When cooled the sauce was filled into sterilized sauce bottles and sealed.

3.5 Selection of the best blend of different products formulated

Among the three different proportions of products formulated in this experiment viz. nectar, fruit butter fruit leather and sauce; the best accepted blend in each item was identified as the standardised one. Products were evaluated organoleptically by a panel of ten expert judges with the help of a score card using five point scale for their quality parameters like appearance, colour, flavour, taste and texture or consistency. Larmond (1977) recommended that panelists refrain from smoking, chewing gum, eating or drinking for atleast 30 minutes before the test. The same was observed in this present investigation. The products prepared were served in white plates for clear visibility. Water was provided for the judges for oral rinsing after the scoring of each sample. Judges were permitted to take enough time to score the samples leisurely on each criteria. The overall acceptability was computed from the total mean scores obtained by each blend.

3.6 Detailed study on the selected blended papaya products

The combination that possessed the highest acceptability in each papaya-mango blended product was subjected to an indepth observation for its various quality aspects. The same product made with papaya alone and mango alone were taken as control against the standardised blended

papaya products. The observation on the large scale production potentialities of blended papaya products in comparison with that of the commercially well known mango products is also targeted at this experiment. To study the possible level of quality improvement by blending compared to plain papaya products and its utilization possibility through processing industry were also simultaneously studied by the comparative analysis of plain and blended papaya products.

3.6.1 Observations carried out on fresh and stored products

3.6.1.1 Comparative acceptability of products by panelists

The acceptability of blended papaya products was judged by comparing the blended products with similar plain products of luscious papaya and that of the king of fruits mango. The extent of enhancement in acceptability of papaya products that could be attained when blended with mango was observed by scoring test on its sensory qualities through selected panel members.

3.6.1.2 Chemical and nutritional composition

Quality of the product is determined by its chemical and nutritional composition. According to Rajalakshmi (1993) quality assurance in food industry is an ordered set of planned and systematic actions, necessary to provide adequate confidence that processes, products and services satisfy the

requirements of quality. Chemical and nutritional composition of the standardised blended papaya products were ascertained. The chemical parameters analysed were pH, acidity, total soluble solids, reducing sugar, total sugar and vitamin C on freshly prepared papaya products like nectar, fruit butter, fruit leather and sauce.

3.6.1.3 Confirmation with FPO requirements

According to Kapoor (1993) for the safety of food certain laws are essential. He also stated that standards are meant to provide a uniform and consistently good quality of food products to the consumers. Food standards for ensuring the quality and safety of natural and processed foods for human consumption have been formulated and enforced by law in different parts of the world for the past several years (Swaminathan, 1974). Inorder to ensure quality of the products formulated they were checked for agreement with the FPO requirements and for ensuring whether these standards are met in the products developed.

3.6.1.4 Cost benefit analysis of the product

The economics of a product depends much on the cost of ingredients used in the product. According to How (1990), information as accurate and up to date as possible on supply, demand and prices is essential for anyone directly involved in the business of marketing fruits products. The cost of product

in this study was calculated by taking into consideration the expense of sugar, preservatives, bottles and also accounting the labour cost.

3.6.1.5 Fruit product yield ratio

Information on product yield ratio is indispensible in ensuring the total out put out of certain quantity of raw materials. This was analysed by considering the quantity of fruit used to produce a particular unit of each product.

3.6.1.6 Consumer acceptability and preference

According to Watt (1989) consumer awareness and preperence decide the success of a food product. Acceptance and preference are consumer oriented tests. He also opined that in consumer testing a large random sample of people, representative of the target population of potential users, is selected to obtain information, consumer attributes and their preferences to products.

Acceptance

Watt (1989) reported that acceptance tests are used to determine the degree of consumers acceptance to a product. He also further stated that acceptance of a food product usually indicates actual use of the product. Thus the four papaya based products nectar, fruit butter, fruit leather and

sauce were subjected to acceptance testing by a consumer group of untrained persons in the university campus consisting of academic and non academic personnel, labourers and students. The same score card designed for acceptability on trained panel members were used for field trial among consumers also.

Preference

Preference tests allow consumers to express a choice between samples, one sample is preferred and chosen over another or there is no preference (Watt, 1989). A preference test was also conducted along with consumer acceptance scoring to find the order of their liking for papaya blended products. Here the consumers were asked to rank the four products in the sequence of their liking. The preference evaluation was made in order to select the most promising products for large scale production.

3.7 Shelf life assessment of products

The products standardised were stored at ambient conditions to assess their storage quality. The shelf life behaviour of the four products viz. nectar, fruit butter, fruit leather and sauce were assessed at monthly intervals for a period of 4 to 10 months. The storage qualities were monitered based on the changes in chemical aspects, sensory characters and occurance of microbial infestation in the product.

3.7.1 Changes in the nutritional and chemical qualities during storage

The stored products were analysed for the chemical changes like pH, total soluble solids, acidity, reducing sugar, total sugar and vitamin C. Periodical evaluation of chemical and nutritional qualities of four products were done on every month to observe the effect of storage and keeping quality.

3.7.2 Changes in sensory qualities

According to Jellnik (1985) chemical indices of deterioration alone will not decide the quality deterioration and it should be correlated with sensory evaluation of stored product. Monthly assessment was conducted on the organoleptic qualities to observe the changes in the sensory parameters in these products as a result of storage.

3.7.3 Microbiological profile

The incidence of microbial contamination due to storage of the products under study was also observed. The microbial load was assayed by dilution plate count method. Nutrient agar, potato dextrose and malt extract agar media were used for estimating bacterial and fungal counts. Mould and yeast colonies were observed microscopically for identification.

3.8 Statistical analysis of the data

The data generated during the study were compiled analysed statistically and the results are presented and discussed.

RESULTS AND DISCUSSION

RESULTS AND DISCUSSION

Results pertaining to the present investigation entitled "Development of papaya (*Carica papaya* L.) based blended products" are furnished under the following subtitles.

4.1 Assessment of physico-chemical and sensory characteristics of papaya fruit (CO-2 variety)

4.2 Standardisation of blended papaya products

4.3 Indepth studies on blended papaya products

4.4 Assessment of shelf life

4.1 Assessment of physico-chemical characteristics of papaya fruit

The physico-chemical composition of papaya variety selected for this study (CO-2) was analysed to learn its characteristics and also to provide full details regarding suitability for processing. The physical attributes assessed were the size of the fruit, shape, colour, fruit weight, wastage, pulp content and the chemical constituents like pH, total soluble solids, acidity, reducing sugar, total sugar, vitamin C and Betacarotene. The values obtained are presented in Table 1.

PLATE-1 PAPAYA CO-2 VARIETY

Table 1 Physico-chemical characteristics of papaya fruit

Particulars	Fruit characteristics
Size of the fruit	Medium to large
Length of the fruit	8.5 to 9.5 inch
Upper and lower diameter	12 inch to 16 inch
Shape	Obovate
Colour	Orange
Fruit weight	1000 to 1500 g
Wastage per cent (peel and seed weight)	5.6 to 8.3%
Pulp weight	870 g - 1.25 kg
pH	6.28
Total soluble solids (°brix)	10.5
Acidity (Per cent)	0.23
Reducing sugar (Per cent)	3.39
Total sugar (Per cent)	8.4
Vitamin C (Mg/100 gm)	56 mg
Beta carotene (IU)	2401 IU

According to Veeraraghavathatham *et al*. (1996) papaya is a very popular commercial fruit with dual purpose for fruit and papain extraction. As evidenced in Table 1, the Co-2 fruits are large in size having a length of 8.5 to 9.5 inches. Upper and lower diameter ranges from 12 to 16 inches. From

these measurements, it is assumed that the papaya Co-2 is big sized fruit when compared to many other varieties.

It was noted that the fruits are obovate in shape bestowed with an attractive orange colour. The rich colour of the ripe papaya flesh is due to its high carotenoid pigments. The change of the colour in the fruit is an index of their ripeness; in general this change is considered to be due to an increase in carotene content and decrease in Chlorophyll (Goodwin and Goad, 1970). The authors also indicate that in the papaya variety, whose flesh is of reddish-salmon colour, considerable levels of carotenoids are found such as lycopene, which is absent in papaya, whose flesh is yellow.

The average weight of the fruit ranged from 1 to 1.5 kg which was observed by weighing randomly selected fruits. The pulp yield per kg of fruits ranged from 870 g to 1.25 kg. The size of the fruit and seed weight in a fruit gives an indirect indication of the pulp content. From the present data, it was noted that papaya Co-2 variety has a very low percentage of waste portion. For any fruit, lower wastage is a mark of higher per cent of pulp yield.

The chemical constituents of fresh papaya fruit in Table 1 elucidates that CO-2 variety has a pH of 6.28 and acidity 0.23 per cent. These chemical constituents are in the range reported by Pulley and Von Loesecko (1941). Among

fruits, papaya is notably low in acid, with pH range of 4.5 to 6.0. On analysis the total soluble solids of CO-2 variety was found as 10.5°brix. The reducing and total sugar contents were 3.39 and 8.4 per cent respectively. During ripening of the fruit, the sugars generally tend to increase due to metabolism of polysaccharides in the cell wall. In the case of the papaya, the sugar content is greater than the acidity and therefore a sweet flavour predominates.

During development of the papaya fruit, the vitamin C content increases gradually (Orr *et al*., 1953) reaching the maximum value at ripeness 55 mg/100g (Arriola *et al*. (1975): Civetta *et al*. (1965). The vitamin C content of CO-2 variety was observed to be 56 mg/100g which is in accordance with the value observed for papaya by Arriola *et al*. (1975). Beta carotene was recorded to be 2401 IU. The attractive colour of this fruit at ripe stage is due to its high carotene content.

On analysing the quality of pectin, it was found that a single transparent clot was formed showing the rich pectin content in this papaya fruit.

The physico-chemical observation revealed that Co-2 papaya is medium to large sized fruit with lesser wastage and high flesh per cent. The pulp characteristics of the fruit is highly suitable for processing into beverages and other items. Fruits have rich yellow colour representing the abundant

availability of carotene and attractiveness to processed products. These fruits have less acidity, while the total soluble solids, sugar content and pectin content is high. The vitamin C level is also satisfactory compared to many other fruits. Organoleptic assessment of the fruit indicated that CO-2 is a sweet variety. Its flavour is also attractive having no pronounced characteristic aroma of the fruit. The flesh possessed a firm and soft texture.

Hence the variety Co-2 can be highly recommended for processing because of its qualities viz. attractive colour, sweetness and flavour as well as carotene content, vitamin C, total soluble solids, high pulp yield with good consistency, high pectin content, low wastage and above all its availability and economic viability.

4.2 Standardisation of blended papaya products

Though papaya is one of our commonest Indian fruit and ranks first for lusciousness and appearance, it is not fully utilised for the preparation of processed items. Using standardisation as the yardstick for the improvement in quality and enhancement of productivity four novel products using papaya and mango pulp were standardised at three different proportions. Bhagwan (1968) stated that standardisation should bring about harmony and not uniformity. This harmony can be attained only by trial and error. The products

experimented for standardisation of blended papaya products were nectar, fruit butter, fruit leather and sauce. The three proportions of papaya and mango tried for standardisation of the above were

T_1 - 55:45

T_2 - 60:40

T_3 - 65:35

The products prepared in three different blends were assessed organoleptically for its sensory attributes to identify the most desirable one. Sensory method in which palatability is evaluated by a panel of judges is essential to every standardisation procedure because they answer all important questions of the food tastes, smell, looks and feels (Mc Dornett, 1992). In a modern food corporate, sensory evaluation play a critical role. According to Pal *et al*. (1995) sensory evaluation is one of the simplest analytical tools for monitoring quality control at all stages of food product processing, starting from the inspection of incoming raw materials to surveillance of their finished product. The consumer appreciation of food quality is thus all important.

According to Almeida and Nogueira (1995) organoleptic properties determine acceptance of food by the consumer with appearance being the first factor that determines the

acceptance or rejection of a food and colour is a fundamental characteristics of appearance.

Abraham *et al*. (1993) opined that flavour is a unique experience involving an integrated sensation of odour, colour texture, temperature and even taste. Stillman (1993) stated that flavour is seen in several sensations originating from the elementals of taste receptors, olfactory receptors and nerve fibres registering touch and chemical feelings.

Krammer and Twigg (1970) had suggested that among the various quality attributes, taste is the primary and most important.

According to Ranganna (1991) texture is the property of food which is associated with the sense of feel or touch experienced by the fingers or the mouth. The textural quality is an overall physical sensation perceived about a food during mastication (Pant, 1996).

Kordylas (1990) the overall acceptability depends on the concentration or amount of particular components, the nutritional and other hidden attributes of a food and its palatability or sensory quality.

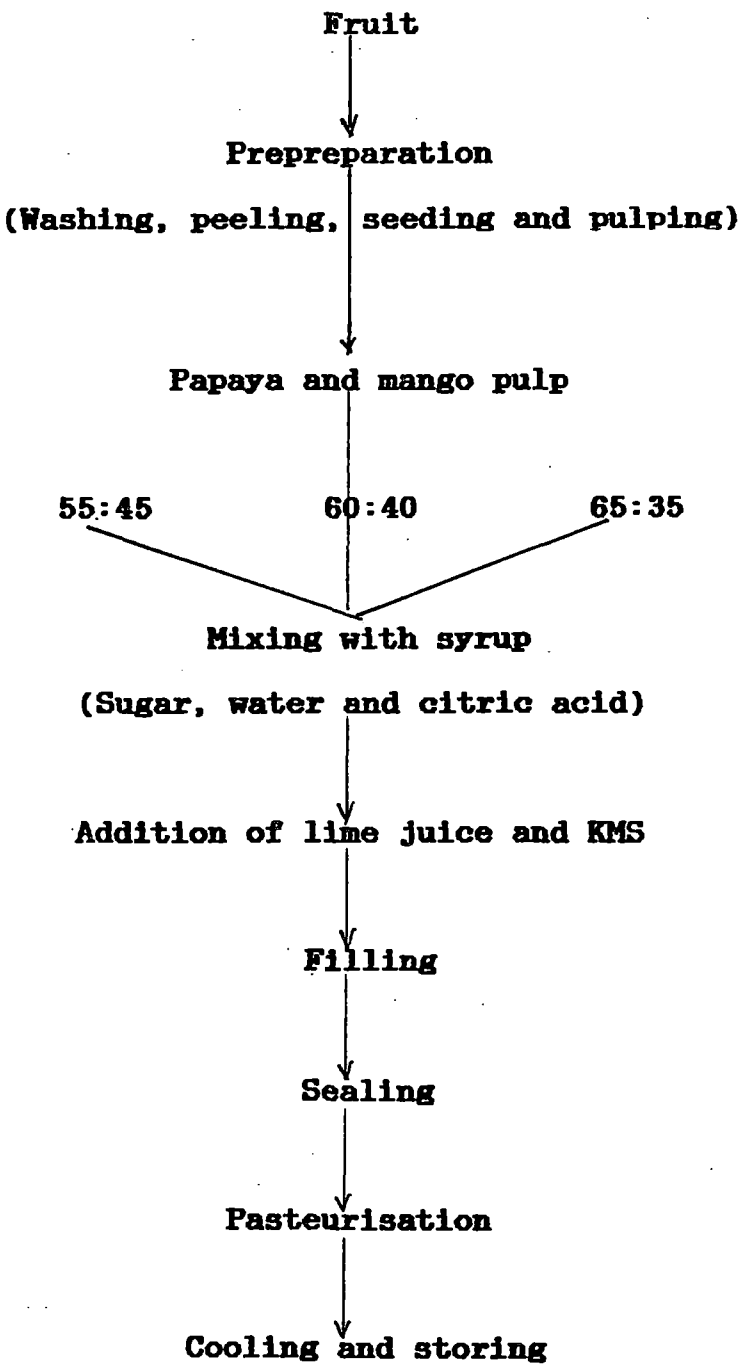
The chemical composition of many fruit juices is not balanced from an organoleptic point of view. According to Navani (1965) inorder to avoid chemical alterations such as

neutralising or increasing the acidity, juices of varying composition may be blended together to provide the desired balance of sweetness and sourness. This brings about the standardisation of acid constituents. Almost all fruit juices have some aroma and in some, the quality may be pronounced and pleasing and are therefore useful in building bouquet in blend. Three proportions of papaya and mango combination were tried for standardisation of blended items under this investigation. The results of organoleptic qualities such as appearance, colour, flavour, taste, consistency, texture and overall acceptability of different proportions of papaya-mango blended products are depicted in the tables given below. The results highlighted in the tables are based on the mean scores obtained for each quality parameter evaluated organoleptically by the ten judges.

4.2.1 Acceptability of blended nectar

Three different proportions of papaya-mango blended nectar was formulated. The flow chart on preparation of blended nectar is given in Fig. 1. The results of the acceptability trial of different blends of papaya nectar are presented in Table 2.

Fig. 1 FLOW CHART FOR PREPARATION OF PAPAYA-MANGO BLENDED NECTAR



The data summarised in Table 2 reveals that papaya mango nectar at 60:40 ratio (P_2) performed best in appearance with a mean score of 4.7 and P_1 and P_3 obtained the score of 4.1 and 3.8 respectively. Statistical analysis of the data showed a significant difference between P_2 and P_3 but P_1 and P_3 were on par.

Table 2 Acceptability levels of blended nectar (Mean scores)

Nectar blends	Quality parameters					
	Appearance	Colour	Flavour	Taste	Consistency	Overall acceptability
P_1	4.1	4.5	4.0	3.6	3.9	4.0
P_2	4.7	4.4	4.2	4.7	4.7	4.5
P_3	3.8	3.9	3.9	3.5	4.2	3.9
CD	0.627	NS	NS	0.770	0.518	0.451

P_1 - 55:45 Papaya-mango ratio
P_2 - 60:40 Papaya-mango ratio
P_3 - 65:35 Papaya-mango ratio

The colour attribute scores of all the three blends of nectar were found to be attractive because of better blending compatibilities of the fruits. The intense colour originally present in the fresh pulp was adequate enough to contribute a bewitching colour to the product. However P_1 and P_2 bagged higher score compared to P_3. The data when statistically interpreted, the colour of different blended nectar remained on par.

When the flavour profile of blended nectar was taken into consideration, it was noted that P_2 had secured the highest score (4.2). The pleasant flavour of this blend was encouraged by the apt proportion of papaya and mango pulp that was judiciously mixed in this product.

The mean scores obtained for the most important sensory characteristic taste was also maximum (4.7) in 60:40 combination (P_2) while the scores obtained by P_1 and P_3 were much lower. The data showed that the ratio P_2 could provide the best taste in the formulation of nectar using papaya and mango. There existed significant difference between P_1 and P_2. But the difference between P_1 and P_3 were on par.

Consistency score of nectar was also maximum for P_2 (4.7) followed by P_3. Statistical analysis of the data reveals that no significant difference existed among the three blends.

The overall acceptability values was computed analysing the scores for all the quality criteria. It was observed that P_2 had secured the maximum overall acceptability score (4.5) followed by P_1 (4.0) and P_3 (3.9). A highly significant difference was observed in P_2 and P_3. However no significant different was observed between P_1 and P_3.

Regarding the organoleptic performance of three blends of nectar we can assume that the 60:40 proportion of

papaya and mango is best suited for the preparation of nectar because of the best taste, sharp flavour and correct consistency which was identified by the panel members from the three proportions tested. Standardisation study of ber and guava mixed juice conducted by Vaidya *et al*. (1998) the combination with 60:40 proportion was found superior. Similarly Saxena *et al*. (1996) have reported that grape-mango beverage with the blend containing 3:1 ratio received the highest sensory quality scores. The best acceptable blends of harmonised flavour were obtained by mixing 60 parts of Maharaji juice with 40 parts of American juice while standardising mixed apple juice by Naik *et al*. (1996).

4.2.2 Acceptability of blended fruit butter

Fruit butter is a product similar to jam prepared from pureed fruit. The data obtained on the acceptability levels of different papaya-mango blended fruit butter is presented in Table 3 and Fig. 2 depicts the flow chart on preparation of blended fruit butter.

Fig.2 **FLOW CHART FOR PREPARATION OF PAPAYA-MANGO BLENDED BUTTER**

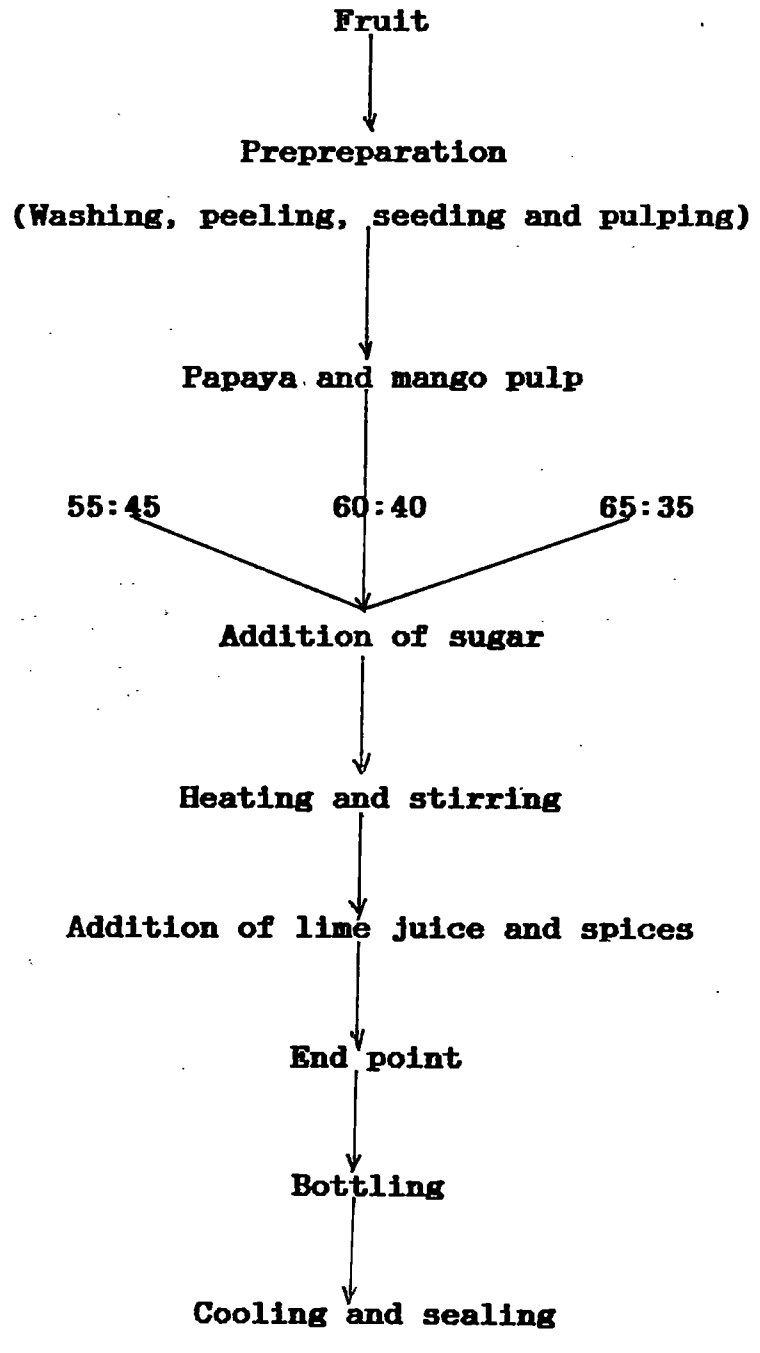


Table 3 Acceptability levels of blended fruit butter (Mean scores)

Butter blends	Quality parameters					
	Appearance	Colour	Flavour	Taste	Consistency	Overall acceptability
P_1	5.0	4.9	4.3	4.6	4.9	4.7
P_2	3.8	3.6	3.8	3.6	3.0	3.6
P_3	3.5	3.2	3.3	3.7	4.2	3.6
CD	0.436	0.527	0.745	0.634	0.515	0.350

P_1 - 55:45 Papaya - Mango ratio
P_2 - 60:40 Papaya - Mango ratio
P_3 - 65:35 Papaya - Mango ratio

As indicated in Table 3 regarding the appearance of papaya mango blended butter P_1 was most preferable to the judges than the other two combinations. P_1 secured a cent per cent score, while P_2 and P_3 were lower in scores and significantly different from P_1.

Assessment of colour preference also identified P_1 to be the best with score 4.9 followed by P_2 with score 3.6. P_3 attained the least colour preference. It was evident that the product prepared from 55:45 ratio (P_1) gave the best preferred intensity of natural yellow colour to the butter.

Mangoes are well known for its exotic flavour. Assessment of flavour profile of blended papaya butter prepared

from P_1 having 45 per cent mango pulp recorded maximum liking (4.3) for its fragrance followed by P_2 with a mean score of 3.8. P_1 and P_3 gave significant difference to statistical interpretation. The higher proportion of mango in P_1 blend had accounted for its superiority in flavour profile.

Likewise in other qualities the taste in the different blends of fruit butter also showed the highest acceptance level by P_1, as revealed by the score 4.6. The other two blends gave significantly lower score values for taste compared to P_1. When P_1 was compared with P_2 and P_3 there existed significant difference. Since papaya does not contribute an intensified taste with product, the blend with the highest share of mango produced the superior taste.

Regarding the consistency of blended fruit butter P_1 obtained the best score (4.9). A significant difference in consistency was observed among the proportions of blends. The result show that consistency of fruit butter could be well framed when 55 per cent papaya and 45 per cent mango was mixed.

On overall evaluation of acceptability levels of the blended fruit butter, the product from 55:45 papaya-mango blended ratio (P_1) produced a superior overall performance scoring a mean value of 4.7, while both P_2 and P_3 recorded a score of 3.6. Statistically a significant difference was noted for overall acceptance scores of P_1 with that of P_2 and P_3.

Assessment of different blends of fruit butter constituting papaya and mango revealed that in all quality parameters studied, 55:45 blend (P_1) ranked high and was markedly better than the other two ratios in all parameters.

4.2.3 Acceptability of blended fruit leather

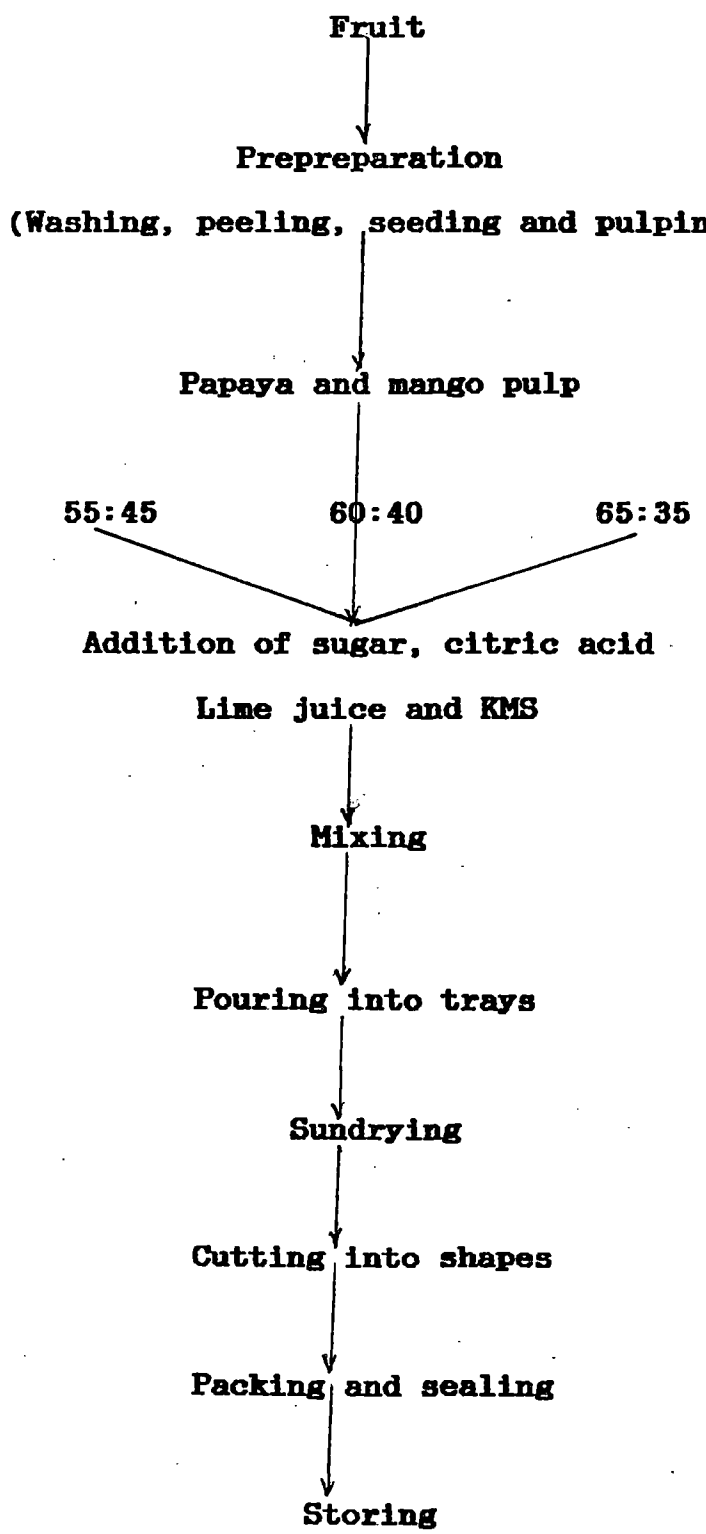
Fruit leather is a well established product manufactured by dehydrating a fruit puree into leathery sheet (Raab and Oehler, 1976). Selected fruits viz. papaya and mango were blended in three different proportions for preparation of leather. The flow chart 3 shows the steps involved in the preparation of blended leather and the data on the organoleptic evaluation of the mixed leather samples is given in Table 4.

Table 4 Acceptability levels of blended fruit leather (Mean scores)

Leather blends	Quality parameters					
	Appearance	Colour	Flavour	Taste	Consistency	Overall acceptability
P_1	3.7	3.8	3.5	3.6	3.4	3.6
P_2	4.8	4.7	3.9	4.0	3.6	4.2
P_3	2.6	2.5	3.6	3.5	4.2	3.3
CD	0.709	0.564	NS	NS	NS	0.568

P_1 - 55:45 Papaya - Mango ratio
P_2 - 60:40 Papaya - Mango ratio
P_3 - 65:35 Papaya - Mango ratio

Fig. 3 FLOW CHART FOR PREPARATION OF PAPAYA-MANGO BLENDED LEATHER



The above table indicates that among the three blends of fruit leather prepared, the appearance attribute of P_2 showed the best attraction scoring 4.8 followed by P_1, while the performance of P_3 was very low the score being 2.6. Statistical analysis indicated significant difference in appearance of fruit leather made from different proportions.

On accounting the colour preference of blended leather, it was noted that P_2 was most attractive having higher score (4.7). It was also worthy to note that the score level for P_1 and P_3 in this character were significantly lower than P_2 scores 3.8 and 2.5 respectively. This supports that colour appeal of papaya-mango leather could be brought to the best choice at 60:40 ratio blend.

Like other parameters, flavour intensity score was also best when papaya and mango pulp were combined at 60:40 level. But the difference was not significant between the three proportions in flavour attributes of leather. This appears to state that in all the three blends of papaya-mango leather, the flavour quality was brought more or less similar.

On analysing the appreciation on taste of leather, the score ranged between 3.5 and 4.0. The best tasted blend was P_2 followed by P_1 and P_3. Results show that palatability of blended leather was adjusted at the apt point when 60 per cent

papaya and 40 per cent mango was mixed between these treatments in taste attribute of leather, as the differences among the treatments did not exceed the CD value.

According to Matz (1962) texture has long been recognised as an important element in the total sensory impression obtained during the consumption of the food. While concentrating on the texture of blended leather judges ranked P_3, the combination in which papaya constitute the higher portion as best with score of 4.2. The texture quality of P_1 and P_2 was moderately preferred as the scores were 3.4 and 3.6 respectively. At the same time the texture of the fruit leather showed statistically no difference between treatments.

Overall acceptability of the fruit leather indicated that 60:40 ratio was distinguished to have the best acceptance followed by 55:45 and 65:35 ratios. There existed significant difference between P_2 and P_3. But the difference between P_1 and P_3 was on par.

In a nutshell, the less appreciated taste of papaya was made most acceptable when mixed with mango at 60:40 ratio for the preparation of fruit leather than the other combinations due to its of its judicious mixing. Thus as per the results of sensory evaluation by judges P_2 was ranked first among the three samples with respect to appearance colour, flavour and taste.

4.2.4 Acceptability of blended sauce

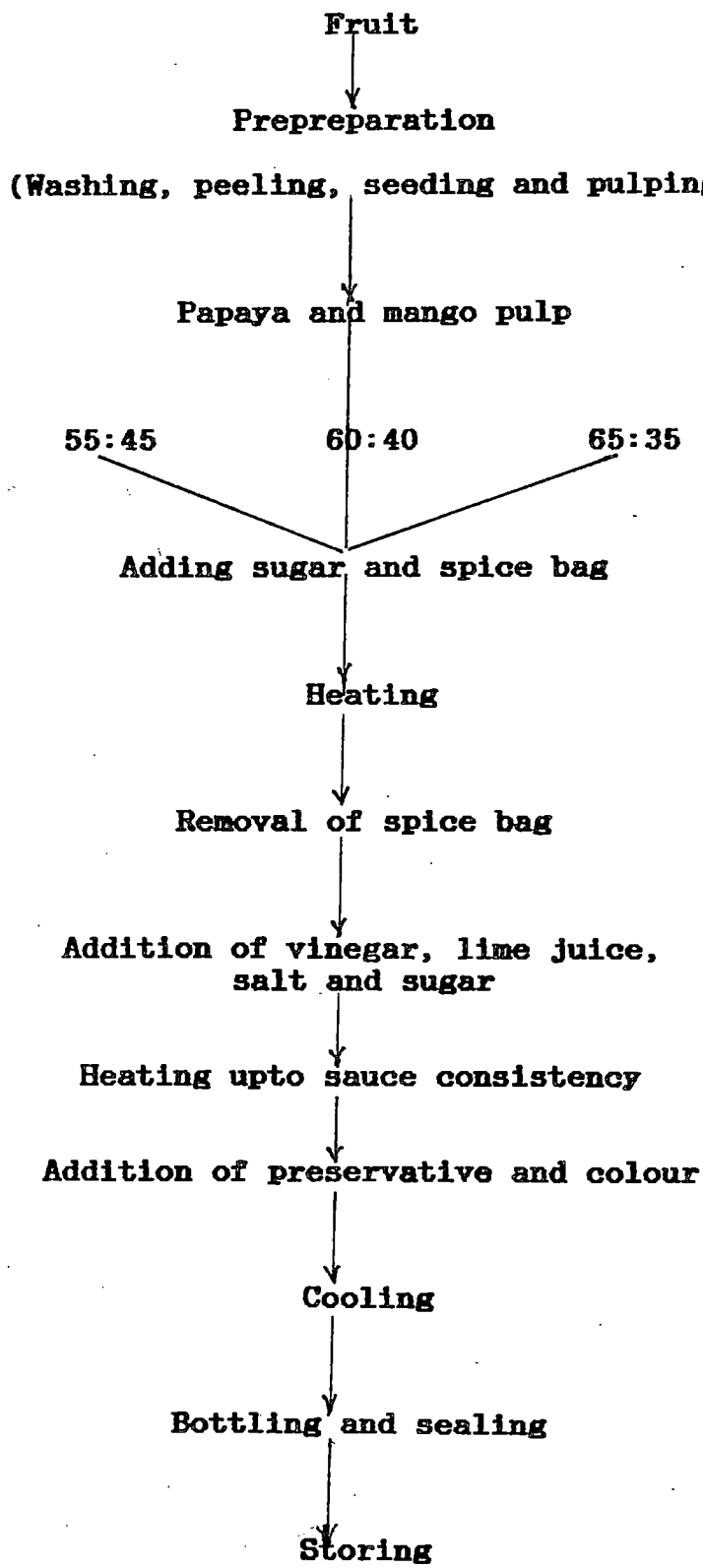
"A sauce emphasizes flavour, provides contrast and makes perfection complete" reported by Lapedes (1977). The purpose of any sauce is to enhance the flavour of the food, it graces, not to disguise it. The blended sauce from papaya and mango made in three different proportions were evaluated. Table 5 presents the mean scores for different quality attributes obtained for blended sauce and Fig. 4 shows the steps involved in the preparation of blended sauce.

Table 5 Acceptability levels of blended sauce (mean scores)

Sauce blends	Quality parameters					
	Appearance	Colour	Flavour	Taste	Consistency	Overall acceptability
P_1	3.4	3.2	3.8	3.5	3.0	3.4
P_2	4.0	3.8	3.2	3.4	4.0	3.7
P_3	4.8	4.8	4.2	4.7	4.9	4.7
CD	0.353	0.461	0.387	0.530	0.168	0.156

P_1 - 55:45 Papaya - Mango ratio
P_2 - 60:40 Papaya - Mango ratio
P_3 - 65:35 Papaya - Mango ratio

Fig. 4 FLOW CHART FOR PREPARATION OF PAPAYA-MANGO BLENDED SAUCE



Trials with different proportions of papaya-mango blended sauce in this study revealed that the meanscores obtained for appearance of blended sauce ranged between 3.4 to 4.8. Among the different proportions tried P_3 was marked best in its appearance (4.8) followed by P_2 with a mean score of (4.0). While P_1 had the lowest eye appeal. The three proportions were found significantly different in appearance as per statistical treatment.

In the evaluation of colour range, mean scores were observed between 3.2 to 4.8. Among the three blends, P_3 secured the highest value (4.8). Since colour of the best choice was produced by this proportion. It is quite evident from the present findings that more carotene pigment from papaya pulp in this ratio has resulted in correspondingly attractive colour contribution to the sauce. Data on the mean score obtained for colour of different treatments revealed a significant difference.

Flavour scores of sauces ranged between 3.2 and 4.2. The flavour intensity was also superior in combination 65:35 (P_3). This suggests that sauce with appreciable aroma could be prepared from a blend with major share papaya in combination with mango. Higher aroma score confirm the presence of desirable aromatic compounds in the mix. P_2 was lowest in flavour contribution. There existed a significant difference in the flavour character of different combinations.

When taste of different samples of blended sauce was tested by sensory evaluation, the combination three (65:35) recorded a distinguishly superior grade (4.7). Further better sugar-acid blend have given the better acceptable taste to this treatment. Taste quality of P_1 and P_2 was similar with 3.5 and 3.4 scores respectively. Significant difference between P_3 and P_1. But the difference between P_1 and P_2 was on par. It was evident from the experiment that sauce from papaya and mango could taste better when 65 per cent papaya and 35 per cent mango was mixed.

With regard to the consistency of sauce samples tried P_3 attained the highly appreciable score (4.9) compared to P_2 and P_1 since the score level was 4.0 and 3.0 respectively. It could be observed that the higher pulp content of papaya was able to contribute a right consistency to the product than the ratios in which the percentage of mango is high. The consistency characteristics were significantly different in the three proportions of sauce.

While considering the overall scores, the best sauce was formed by the procedure attempted with treatment three (4.7) followed by P_2 (3.7) and P_1 (3.4). A significant difference was noted among the samples in overall acceptability.

It was a welcome observation that the combination P_3 which constituted the highest share of papaya performed best

among papaya mango mixed sauce. Based on the appearance, colour, flavour, taste and consistency, the best blended sauce was formed from 65:35 proportion papaya and mango pulp. The results offers scope for the development of blended sauce with 65 per cent papaya with good sensory qualities against an increased share of mango in these combination. The experiment on sauce also highlights that even the taste and flavour of this product were preferred at a higher proportion of papaya. This favours the feasibility of utilising papaya fruit in preparation of spicy products like sauce.

4.2.5 Identification of the best blend among mixed products

The most preferred proportion from the blended products viz. nectar, fruit butter, fruit leather and sauce was identified as the standardised ratio for the particular product. The standard product was selected by computing the overall acceptability based on the score values for each sensory quality assessed. The proportions thus identified for the formulation of different blended products studied are presented in Table 6.

Table 6 Proportions identified for blended papaya products

Products	Fruit combination	Proportion selected
Nectar	Papaya-mango	60:40 (P_2)
Fruit butter	Papaya-mango	55:45 (P_1
Fruit leather	Papaya-mango	60:40 (P_2)
Sauce	Papaya-mango	65:35 (T_3)

Table 6 revealed that for the preparation of blended papaya nectar and fruit leather the composition with a major share of sixty per cent papaya along with forty per cent mango was most suitable and constituted the best items. In the case of fruit butter a slightly increased portion of mango pulp evidenced to be the ideal combination. Since the 55:45 ratio of papaya and mango contributed best quality in fruit butter. At the same time for sauce preparation the ratio with the highest quality of papaya in the mix presented the superior result thus identifying 65:35 combination as the standardised formula.

4.3 Indepth studies on selected blended papaya products

The blend which gained most acceptability in the standardisation process was experimented further for detailed information. Plain products made with papaya and that of mango

were included as control against the respective standardised blended item.

Thus three samples each of the four products viz., nectar, fruit butter, fruit leather and sauce were prepared in required quantities following standardised procedure. Products were stored in suitable sterilized and sealed bottles and were stored at room temperature. Indepth comparitive observation of the above products were undertaken based on their chemical, organoleptic and storage performance.

4.3.1 Comparative acceptability of products by panelists

Singh *et al*. (1992) reported that organoleptic observation was done mainly to draw conclusion about a particular food from a large population through the selection of limited number of panel members.

Indian Food Industry (1995) reported that the quality is the main criteria on which the acceptability of any product depends. Sharma *et al*. (1995) is of the opinion that subjective qualitative evaluation relies on physical senses of the panelists.

The acceptability of papaya based blended products viz. nectar, fruit butter, fruit leather and sauce was judged by comparing it with similar products from papaya alone and that of mango alone at the laboratory through selected panel members. The qualities assessed were appearance, colour,

flavour, taste and consistency. The maximum score that could be obtained for any quality is 5. The preference of a product rely not only on a particular character examined but on every quality involved in the evaluation. Thus to assess the overall acceptability total score of the parameters mentioned above was taken.

4.3.2.1 Organoleptic assessment of fresh nectar

Manan *et al*. (1992) reported that there has been a tremendous increase in non-alcoholic beverages such as fruit based drinks because of rapid growth and development of the beverage industry in India. He also pointed out that fruits based ready-to-serve beverages and fruit juices are not only rich in essential minerals, vitamins and other nutritive factors but also are delicious and have an universal appeal. The details on sensory quality of plain and blended nectar studied under the present experiment are depicted in Table 7.

Table 7 Organoleptic characteristics of fresh nectar

Nectar samples	Mean scores for quality attributes					
	Appearance	Colour	Flavour	Taste	Consistency	Overall acceptability
N_1	5.0	5.0	4.8	4.4	4.9	4.8
N_2	4.6	4.8	3.2	3.1	3.9	3.9
N_3	3.8	3.8	4.9	4.9	3.8	4.2
CD	0.353	0.316	0.358	0.440	0.410	0.145

N_1 Papaya - Mango blended nectar
N_2 Papaya nectar
N_3 Mango nectar

PLATE-2 NECTAR

It is evident from Table 7 that among three types of nectar prepared, the appearance attribute score of papaya blended nectar (N_1) obtained the highest and maximum score (5.0) followed by papaya nectar (N_2) which attained a mean score 4.6, while the mango nectar (N_3) failed to catch much appreciation in appearance attribute being obtained the least score (3.8). It is evident from the results that the appearance of nectar was found superior in papaya and mango mix than its plain nectars particularly in the case of mango nectar. The least preference for mango nectar in this aspect is due to its dull appearance and nature of pulp.

Regarding the colour attributes of nectar, the sample N_1 (papaya-mango blend) obtained the maximum score of 5.0 and the plain papaya nectar could also record a very appreciable mean score in colour (4.8) which was statistically on par with N_1 (papaya-mango blend) while plain mango nectar could maintain only a score level of 3.8. The colour and appearance profile of three nectars were in similar order. The data disclosed that the colour of papaya-mango nectar was most attractive. Nectar prepared with mango alone was much inferior in colour appeal than papaya based nectars. According to Sharma *et al*. (1995) colour scores was significantly related with acceptability.

In the present study the colour appeal of nectar could be made highly preferably through balancing the hue by combining papaya with mango.

The score values for flavour in nectar samples N_1 and N_3 were high and was statistically on par. The flavour performance of N_2 was significantly low due to the characteristic odour of the papaya fruit that accounts for its less preference by fruit processing industry. Efforts made through the present study to formulate blended papaya nectar gives a promising solution for this handicap. The notable increase in score for N_1 by blending 40 per cent mango pulp is worth highlighting. It was also noted that flavour rank of papaya blended nectar (N_1) and mango nectar (N_3) was more or less same and statistically on par.

Results of the taste of nectar gives the same data as seen in the case of flavour. Nectar prepared from mango, a highly valued fruit for processing, remained superior with a maximum score of 4.9. Though the mean score obtained for taste attribute in N_2 was low (3.1), blending with mango lifted the mean score to an appreciable level of 4.4. Thus the taste value of N_1 could be significantly improved and remained comparable to mango nectar.

Nanjundaswamy *et al*. (1964) reported that the plain juice of papaya can be blended with other fruit juices to make

it highly acceptable beverage. Data showed that nectar prepared from papaya-mango blended sample secured good acceptability with regard to its consistency having score value of 4.9 whereas N_2 and N_3 attained low scores of 3.9 and 3.8 respectively. There existed significant difference between N_1 and N_2. While N_2 and N_3 were on par. The above result highlights that consistency of nectar could be improved by way of blending than when it is prepared with papaya or mango alone. There might have been mutual contribution of favourable aspects during blending.

When the overall acceptability was computed, the nectar prepared from papaya-mango blend carried the best acceptance among the panel members with mean scores recording 4.9. The lowest overall acceptability was recorded by papaya nectar (3.9). Since the organoleptic aspects viz., appearance, colour, flavour and consistency was preferred most and taste close to mango nectar, N_1 (blended nectar) was proved to be on top in overall preference. The result points out that the nectar from papaya-mango mix was choiced for its sensory quality than the same product from mango alone or papaya alone.

From the foregoing result it may be concluded that a highly appreciable nectar comparable to the subjective quality parameters of mango could be prepared from papaya-mango blended juice. The appearance, colour, flavour and consistency were

preferable than mango nectar. The taste of mixed nectar at 60:40 ratio of papaya-mango was not found inferior to mango nectar and at the same time excelled in few other qualities All the quality parameters and acceptability of papaya nectar could be highly improved by the incorporation of 40 per cent mango juice. Srivastava and Kumar (1994) reported that blended juices can yield a well behaved, righly flavoured, highly palatable and refreshing drink. The present results agree with this statement. In support to our findings a blended RTS beverage formulated with muskmelon and mango by Teotia *et al*. (1992) was found to be successfully accepted.

4.3.2.2 Organoleptic assessment of fresh fruit butter

A comparative assessment on the sensory quality of papaya-mango blended butter, papaya butter and mango butter was made and the data are summarised in Table 8.

Table 8 Organoleptic characteristics of fresh fruit butter

Butter samples	Mean scores for quality attributes					
	Appear-ance	Colour	Flavour	Taste	Consis-tency	Overall acceptability
B_1	4.3	4.5	4.3	4.3	4.6	4.4
B_2	4.0	4.6	2.2	2.6	2.8	3.2
B_3	3.7	3.9	5.0	5.0	3.6	4.4
CD values	-	0.493	0.490	0.375	0.670	0.289

B_1 - Papaya - Mango blended butter
B_2 - Papaya butter
B_3 - Mango butter

PLATE-3 FRUIT BUTTER

Perusal of the data revealed that for appearance papaya-mango butter (B_1) and papaya butter (B_2) secured the higher scores 4.3 and 4.0 respectively, while the mango butter (B_3 remained lower in appearance showing mean score of 3.7. The point to be highlighted from this observation is that when papaya fruit was used for preparation of butter the product gave better eye appeal. At the same time mango butter could not perform upto the level of the other two fruit butters.

The colour attribute scores of the fruit butter developed were in the range 3.9 to 4.6. The highest value was recorded for papaya mango blended butter. The judges graded mango butter to be least preferred in colour aspect. The analysis revealed that papaya-mango blended butter was comparable in colour, attractiveness as that of papaya butter and at the same time performed much superior to mango butter. The results also leads to the possibility of improving attractiveness of mango products by blending with papaya pulp.

Flavour is a complex sensation comprising mainly of odour and taste, odour being more important (Sharma and Wani, 1995). The mean score for flavour in mango butter was much higher than papaya. While the maximum value of five was scored by B_3, B_2 scored only 2.2. At the same time a good score of 4.3 was attained by B_1 (Papaya-mango blend). The difference in flavour attributes between B_1, B_2 and B_3 was found to be

significant on statistical interpretation. Papaya fruit is usually neglected for the consideration in the production of processed item due to its unacceptable order. However this major constraint could be successfully overcome through blending with mango. It was noticed that in the mixed butter the flavour score was surprisingly increased from 2.6 to 4.3.

Taste of fruit butter in the experiment varied from score values of 2.6 to 5.0. Mango butter gave the most promising product and thus the highest score (5.0). Performance of papaya-mango blended butter also could serve 4.3. Meanwhile papaya butter was downgraded with a low score (2.6). There existed significant difference between N_3 and N_2. Eventhough the taste preference for the papaya butter was rather very low, the same was increased to an appreciable level of 4.3, when its juice was blended with papaya in the ratio 55:45. This shows that papaya could be effectively utilised for processing when part of the pulp was replaced by fruits like mango which improved its taste and flavour to a successful level. The taste appeal of papaya-mango blended butter in this experiment was not much inferior to mango butter.

The mixed butter (B_1) secured the highest score of 4.6 for consistency. B_3 attained a middle place in score value (3.6) for consistency, whereas B_2 obtained the least score

of 2.8. A significant difference in consistency characteristic was observed in the mean score obtained for N_1 and N_2. A noteworthy result obtained in this study was that the consistency of blended butter was superior to its component plain fruit butters. This might have effected due to the proper balancing of texture when these pulps were mixed at 55:45 ratio.

Scores obtained for overall acceptability ranged between 3.2 to 4.4. Papaya-mango mixed butter was found superior and mango butter stood very near to it (4.2) and are statistically on par. The results give evidence to the fact that overall performance of B_1 and B_3 are similar and remain at a higher level. While acceptability of B_2 was low compared to B_1 and B_2.

On perusal of organoleptic assessment of three samples of fruit butter we can come to the conclusion that papaya mango butter was overwhelmed by mango butter in appearance, colour and consistency, whereas the flavour and taste attributes were superior for mango butter. The deep orange colour of papaya fruit contributed a highly appealing characteristic natural colour in mixed fruit butter and hence remained outstanding to plain mango butter which appeared to be dull in colour. Another observation was that the less appreciated papaya butter could be prepared more attractive and

tasty by combining with mango retaining a closer status in quality to mango butter. Our findings on blended butter is supported by the studies of Pal (1995). The organoleptic evaluation of blended jelly prepared by utilising papaya and passion fruit was found highly acceptable than plain passion fruit jelly. Similarly peeled watermelon rind was processed alone and in combination with grape by Bhatnagar (1991). The study resulted in a mixed jam with high acid and pectin content, better consistency, colour and flavour.

4.3.2.3 Organoleptic assessment of fresh fruit leather

Fruit leather is a well established product. It is prepared by drying the pulp of ripe fruits. The data obtained on sensory parameters of fresh fruit leather are summarised in Table 9.

Table 9 Organoleptic characteristics of fresh fruit leather

Leather Samples	Mean scores for quality attributes					
	Appearance	Colour	Flavour	Taste	Texture	Overall acceptability
L_1	4.7	4.8	4.2	4.8	5.0	4.7
L_2	4.3	4.2	2.7	2.8	2.7	3.3
L_3	3.2	3.4	5.0	4.8	4.5	4.2
CD	0.631	0.547	0.572	0.539	0.454	0.282

L_1 - Papaya-mango blended leather
L_2 - Papaya leather
L_3 - Mango leather

PLATE-4 FRUIT LEATHER

Table 9 indicated that for eye appeal, papaya-mango leather (L_1) scored high securing 4.7, while mango leather (L_3) remained lower in appearance showing mean score of only 3.2. The colour of the leather might have influenced its appearance too. In total the appearance of L_1 and L_2 were rather well appreciated than that of mango leather (L_3).

Regarding the colour, the fruit leather made from papaya-mango blend (L_1) remained superior with a maximum sore 4.8 followed by papaya leather (4.2). Mango when dried into fruit leather, the colour was not felt attractive which might be due to the browning reaction. At the same time the more bright colour of plain papaya was also less preferred by the judges compared to the pleasant colour obtained when the product was prepared by mixing papaya and mango. A significant difference in colour was noted between three samples on statistical interpretation.

The mango leather secured the highest score of 5.0 for flavour. Though the mean score obtained for flavour attribute in L_2 was very low (2.7), while blending with mango lifted the mean score to 4.2. The data discloses that the exotic flavour of mango is appealing and at the same time provide pleasing flavour to papaya juice when mixed together. In tune with its performance in other quality characters, the leather prepared from papaya-mango blend was considered

acceptable by the judges in flavour too. The flavour intensity of blended leather as per the laboratory evaluation was appreciable like mango leather and blending papaya with mango did not degrade this quality to any noticeable level.

The taste attribute score in the fruit leather ranged from 2.8 to 4.8. The fruit leather prepared from mango (L_3) was observed to have a highest score of 4.8. The taste profile of papaya-mango blended leather (L_1) also more or less equal and was on par with L_3. This advocates that mango can be blended with papaya to prepare leather without degrading its taste and aroma. The leather prepared from papaya alone (L_2) obtained the lowest score of 2.8.

Data showed that the texture attribute score of leather developed was in the range of 2.7 to 5.0. The highest score was recorded for mixed leather (5.0) and lowest for plain papaya leather. This reveals that the texture of leather could be improved considerably when the product was prepared with a mixed pulp of papaya and mango. A report published by CFTRI (1978) stated that variety of the fruit and consistency of the pulp have definite impact on the quality of fruit bar. Interpretation of the statistical analysis of the data indicated the significant difference that existed between the three samples.

When the overall acceptability was computed based on sensory qualities, the leather prepared from papaya-mango blend (4.7) showed high acceptance by the panel members. This result leads to the conclusion that the less appreciated papaya leather could be prepared more attractive by combining with mango.

The present data on preparation of leather using papaya and mango gave promising results. Results of the organoleptic evaluation of leather clearly indicated that papaya fruit has a potential for processing into blended leather bearing an overall acceptability value superior to similar product from mango.

The appearance, colour and texture was preferable than mango leather bearing a comparable taste and flavour. But plain papaya leather was found inferior in taste, texture and overall liking. Studies conducted by Jyothi (1997) revealed that fruit bar prepared from mango and papaya blend was organoleptically more acceptable than plain mango bar. This report lends support to the present results on blended papaya fruit bar. Nanjundaswamy *et al*. (1976) reported that mango bar prepared from different varieties of the fruit had high organoleptic qualities than the product prepared from only one variety fruit.

4.3.2.4 Organoleptic assessment of fresh sauce

Sauce, prepared from individual fruits viz. papaya and mango and their blends were evaluated by a panel of selected judges to compare their acceptability. The results are given in Table 10.

Table 10 Organoleptic characteristics of fresh sauce

Sauce Samples	Mean scores for quality attributes					
	Appearance	Colour	Flavour	Taste	Consistency	Overall acceptability
S_1	4.5	4.2	4.4	4.7	4.9	4.5
S_2	4.4	4.8	2.6	2.8	3.2	3.6
S_3	3.4	2.9	4.6	4.3	3.8	3.8
CD	0.477	0.358	0.474	0.425	0.358	0.156

S_1 - Papaya mango blended sauce
S_2 - Papaya-sauce
S_3 - Mango sauce

According to Birch (1977) appearance is the compound of all information about the product and its environment which reaches the eye. It is evident from table 10 that among the three types of sauce prepared, appearance attribute score of S_1 (mixed sauce) was 4.5 and that papaya sauce remained with only tinge of difference in scores (4.4) and statistically on par. The sauce prepared from mango alone (S_3) obtained the lowest score of 3.4. Similar to the results of other products, the

PLATE-5 SAUCE

dull colour formation in plain mango sauce might have resulted in choosing as the third by judges.

While assessing colour, papaya sauce showed high acceptance among the panel members with mean score recording 4.8. The lowest score was recorded by mango sauce with an average score of only 2.9 which could be improved to an appreciable level of 4.2 by melding with papaya.

Regarding the flavour, the sauce made from mango, a fruit with good aroma secured the highest place (4.6). This need no explanation as mango fruit is worthy enough to provide good flavour when processed into sauce and the same was reflected by the opinion of panel members. Mean while the flavour profile of papaya sauce was very low (2.6). However this quality could be much improved by attaining an encouraging result when sauce was prepared by blending papaya and mango.

The mixed sauce (S_1) secured the highest score of 4.7 for taste attribute which was statistically on par with S_3 (mango alone). S_2 (Plain papaya) recorded the least score of 2.8 for this most important quality. To the surprise the taste of the mixed sauce was lifted to the prime position as a result of the experiment in product diversification.

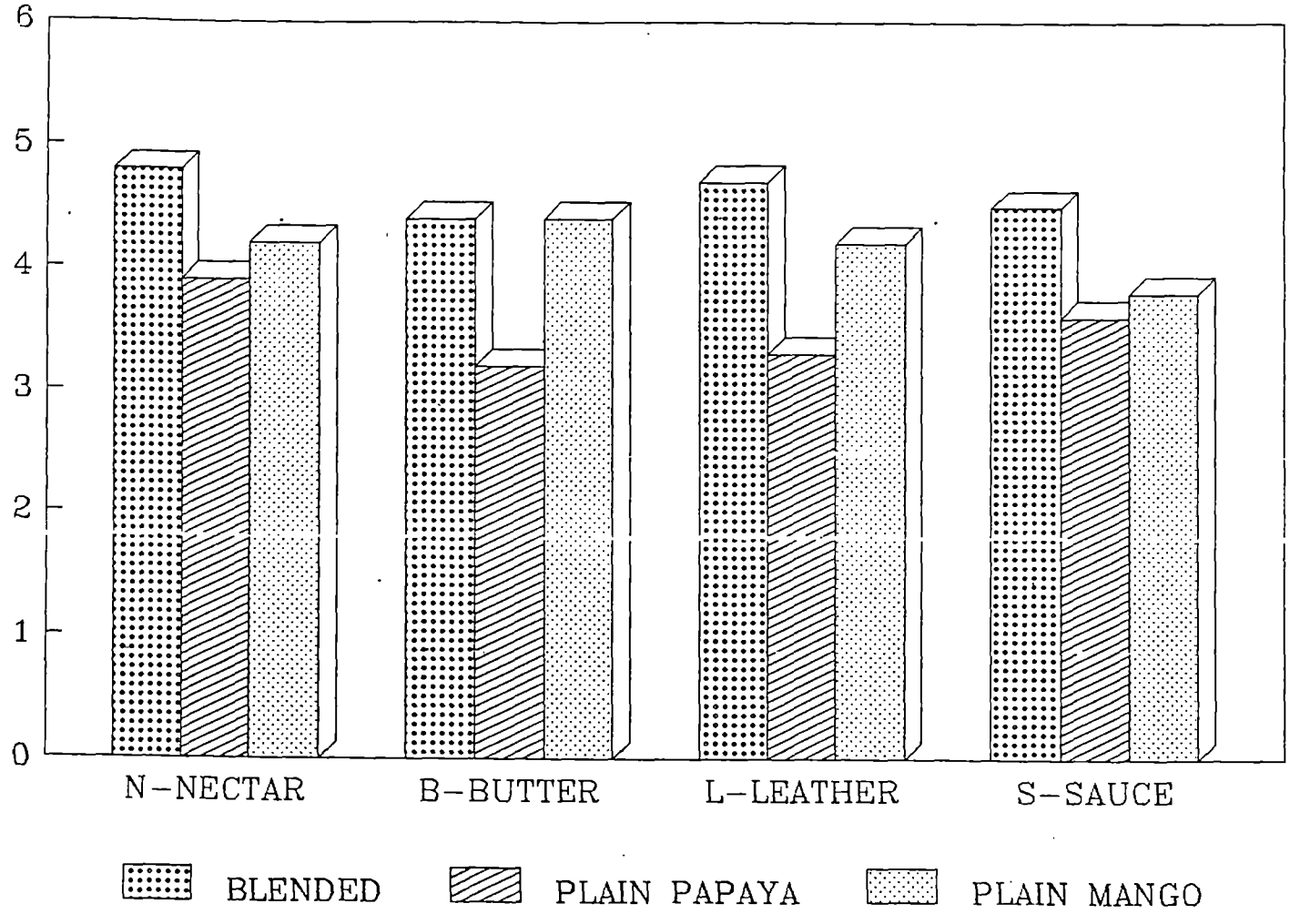
The consistency scores of the sauce developed was in the range 3.2 to 4.9. The maximum score for consistency was observed in sauce prepared from papaya-mango blend (4.9)

followed by mango alone (3.8). Plain papaya sauce exhibited the lowest preference for its consistency. The difference in consistency score of three sauce was found to be significant on statistical interpretation. A balancing of texture highly suitable for sauces could be achieved when these fruit pulps were mixed making the consistency much superior to papaya sauce and better than mango sauce.

Considering each quality of sauces prepared, the overall acceptability remained to be highest with papaya-mango mixed sauce (4.5) followed by mango sauce (3.8). Papaya sauce gave the least acceptability to the judges with an overall mean score of 3.6. Statistical analysis of the data indicated that a significant difference in the overall acceptability score was shown between the sauces S_1 and S_3 whereas the difference that existed between S_2 and S_3 were on par indicating that papaya fruit can be utilised for processing into acceptable sauce by mixing with mango. The mixed sauce showed higher level of acceptance in overall quality than mango sauce and was highly preferred than papaya sauce.

The above results offer scope for the preparation of acceptable sauce from papaya by incorporating 35 per cent mango pulp. The appearance, flavour and consistency of blended sauce was preferable than mango sauce and a comparable taste was obtained. It could be also inferred that the less appreciated

COMPARATIVE OVERALL ACCEPTABILITY OF FRESH PRODUCTS



papaya sauce could be made more attractive by combining with mango. Navani (1965) and Kalra *et al*. (1991) have stated that blending of juices supplement appearance, nutrition and flavour. It is also possible to bring out the latent flavours of the ingredient juices and the resultant blend due to multiplicity of the flavours and bewitching colour is outstanding and unique. The present results is in accordance with these statements.

4.3.3 Nutritional and chemical components of standardised products

Analysis of the chemical constituents in the products provide valuable information about the nature of the product, their quality and susceptibility of deterioration. The nutritional and chemical composition of the four papaya and mango products viz. nectar, fruit butter, fruit leather and sauce formulated under the present investigation was ascertained. The major chemical constituents analysed were pH, acidity, TSS, reducing sugar, total sugar and vitamin C.

4.3.3.1 Assessment of chemical constituents in nectar

The data obtained on the chemical parameters of fresh nectar are summarised in Table 11.

Table 11 Chemical constituents of fresh nectar

Type of products	pH	Acidity %	Total soluble solids °brix	Reducing sugar %	Total sugar %	Vitamin C mg/100g
N_1	3.58	0.50	15.03	12.39	15.63	20.83
N_2	3.32	0.76	19.03	15.95	18.53	30.21
N_3	4.21	0.21	17.03	12.19	15.46	13.54
CD	0.011	0.113	0.116	0.522	1.022	3.602

According to Ranganna (1977) pH is a measure of active acidity which influences the flavour or palatability of a product and affect the processing requirements. A perusal of data given in Table 11 revealed that pH of the three types of nectar were found to be 3.58, 3.32 and 4.21 respectively in N_1, N_2 and N_3. The variation in pH is in relation with the acidity of the products. The pH position of blended nectar remained in between the plain nectars. The lowest value observed in papaya nectar indicated the relatively high acid content of the product. With respect to pH, three nectars were found to be statistically different. Reports on pH values of nectar given by earlier workers fall at similar levels as obtained in this study. Aruna (1997) noted that papaya nectar showed a pH of 3.71. Okoli and Ezanweke (1990) had reported that papaya juice prepared with a pH of 3.9. Varghese (1997) reported the pH of fresh Neelum mango RTS beverage as 4.10.

Observation on the acidity of the fresh nectar revealed a range of 0.21 to 0.76 per cent expressed as percentage citric acid. The variation in acidity may be explained by the higher vitamin C content of fruit juice and addition of acid ingredient in preparation. Plain papaya nectar recorded the highest acidity followed by its blend. Annapurna (1977) observed that the RTS prepared from passion fruits showed an acidity of 0.70 per cent. Varghese (1997) found the acidity of fresh Neelum mango RTS to be 0.33 per cent. According to Sahini and Khurdiya (1989) the acidity content of mango nectar from Neelum variety was observed to be 0.28 per cent. Chakraborthy *et al*. (1991) reported that the percentage of acidity was in the range of 0.20 to 0.40 in canned nectar prepared from different varieties of mango. It was a welcome observation that the acidity level of blended nectar was more balanced than that of papaya nectar and mango nectar. By way of blending, it was also possible to adjust the higher acidity of plain papaya nectar and low acidity of plain mango nectar.

Total soluble solids (TSS) consist essentially of the sugars and soluble minerals present in the fruit products. The TSS of nectar prepared ranged from 15.03 to 19.03°brix. It was observed that plain papaya nectar registered the highest brix followed by mango nectar (17.03) and papaya-mango blend. These values agrees with the findings reported by Aruna *et al*. (1997)

having a brix of 17.50 in papaya nectar. Mango nectar recorded a TSS of 15.0°brix as per a study conducted by Chakraborthy *et al*. (1991). Ghosh (1995) mentioned that the TSS of the juice of different types of cashew apple ranged from 13.10 to 17.70°brix. Canned nectar prepared from different varieties of mango was found to be in the range of 13°brix to 22°brix as observed by Chakraborthy *et al*. (1991).

On analysis of the reducing sugar percentage of nectar, it was observed that the values ranged between 12.19 to 15.95 per cent. The reducing sugar level in papaya nectar was highest. Sreeja (1996) reported the reducing sugar in cashew apple squash to be 15.20 per cent.

Evaluation of the data observed for total sugar of fresh nectar indicated that nectar prepared from papaya was found to be high with per cent 18.53 per cent followed by papaya-mango mix (15.63%). The high sugar content of the CO-2 variety papaya have resulted in higher total sugar level of plain papaya nectar. Mango nectar attained the lower value of 15.46 per cent. According to Aruna *et al*. (1997) the total sugar content of papaya nectar was estimated to be 16.41 per cent. Statistical evaluation revealed that N_1 and N_3 were on par with respect to its total sugar content.

The ascorbic acid content of the fruit products varies depending on the type of fruits. Considering the

vitamin C content of different nectar, the value ranged between 13.54 to 30.21 mg/100g. Among the samples prepared, the highest vitamin C level was recorded for papaya nectar. Comparitively low ascorbic acid content was recorded for mango nectar, and mixing of papaya with mango improved the ascorbic acid content (20.83%) resulting in a more stablished product. Palaniswamy (1974) prepared RTS beverage from lime which showed an ascorbic acid content of 14.76 per cent. Sahni and Khurdiya (1989) have recorded an ascrobic acid content of 10.86 mg in mango nectar prepared from Neelum variety. A significant difference existed between the nectar samples in its vitamin C content as indicated by statistical interpretation.

From the above results, it is clear that the chemical constituents of all the nectar developed were in accordance with the nectar prepared from other conventional fruits. The analysis revealed that all the chemical components were found highest in papaya nectar. However the chemical composition of blending papaya nectar could be proved better adjusted and balanced than the plain nectars. Thus it may be stated that papaya could be very well utilised by blending with mango for the preparation of nectar having good chemical and nutritional quality. More over few aspects like acidity of nectar could be made at proper level when blended. The mixed nectar was found appreciably better in composition than the plain mango nectar.

4.3.3.2 Assessment of chemical constituents in fruit butter

Chemical constituents of blended and plain fruit butter samples analysed are presented in Table 12.

Table 12 Chemical constituents of fresh fruit butter

Type of products	pH	Acidity %	Total soluble solids °brix	Reducing sugar %	Total sugar %	Vitamin C mg/100g
B_1	4.46	0.17	51.03	21.43	25.44	12.45
B_2	4.36	0.10	49.73	17.65	24.60	23.52
B_3	4.90	0.17	58.53	13.04	19.74	12.45
CD	0.014	NS	0.119	0.756	1.289	2.763

The data indicates that the pH content of different fruit butter developed in the present study ranged between 4.36 to 4.90. It was observed that mango butter showed the highest pH level of 4.90 followed by papaya-mango mix (4.46) and plain mango observed the lowest value (4.36). According to Donchenko and his colleagues (1983) pH value in range 2.8 to 3.2 are considered optimum for maximum strength of jam from pineapple. Meanwhile Bhatnagar (1991) conducted studies on the preparation of jam from watermelon rind. The jam was found to be low in acid and pectin. However the pH values reported by Varghese (1997) in mango jam prepared from Neelum variety was to the tune of 4.9 and this agrees with the present data on fruit butter.

A detailed assessment of the acidity of different samples had shown the values to be 0.10 per cent and 0.17 per cent. Lesser acidity was noted in papaya butter whereas both the mango and papaya-mango blend attained a similar value of 0.17 per cent. However there was no significant difference between the acidity levels of fruit butter samples.

Data on the total soluble solids content evidenced that TSS of fruit butter ranged from 49.73 to 58.53 °brix. In this experiment the butter made from plain mango and from plain papaya exhibited a TSS content of 58.53 and 49.72°brix respectively, while that of papaya-mango blend was 51.03°brix. Present results show that papaya based blended butter attained a relatively higher TSS content than that from papaya alone. This again is an indication to the advantage of blending fruits in improving its nutritional quality. Statistical analysis showed that the TSS of fruit butter samples differed significantly.

Estimation of reducing sugar registered the higher value of 21.43 per cent for papaya-mango blended butter followed by papaya butter and mango butter. Sheeja (1994) reported the level of reducing sugar in papaya jam to be 26.30 per cent. Generally the sugar content of butter is significantly lower than that of jam since the amount of sugar to be added for the preparation of butter is lesser than jam.

Hence the value recorded can be considered adequate. There existed a significant difference in the reducing sugar per cent beteween the fruit butter samples.

In the present study, the total sugar of fruit butter varied from 19.74 to 25.44 per cent. It was also evident that the total sugar of mango butter was lower than the values obtained with plain papaya butter and papaya mango mix, where the later possessed the highest value (25.44). As in the case of butter the higher sugar level of papaya fruit selected for the study is accountable to this. Sheeja (1994) observed a total sugar percentage of 38.50 in papaya jam. According to Mc William and Paine (1977) the level of sugar in fruit butter is significantly less than is found in the other pectin containing products. Thus the total sugar content in fruit butter observed in this experiment satisfies the standard level. Statistical analysis revealed that significant difference in total sugar was observed between B_1 and B_3 while B_1 and B_2 was on par.

During processing the total ascorbic acid content of fruits are destroyed by a combination of chemical and enzymatic oxidation. Geetha and Shivaleela (1982) reported that a maximum loss of ascorbic acid occurred in products subjected to continuous boiling, steaming etc. The analysis of ascorbic acid content of fresh fruit butter revealed that the

composition of this nutrient in B_1 and B_3 were same with 12.45 mg. Comparatively higher vitamin C was observed in B_2 (papaya butter) having 23.52 mg. This is due to the higher level of vitamin C content of the papaya fruit. According to ICMR (1989) papaya fruit contains 57 mg/100g of vitamin C content.

From the detailed analysis of the chemical parameters of fruit butter, it was clear that the product were highly satisfactory in their nutritional and chemical composition. The blended butter was notably superior to papaya butter and was maintaining the harmony in most of its quality aspects with the well known mango butter. The results confirm that the present formula can be very well suggested to prepare nutritionally good papaya-mango blended butter.

4.3.3.3 Assessment of chemical constituents in fruit leather

Values on the chemical constituents of the fresh samples of fruit leather analysed are presented in Table 13.

Table 13 Chemical constituents of fresh fruit leather

Type of products	pH	Acidity %	Total soluble solids °brix	Reducing sugar %	Total sugar %	Vitamin C mg/100g
L_1	4.21	0.49	68.03	32.64	39.53	12.50
L_2	4.41	0.34	65.10	34.12	40.59	18.75
L_3	4.46	0.42	66.03	34.92	42.92	9.37
CD	0.177	0.134	0.073	2.635	3.935	NS

The compositional analysis of fresh fruit leather carried out revealed that the pH of the three fruit leathers remained between 4.21 and 4.46. L_3 (mango leather) was found to have slightly high value compared to L_1 (papaya-mango leather). The data when interpreted statistically revealed a significant difference in the pH of L_1 and L_3 while L_2 and L_3 were found to be on par. The pH value of papaya fruit was observed to be 6.25. This pH level needs to be lowered for the adequuate preservation of dried fruit products (Tonaki *et al*. 1993). Jyothi (1997) had recorded a pH of 4.60 in mango-papaya bar (1:1).

The acidity of fruit products can be attributed to many organic acids which occur in fruits and citric acid added while processing. A careful observation of the data obtained revealed that the acidity of fruit leather was found to range from 0.34 to 0.49 per cent. The acidity level of papaya leather which was low could be increased by 15 per cent while blending. Sheeja (1994) observed the acidity content of papaya kandy to be 0.50 per cent. According to Majeed (1995) observed the acidity content of karonda candy was observed to be 0.65 per cent.

Considering the TSS content of fruit leather, the value ranged between 65.10 to 68.03 °brix. Critically analysing the soluble solid level of fruit leather made from plain fruits and their combinations, it was observed that the

blended leather recorded the highest brix followed by mango leather (66.03) and plain papaya. The results on blended the formula for leather preparation revealed that the TSS of the product could be elevated from the level than its preparation with plain papaya. According to Nuri *et al*. (1963) when fruits are dehydrated the soluble solid contents become great enough so that the fruits will resist microbial spoilage for fairly extended periods of time. It is evident that the TSS level of the fruit leather were within the satisfactory level and the higher TSS recorded by blended leather would be advantageous for its quality and storability.

With regard to the reducing sugar, it was noted that the value for different leathers ranged between 32.64 to 34.92. During drying the amount of reducing sugars increase and therefore the quantity of reducing sugar is more in dehydrated foods (Das, 1986). Chauhan *et al*. (1993) reported a similar reducing sugar level for fruit bar prepared by dehydration of apricot pulp supplemented with soy slurry having 33 per cent reducing sugar. In this study the higher reducing sugar was recorded by plain fruit leather, while the minimum was found in papaya-mango blended leather. This shows that the amount of reducing sugar could be lowered when leather was preparing by mixing fruits compared to its preparation from individual fruits. There was significant difference in the reducing sugar content of the three fruit leathers studied.

Total sugar percentage of leather samples under study varied between 39.53 to 42.93 per cent. Observations on total sugar percentage was similar to that of the TSS contents. The highest total sugar percentage (42.92) was noted in L_3. The values obtained for L_2 was 40.59 and that of plain papaya recorded the lower value of 39.53 per cent. However the variation was not significant since statistically the total sugar level remained on par.

The vitamin C content of fruit leather ranged from 9.37 mg to 18.75 mg. The highest vitamin C value was noted in papaya leather followed by blended leather (12.50 mg). Mango leather recorded the lower value. However statistical analysis of the data revealed there was no significant difference in Vitamin C content of fruit leathers. According to Chauhan *et al*. (1993) the vitamin C content of mixed apricot soy fruit bar 60:40 ratio was observed to be 15.9 mg/100g. According to Sagar *et al*. (1998) the ascorbic acid content of dehydrated ripe mango slices was found to be 10.50 mg/100g.

Results of the analysis of chemical and nutritional characters of fruit leather under the present study were found more or less satisfying the range observed by other workers with respect to this product. However the acidity and TSS could be improved through blending papaya which are important components in quality improvement. Like wise the value on

reducing sugar could be minimised. But a reduction in vitamin C was noted while mixing mango for leather making.

4.3.3.4 Assessment of chemical constituents in sauce

Chemical constituents of the blended sauce standardised along with the plain sauces were assessed, results of which are presented in Table 14.

Table 14 Chemical constituents of fresh sauce

Type of products	pH	Acidity %	Total soluble solids °brix	Reducing sugar %	Total sugar %	Vitamin C mg/100g
S_1	3.81	0.64	26.10	11.71	14.42	23.66
S_2	4.04	0.37	22.10	12.29	15.45	36.68
S_3	3.35	1.08	27.57	6.60	7.31	15.38
CD	0.017	0.175	0.612	0.284	0.416	4.094

pH is an indication of the acidity or alkalinity of the product. The range that was observed for the pH of various sauce was between 3.35 and 4.04. The analysis on pH of fresh sauce revealed that mango sauce (S_3) recorded the lowest value. Comparatively higher pH was observed in plain papaya sauce (S_2) and papaya-mango blend. Kaur and Khurdiya (1993) observed a pH of 3.64 in mango sauce prepared using mango and sugarcane in the ratio 6:1. It was noted that the above value fall within the range of the pH of sauce recorded in this study. The lower

pH of mango sauce is correlated to the lower pH of fruit juice used in the preparation. Statistical analysis of the data indicated that significant difference was observed in pH values in all the sauces.

The acidity of the sauce ranged from 0.37 to 1.08 per cent. The data in the Table 14 revealed that the tritable acidity of sauce was maximum in mango and minimum in papaya sauce. It was also found that papaya mango blend attained a relatively higher acid percentage than the sauce from plain papaya. This could be related to the higher acid level of mango than papaya. Unlike in other products undertaken in the study, for the preparation of sauce mature underripe mango was used. Pruthi *et al*. (1980) observed an acidity content of 1.43 to 1.80 per cent in tomato ketchup prepared from different varieties of tomato. According to Aruna *et al*. (1990) the acidity content of tomato concentrates prepared from different varieties of tomato was observed to be 0.30 to 0.65 per cent. The three sauces differed significantly in acidity.

The TSS of different sauce ranged between 22.1 to 27.57°brix. Plain mango sauce recorded the highest TSS followed by blended papaya sauce (26.1). TSS of papaya sauce was comparitively low. However the values were satisfactory as evidenced by other reports. Kaur and Khurdiya (1993) who observed a TSS of 22°brix in sauce prepared from unripe mango

and cane sugar in the ratio 6:1. Similarly the TSS content of tomato ketchup prepared from different varieties of tomato was observed to be 28°brix by Pruthi *et al*. (1980). A significant difference was existed between the sauces in its TSS content as shown by statistical interpretation.

The reducing sugar was found to be highest in papaya sauce (12.29) followed by papaya-mango sauce (11.72) and plain mango sauce (6.60). Joshi *et al*. (1996) reported that the sauce prepared from apple pomace had a reducing sugar content of 11.69. This study supports the reducing sugar level recorded in sauces analysed in the present experiment. The results were also in proof to the proper chemical composition of the blended formula for sauce prepared from papaya.

The sugar present in fruits consists mainly of sucrose, fructose and glucose and the percentage of total sugar is subjected to variation with respect to the particular fruit. On analysis of the total sugar percentage of sauce, it was observed that the highest value was registered for papaya sauce (15.45) followed by papaya-mango blend (14.42) and plain mango sauce which possessed the least percentage (7.31). The results also reveal that the total sugar composition of mango products could be improved by addition of papaya pulp with mango. Statistical analysis of the data reveals that there existed significant difference between the three different sauce.

The vitamin C content present in the three different sauce ranged between 15.38 mg to 36.68 mg. Papaya sauce (S_2) secured the highest vitamin C content (36.68 mg) while the mango sauce (S_3) recorded the lowest (15.38 mg). Statistical analysis showed all the sauce to be significantly different in vitamin C content.

On observation of the chemical parameters of sauce, the results were worthy enough to state that papaya could profitability be exploited to prepare blended sauce with better nutritional qualities than plain sauce from either papaya or mango. Mixing of these fruit pulps in sauce making could profitably be utilised for the distribution of nutrients rich in these fruits at a fairer balance in blended sauce.

4.3.4 Confirmation with FPO requirements

According to Kapoor (1993) food laws are essential for food safety. Day by day consumers are becoming quality conscious about food, not only about appearance but also about food free of contamination. To ensure food quality, many type of quality standards have come into existence. Kalia and Sood (1996) stated that the development of grades and standards of quality depends upon the definition of the quality characteristic to be measured. The quality of the preserved product is controlled by the government through the fruit product control order (FPO) 1955 and later modified in 1961 as fruit products (Amendment) order 1961.

The papaya based blended products developed in the present study were analysed for FPO specifications in its requirements for particular items.

FPO specifications for fruit nectar prescribe a minimum 15-20 per cent total soluble solids, a minimum of 20 per cent fruit juice. In the present investigation, it was observed that all the three nectars developed possessed a TSS per cent more than 15 per cent. Plain papaya nectar and plain mango nectar consisted of 19.03 and 17.03 per cent total soluble solids respectively. The papaya based blended nectar also stood above the standards in TSS content with 15.03 per cent. Likewise the fruit juice content of all the three nectars maintained a level above 20 per cent. Thus it could be confirmed that all the nectar in the present study were well competent with a standard nectar. Therefore all the nectar prepared confirmed its standard since agreed with the FPO levels.

With relevant to fruit butter FPO has not strictly specified its requirement. However recording to Kalia and Sood (1996) fruit butter should not have less than 43 per cent soluble solids. TSS value on plain mango butter was on top with 58.53 per cent. Blended fruit butter contained 51.0 per cent followed by plain papaya butter with 49.73. Thus the TSS of the different fruit butter prepared in the present study

were found crossing the minimum TSS percentage prescribed by Kalia and Sood. While comparing the fruit butter with similar product jam for fruit content in the final product, indicates a minimum of 45 per cent. The fruit butters standardised were in tune with these standard levels of fruit juice content bearing 48 per cent.

Though fruit leather is widely sold in domestic market there is no standard specification for the physico chemical or microbiological quality of mango powder and leather (Jagtani *et al*. 1988). In this experi-ment the blended leather prepared attained a TSS of 68.03 followed by mango leather with 66.03 and papaya leather with 65.10.

Srivastava and Kumar (1994) reports FPO standards for sauce to be a minimum of 15 per cent total soluble solids. In this investigation sauce prepared from papaya, mango and blended sauce were found to have a total soluble percentage 22.1, 27.57 and 26.1 respectively which was far above the limits specified.

The above details indicate that the four products developed satisfy the FPO standard presenting a comparable status with standard products of similar category. Thus it could be concluded that in this experiment recipes for papaya based nectar, fruit butter, fruit leather and sauce have been properly formulated and procedures were well adjusted during

their standardisation process. These scientific steps followed in preparation of the products have favoured the products to meet the FPO standards.

4.3.5 Cost of benefit analysis of the product

Cost benefit analysis endorses the potential to assess the cost attained for the development of a product. According to How (1990), information as accurate and upto date as possible on supply, demand and prices is essential for anyone directly involved in the business of marketing fruit products. Hence the production cost of each item was worked out to assess the expenses incurred.

The cost benefit analysis was carried out based on the cost of various commodities needed for the preparation of products in this investigation such as cost of fresh fruits, sugar, chemicals, bottles and overhead charges including labour cost and fuel. Table 16 depicts the expenses incurred for the production of papaya mango blended products and also that of plain papaya and plain mango products worked out in the present trial.

The cost of one litre fruit nectar varied from rupees six to rupees eighteen. Beverage prepared from papaya was observed to be the cheapest while the cost incurred for the nectar made from Neelum variety mango was found to be

comparitively high (Rs.18.00/litre) and blended nectar costed rupees eleven. Cost benefit analysis of blended nectar throws light to the possible production of nutritious, tasty and appreciable soft drinks with papaya and mango at a lesser cost (Rs.11.00) compared to other fruit based beverages available in the market.

Table 15 Cost analysis of the products

Particulars	Cost per kg./litre (Rs.)
Nectar	
Papaya nectar	6.00
Mango nectar	18.00
Papaya-mango nectar	11.00
Fruit butter	
Papaya butter	15.00
Mango butter	35.00
Papaya-mango butter	27.00
Fruit leather	
Papaya leather	20.00
Mango leather	68.00
Papaya-mango leather	46.00
Sauce	
Papaya sauce	13.00
Mango sauce	34.00
Papaya-mango sauce	27.00

The cost analysis of fruit butter samples in this experiment revealed much difference as in the case of nectar. The cost per kg of papaya butter was worthed to be Rs.15 and the same observed for mango butter was Rs.35. The fruit butter prepared from papaya-mango blend was found to have a price of Rs.27. It could be remarked that the cost on sugar is a major expense to bear in the case of fruit butter. On comparison of the three fruit butter, papaya butter could be produced with the least expense due to the lower wastage in the fruit while processing and also the availability of papaya at lesser cost. At the same time mango is a seasonal fruit and exist high varietal cost difference. Thus the fluctuation in cost of mango butter may be related to the high market price of the fruit.

According to Singh (1990) dehydrated products like mango leather, mango cereal flakes and mango powder show great promise for export. The cost of mango leather went up to Rs.68/kg. The expense for production of papaya leather was observed to be the lowest due to the year round availability of papaya fruit at a lower price (Rs.20) and the high pulp recovery. The fruit leather prepared by blending mango was found to have an expense of Rs.46/-.

Coming to the cost of production of sauce, the highest cost (Rs.34) was recorded for mango sauce, whereas

papaya sauce was observed to have the lowest cost (Rs.13). The blended sauce stood in between with respect to cost (Rs.27). As per the judgement of both consumers and scientific panel members, the papaya-mango sauce was found to be highly acceptable. While comparing these sauce with tomato sauce available in the markets the experimental sauces were found to be more cheaper.

The results indicate that among the four products prepared utilising papaya, mango and these fruit blends, it is to be highlighted that the cost of papaya products was very low but this product could not establish as a well competed item among the end-users in the market. On the other side mango products is a well established item liked by all, and is available throughout in the market. However various research groups are conscious of the competition in the international market and are producing novel items. Thus the new blended products formulated would be able to combat the high price to a reasonable level and at the same time catch the consumer attention.

While comparing the different products prepared from papaya based blended products it may be stated that nectar was cheapest item among the four products. Sauce was found to have the second place in cost benefit parameter. When fruit butter was prepared, the economics aspect stood in the third place.

Fruit leather was the most expensive product because on drying water level is reduced leading to the concentration of the product. It could be also inferred from the data that blending mango with cheaper papaya pulp, it might be economically feasible to use highly flavoured Neelum variety for processing industries to improve their economic feasibility and to some extent marketability. However all the four blended products were found to be acceptable, nutritious as well as economical when compared with the similar other products in market. These advantages could increase the 'likelihood to buy' these products.

4.3.6 Fruit product yield ratio

Fruit to product yield ratio gives an estimation of the amount of product obtained for known quantity of the fruit utilised. The yield of the product is dependent upon its pulp recovery. This information is crucial, while introducting fruit products with emphasis on the economy of its products. Table 16 gives the fruit yield ratio of different papaya based blended products standardised in this study.

Table 16 discloses that when nectar beverage was attempted using papaya alone and mango alone, the best yield ratio was presented by papaya nectar followed by papaya-mango blend. Compared to these two nectars mango nectar yielded lowest. The difference resulted in yield ratio could be

explained by the available edible portion of the fruit. Papaya varieties are characterised with less seeds and higher flesh content and hence less wastage. Its flesh contains high amount of juice. The stone weight and peel weight is more resulting in higher percentage of wastage ie. 50 per cent. While blending papaya with mango resulted a better yield than similar products from mango alone. Thus the variation in product yield ratio of nectar was directly influenced by its juice yield of papaya.

Table 16 Fruit product yield ratio

Fruit product	Fresh fruit (kg)	Quantity product yield	Ratio
Nectar			
Papaya nectar	1 kg	1670	1 : 1.6
Mango nectar	1 kg	900	1 : 0.9
Fruit butter			
Papaya butter	1 kg	700	1 : 0.7
Mango butter	1 kg.	350	1 : 0.3
Fruit leather			
Papaya leather	1 kg	325	1 : 0.3
Mango leather	1 kg.	205	1 : 0.2
Sauce			
Papaya sauce	1 kg	700	1 : 0.7
Mango sauce	1 kg.	300	1 : 0.3

Fruit butter from papaya fruit recorded comparatively high yield than its similar products from papaya-mango and mango. It can be attributed to the fact that papaya had lower fruit waste compared to mango. The fruit product yield for papaya butter was found to be highest. It was followed by papaya-mango blend and mango butter.

In the case of fruit leather also papaya leather exhibited the best product yield ratio. Generally fruits when converted to leather its yield would be less compared to other products due to the reduction in moisture content. Inspite of this fact the product yield ratio was good. In the case of papaya, as wastage from papaya was comparitively less which was only 12 per cent mango leather yielded lowest due to the same fact as in the case of other products.

A high yield ratio was obtained for sauce prepared from papaya alone. Mango sauce attained the lowest yield. The blended sauce remained at the middle position with regard to product yield ratio. The difference in yield can be again accounted to the higher wastage in the case of mango.

Data clearly indicates that papaya fruit can yield products in higher quantity compared to mango with relevant to all the products studied. In the present out look, the major thrust is exploitation of papaya fruit to a maximum extent considering that it is an under exploited fruit until now. At

present all our efforts should be concentrated on upgrading the quality of papaya based blended products and economics of its production. So that it can gain access in its global market.

4.3.7 Consumer acceptance of the product

Today consumers have increased concern regarding food safety and sensory qualities. According to Land (1983) most consumers have fairly fixed ideas and know what to expect in terms of sensory quality of a given processed food. Vyvasaya keralam (1994) stated that consumer testing of the processed products should also receive attention to determine acceptability of products. Hence the acceptance of the developed products by the consumers was assessed with special reference to nutritional significance, sensory qualities storage and shelf life of the products. Clement *et al*. (1989) opine that sensory evaluation can be used to predict consumer acceptance of a food item.

Results of the study conducted by Gao *et al*. (1993) indicate that education, sex, race, urbanization and household size are important determinants. The four papaya based products nectar, fruit butter, fruit leather and sauce in the present study which underwent a scientific panel testing were thus subjected to evaluation by a consumer group of untrained persons in the university campus. To select the most promising products developed preferential ranking was also

conducted. They expressed their acceptability level by marking values in the score cards. They also ranked the various papaya based blended products based on their priority of liking the items at a numerical basis.

4.3.7.1. Consumer acceptance of nectar

The mean values of acceptability scores given by fifty consumers by testing various quality parameters of nectar is summarised in Table 17.

Table 17 Consumer acceptance of nectar

Nectar samples	Mean scores for quality attributes					
	Appearance	Colour	Flavour	Taste	Consistency	Overall acceptability
N_1	4.5	4.4	4.6	4.8	4.9	4.6
N_2	4.6	4.8	3.0	3.0	3.8	3.8
N_3	3.4	3.2	4.7	4.4	3.8	3.9
CD	0.193	0.194	0.182	0.166	0.167	0.094

N_1 - Papaya-mango blended nectar
N_2 - Papaya nectar
N_3 - Mango nectar

On critically analysing the data (Table 17) pooled on acceptance of nectar by general consumers, the scores proved that papaya-mango blended nectar was liked best in most of the characters by the consumers. The consumer score recorded for

appearance of papaya nectar (N_2) was found to be superior followed by blended nectar (N_1). Meanwhile the mango nectar (N_3) attained the least score.

Another criteria evaluated by the consumer was colour. Similar to the appearance choice, papaya nectar was the most preferred sample in colour by the consumer group. Colour acceptability scores of papaya nectar was much higher than mango nectar, the scores being 4.8 and 3.2 respectively. They appreciated the colour even when papaya was mixed with mango (4.4). The orange yellow colour of Co-2 variety papaya remained very attractive in beverages. It is a fact that the attraction to any food product by the common people primarily rests on its colour and taste. The deep coloured carotene pigments in papaya favoured colour attraction when papaya alone was processed into nectar.

On taking flavour into account, it was observed that N_3 had showed the best consumer score of 4.7. The familiar flavour of mango was easily detected by them and the blending of 40 per cent mango with papaya increased the acceptance of the product to a level very close to mango nectar. A more or less similar results on flavour preference of blended beverage was reported by Teotia *et al*. (1992) while trying to develop a muskmelon - mango blend beverage. The product from 50:50 blend was adjudged the best because of its balanced flavour.

With reference to taste, the papaya - mango blended nectar was ranked best with score value of 4.8. While the score of 4.4 was given to the popular mango nectar. Taste is the major attribute which determine the acceptability of a food material. The taste of mango fruit and its products have been established as relished choice by consumers mainly due to its delicious taste. However the present results are surprising that the consumer acceptance level of blended nectar was more than that of plain mango nectar. It reveals that for the preparation of nectar even with mango, blending is an ideal step to enhance the taste.

On evaluating the consistency of nectars, the scores of consumers ranged between 3.8 to 4.9. The best consistency was shown by nectar when fruits were combined as in papaya - mango blend. The fibrous texture of mango pulp and smooth texture of papaya pulp when combined attained a more desirable consistency by mutual contribution of textural properties to make up the best by the blended nectar in this aspect. Both plain papaya and plain mango nectar shared an equal score of 3.8 in its consistency.

The range for overall acceptability score of these nectars when judged by consumers was between 3.8 and 4.6 showing a well desirable and top acceptance to papaya-mango blend. In conformity with this consumer findings Begum *et al*. (1983)

found that mixed fruit juice has great consumer appeal than plain juice and improved the nutritional quality of the drink. The authors have tried pineapple and mango mixtures in the ratio of 25:75, 50:50 and 75:25 for squash and have claimed good consumer acceptance. Pruthi and Sondhi (1978) reported the development of interesting products like cashew apple RTS beverage from blends with carotene rich fruit pulps of mango and papaya.

A glance to the consumer acceptability of nectars evidenced that papaya-mango nectar bagged wide acceptability. In the beverage landscape around the world, becoming progressively competitive with increased alternatives and options to the consumer, this product also stands a chance. The score values of blended nectar were found to be on top in most of the qualities. The consumers also judged that the acceptance of papaya nectar could be substantially increased with the addition of 40 per cent mango pulp in nectar preparation. The quality of blended nectar particularly colour was liked more than that of plain mango nectar by the consumer. In general appropriately coloured foods were perceived to have higher preference from consumers. The present formula of blended nectar was therefore effective in the commercial outlet of papaya.

4.3.7.2 Consumer acceptance of fruit butter

The consumer views on the papaya butter, mango butter and blended butter studied by organoleptic evaluation are presented in Table 18.

Table 18 Consumer acceptance of friot butter

Butter samples	Mean scores for quality attributes					
	Appear-ance	Colour	Flavour	Taste	Consis-tency	Overall acceptability
B_1	4.3	4.5	4.0	3.9	4.3	4.2
B_2	4.5	4.0	2.9	2.8	3.2	3.6
B_3	3.7	3.6	4.9	4.9	4.4	4.3
CD	0.205	0.215	0.158	0.137	0.212	0.087

B_1 - Papaya-mango blended butter
B_2 - Papaya butter
B_3 - Mango butter

Perusal of the data revealed that mango butter (B_3) was highly preferred by the consumers for its flavour, taste and consistency among common people compared to the other two samples. Analysis of data on appearance score revealed that among the three fruit butters, B_1 (4.5) and B2 (4.3) proved high acceptance to the consumers as evidenced from the scores, while mango butter was less preferred.

According to Sharma (1995) among the organoleptic attributes, colour is an important factor influencing consumer acceptance of food. With reference to colour B_1 was superior to B_2 and B_3 carrying a score value 4.5, while the others recorded 4.0 and 3.6 respectively. This quality is related to the richness in colour of the papaya fruit under experiment. A significant difference was observed in consumer mean score of colour between products.

Regarding the flavour and taste of fruit butter with papaya, mango and their blends; flavour and taste acceptability of mango butter was much higher than papaya butter with score 4.9 each. The blended butter performed second in these qualities to the mango butter. This suggests that from consumers point of view, blending of these two fruits was found beneficial with regard to elevating taste and flavour attraction of fruit butter made from papaya alone to an appreciably high level.

The consistency score of B_1 and B_3 butter were not conspiquosly varied since scored 4.4 and 4.3, whereas B_2 attained apparently lower score (3.2). In consumer judging consistency of papaya butter was less satisfactory while mixing mango with it showed substantial improvement in liking. It may be mentioned that the textural properties of papaya pulp could be beneficially altered by addition of mango pulp for fruit

butter preparation above the level than its preparation with mango pulp alone.

The overall consumer acceptability evaluation indicated that butter from papaya mango blend could catch a closer acceptability level to the mango butter. Blending fruits for preparation of similar products were remarked with higher consumer acceptability. The study on processing of blended jelly based on passion fruit by Pal (1995) resulted in products which elicited high consumer acceptability than plain passion fruit jelly. Burhan-Uddin (1993) claimed encouraging results from 48 samples of jam blends of mango with a variety of fruits when evaluated for consumer acceptability. The sensory quality score of butter showed that there exists a perceivable variation between B_2 and B_3, while B_1 and B_3 were on par.

Consumer remarks on fruit butter evidenced that mango butter was more appealing than papaya butter. The flavour of papaya butter was not attractive similarly the taste was not well appreciated by the common people compared to their preference on mango butter. However, while blending with mango all the sensory qualities were precisely improved and the acceptance of consumers was also superior to plain papaya butter and catched almost the same appreciation level of mango butter. Altogether the organoleptic characters of papaya

butter were advantageously transformed by the attempt of blending providing good taste, flavour, consistency and attraction to the product. This results of consumer feed back is a good indication to lift the processing scope of papaya.

4.3.7.3 Consumer acceptance of fruit leather

Consumer accreditation of fruit leather on various quality attributed by a group of unscientific members are depicted in Table 19.

Table 19 Consumer acceptance of fruit leather

Leather samples	Mean scores for quality attributes					
	Appearance	Colour	Flavour	Taste	Texture	Overall acceptability
L_1	4.6	4.1	3.9	4.2	4.4	4.2
L_2	4.2	4.4	3.0	2.7	2.8	3.4
L_3	4.0	3.4	4.9	4.8	4.5	4.3
CD	0.265	0.274	0.192	0.191	0.198	0.109

L_1 - Papaya-mango blended leather
L_2 - Papaya leather
L_3 - Mango leather

Analysis of the data obtained revealed that L_3 and L_1 proved high acceptance among the consumers as evidenced from the scores. Colour and eye attraction of papaya-mango leather (L_1) was more acceptable to consumers than mango leather (L_3). Colour of food is one of the first attributes recognized by the

senses of the purchaser and consumer of the product. It is a fact that the primary impression of a food is visual. General approach of common people towards the product mainly rests on this aspects.

In consumer scaling of taste intensity, flavour and texture of mango leather stood ahead. Papaya - mango blended leather stood close to mango leather. The above parameters of blended leather was scored remarkably higher to papaya leather and closer to mango leather in the quality attribute judging by the untrained panel likewise the opinion of scientific members. Papaya leather had a poor consumer appeal because of its inherited flavour, less attractive taste and characteristic texture.

The overall performance expressed by consumers for L_3 and L_1 was at a high level with scores 4.3 and 4.2 respectively. While papaya leather (L_2) scored only 3.4. Overall acceptance of L_1 remained statistically on par with L_3. The score level suggests that consumers welcomed the blended leather with an almost equal appreciation as that of the well rejoiced similar product prepared from the king of fruits, mango. At the same time plain papaya leather failed to catch a consumer fascination upto the level of either mango leather or blended leather since the preference on flavour, taste and texture of papaya leather was at medium level. The findings are in confirmity with the reports of Krishnamurty and Varma (1978)

which stated that mixed fruit slabs were found to be quite delicious than plain papaya slabs.

It could be remarked that the consumer relished papaya - mango blended leather with much preference to plain papaya leather. This indicates that papaya products like leather can find ready market when the characteristic odour of papaya was masked by blending with fruits like mango. Besides it contributes value addition to papaya fruit since a large quantity of this highly perishable fruit can be utilised for the manufacture of a tasty and economically viable product viz., fruit leather or fruit bar.

4.3.7.4 Consumer acceptance of sauce

The data on the consumer evaluation on different sauce undertaken in this investigation are presented in Table 20.

Table 20 Consumer acceptance of sauce

Sauce samples	Mean scores for quality attributes					
	Appearance	Colour	Flavour	Taste	Consistency	Overall acceptability
S_1	4.6	4.4	4.3	4.4	4.6	4.5
S_2	4.5	4.7	2.8	2.8	3.0	3.6
S_3	3.8	3.6	4.9	4.7	4.4	4.3
CD	0.207	0.214	0.168	0.191	0.187	0.093

S_1 - Papaya-mango blended sauce
S_2 - Papaya sauce
S_3 - Mango sauce

As per table 20 among the different sauce prepared, blended sauce was most attracted by general consumers bagging above 86 per cent scores in each criteria evaluated. On the appearance of sauce, consumers scored highest for papaya-mango sauce (S_1) having mean score 4.6 and papaya sauce 4.5.

Papaya sauce (S_2) was highly preferred by consumers followed by blended sauce for its colour compared to mango sauce. The deep orange shining colour made a good impact on the consumer. Colour is therefore one of the major factor influencing consumer acceptability. The consumer study proves that appearance and colour of certain mango products can be improved by adding papaya fruit.

Plain mango sauce gained greater appreciation by the common people for its flavour and taste. The delicious taste of mango fruit and its products were ranked with higher appeal than mango sauce mainly due to the inherited drawback of papaya fruit with the typical flavour characteristic that maker its processing scope limited. However this limitation of papaya could be surprisingly overcomed while blending with mango as evidenced from the consumer opinion on the blended papaya sauce. The consumer scores of mango sauce (S_3) and blended papaya sauce (S_1) were not much varied with regard to flavour and taste. More over the consistency attribute of S_1 was graded best having the apt texture from the lowest position in S_2.

Even with a second position in consumer assessment of few major attributes, the overall appraisal indicated the best acceptance to papaya-mango blended sauce attaining a consumer score 4.5 (90 per cent). Mango sauce was next with 4.3, while the overall acceptability score of papaya sauce by consumers was only 3.6. A significant difference between three products was existed in consumer acceptance of sauces.

Consumer impression on sauce proved that in its overall effect they welcomed blended sauce in top priority with a parallel preference to mango sauce. The trial undertaken to produce a palatable sauce from papaya using a blended formula could be stated worthwhile as enlightened from the results of consumer studies. The plain papaya sauce that carried the least consumer acceptance was relished by them by the process of a mixed formula that would also help in making a new product from the under utilised papaya fruit.

4.3.8 Consumer preference of the papaya based products

Preference grading of the consumers for the papaya mango blended products developed in the present study viz. nectar, butter, leather and sauce was also carried out. The preference evaluation was made inorder to select the most promising and highly acceptable papaya based blended product. The results of the consumer preference based on ranking the four products are depicted in Table 21.

Table 21 Consumer preference level of papaya based blended products (Percentage)

Products	Preference level			
	I (%)	II (%)	III (%)	IV (%)
Leather	70.00	24.00	6.00	0.00
Nectar	28.00	68.00	4.00	0.00
Sauce	2.00	8.00	80.00	10.00
Butter	0.00	0.00	10.00	90.00

When the first preference was analysed, it was found that 70 per cent of the consumers gave their first choice to leather. Nectar was marked by 28 per cent, while only a small group of 2 per cent consumers liked sauce as their best preferred item made from papaya and mango blend. No one liked papaya mango butter to rank as the best item.

On considering the second preference, it was found that majority of the consumers (68 per cent) liked nectar as their second preferred item. The same rank was given by 24 per cent consumers to leather, while it was seen that only 8 per cent of the consumers could find sauce as second in the order and none of the consumer accepted fruit butter to be their second preference. Kaur and Khurdiya (1993) pointed out that fruit based beverages are becoming increasingly popular in the market with the growing consciousness of people in the nutritive value of fruits. The papaya based beverage

CONSUMER PREFERENCE STATUS OF PAPAYA BASED BLENDED PRODUCTS

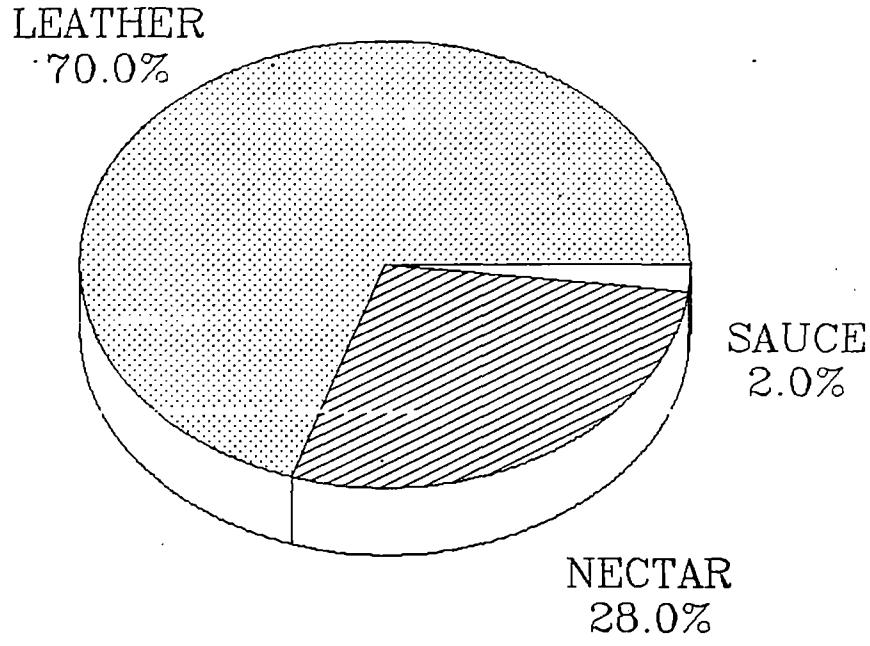


FIG.6 FIRST PREFERENCE OF CONSUMERS FOR PAPAYA BASED BLENDED PRODUCTS

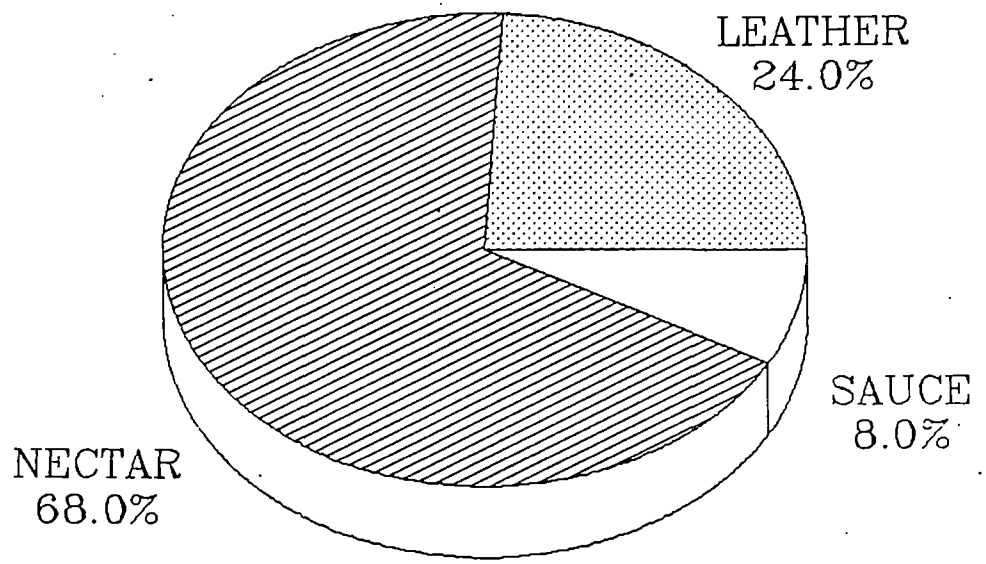


FIG.7 SECOND PREFERENCE OF CONSUMERS
FOR PAPAYA BASED BLENDED PRODUCTS

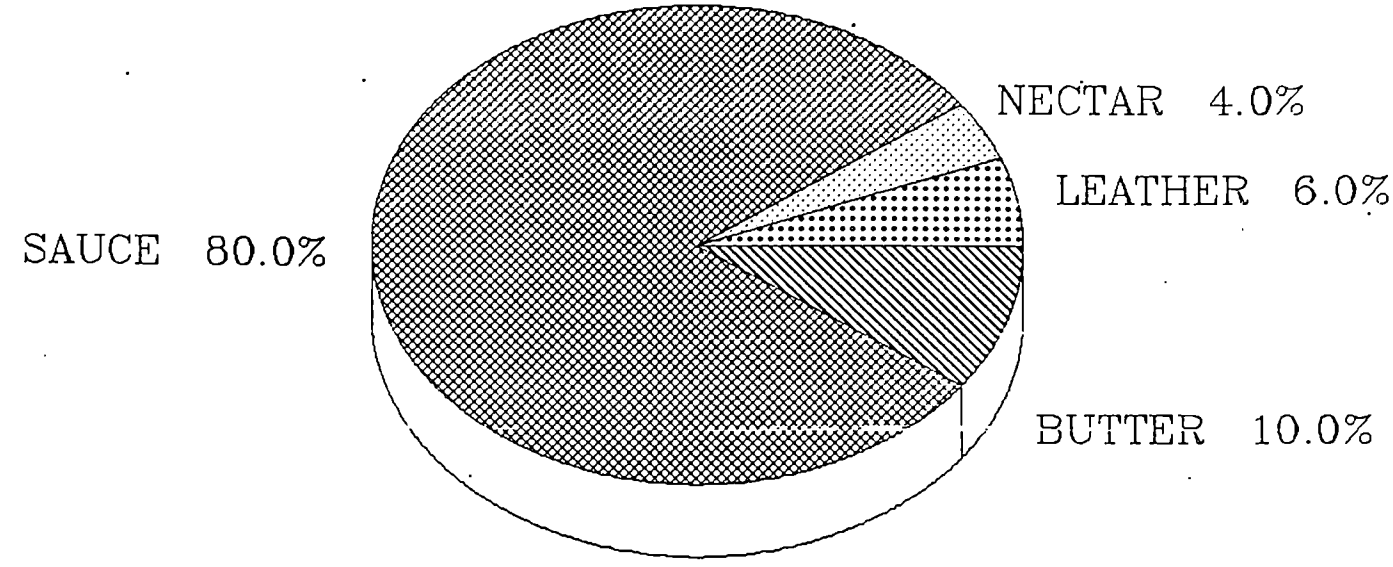


FIG.8 THIRD PREFERENCE OF CONSUMERS
FOR PAPAYA BASED BLENDED PRODUCTS

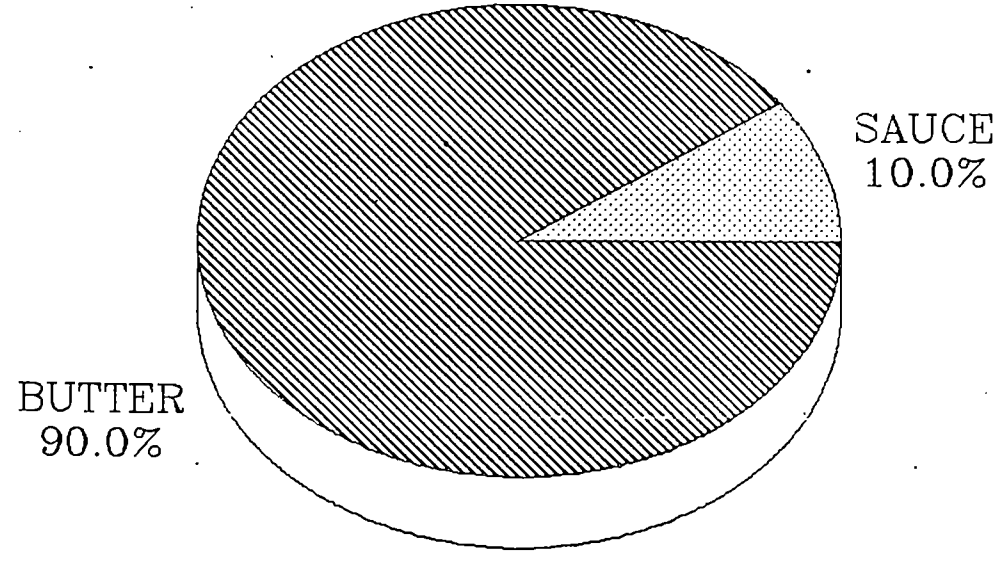


FIG.9 FOURTH PREFERENCE OF CONSUMERS
FOR PAPAYA BASED BLENDED PRODUCTS

formulated in the study was also appreciated by majority of consumers next to fruit leather constituting the same fruit.

To disclose the third preference of the consumers, majority of them forming 80 per cent had their option to papaya-mango sauce. This position in ranking order was given to papaya-mango butter by 10 per cent. Fruit leather was preferred in a third place by a consumer group of only 6 per cent and a mere 4 per cent ranked nectar as their third choice.

While taking into account the fourth preference on blended papaya products, the highest per cent (80 per cent) graded fruit butter to the forth choice. 10 per cent of consumers placed sauce to the fourth preference and nobody accepted either fruit leather or nectar to be opted as fourth preference.

In a nut shell, preference study conducted for papaya mango blended products viz. nectar, fruit butter, fruit leather and sauce clearly indicated that papaya mango leather is a promising product to be popularised. Nowadays fruit leather is establishing well as a fruit product and is gaining popularity rapidly. This product with papaya-mango in this present investigation also observed the same trend. The colour, flavour and taste of papaya based fruit leather could be proved excellent in this study.

Nectar was the next product choiced by majority of the consumers showing feasibility when processed from papaya

and mango blend. Fruit drinks are lately engulfing the domestic market. They are rightly being encouraged as they provide much needed vitamins and minerals. While majority of the RTS beverages available in the market at present are synthetic formulas, it will be highly beneficial both for consumers and processors to produce and popularise RTS drinks like blended papaya nectar, a fruit which is now wasted for want of processing outlet. The formulation of papaya-mango blended nectar promises more consumer attraction than plain papaya drinks.

Sauce was identified as the third product in its outlet among the four products according to consumers. This is quite natural since the present consumers are exposed to the better taste of tomato products like sauce and ketchup, comparison of tomato sauce with sauce from the less liked fruit papaya would largely reflect their opinion. However tomato is a seasonal crop and bears high fluctuation in price and off season scarcity. The results of the present investigation to formulate sauce would be a boon to combat such situation. Butter was preferred last among the blended papaya products where the choice of consumers were considered. This is supposidly due to its less sweetness and spicy taste compared to jam.

4.4 Assessment of shelf life

The mechanism and the kinetics of food deterioration is controlled by storage and packaging techniques (Varsanyl, 1993). Bansal and Dhawan (1993) stated that the main quality attributes like sugar content, ascorbic acid, acidity and browning are affected by the storage. The changes in the chemical components in the processed foods are indicative of the deteriorative changes in the products. The stability of the product is depended upon the changes occurring in these products with the progression of time. Monitoring the storage behaviour is as important as its acceptability with respect to any new product formulated. Hence the shelf life of papaya based products were determined by ascertaining periodically the changes in its nutritional and chemical qualities and also the microflora of products.

4.4.1 Assessment of changes in chemical constituents of nectar during storage

Changes in the nutritional and chemical components of nectar viz. pH, acidity, total soluble solids, reducing sugar, total sugar and vitamin C were studied and the results obtained are discussed below.

4.4.1.1 Changes in the pH of nectar during storage

The data pertaining to the pH of nectar under study during storage is depicted in Table 22.

Table 22 Effect of storage on pH of nectar

Products	Fresh	Storage period (months)						Treatment means
		1	2	3	4	5	6	
N_1	3.58	3.58	3.57	3.57	3.56	3.56	3.55	3.57
N_2	3.32	3.32	3.32	3.32	3.30	3.29	3.28	3.30
N_3	4.21	4.21	4.21	4.21	4.19	4.18	4.17	4.19
F - NS							F - NS	

Evaluation of the data revealed that pH of nectars remained steady during the beginning period of storage. A minute fall in pH was noticed as the period of storage increased. In the present study there was no much variation in pH levels of three nectars by a period of six months. The decrease in pH value of nectar is directly related to the increase in acid content of the product. The studies conducted by Kulwal *et al*. (1985) showed a decrease of pH from 3.52 to 3.45 for papaya nectar stored for 105 days. In the present investigation it was observed that the pH of papaya nectar decreased from 3.32 to 3.28 during six months storage. Similarly the pH of mango nectar and blended nectar decreased from 4.21 to 4.17 and 3.58 to 3.55 respectively. The kinnow RTS stored showed negligible changes in pH when evaluated for storage quality by Renote *et al*. (1992). According to Aruna *et al*. (1997) the pH of papaya nectar decreased from 3.71 to 3.45

on nine months storage. The changes in pH of nectar in the present study were less than the above reports which proves the storage quality of the product.

Statistical analysis revealed that the minor variation recorded among nectars was not significant. Though the pH was found to decrease throughout the storage period this variation was also nonsignificant.

4.4.1.2 Changes in the acidity of nectar during storage

Results of the evaluation on acidity variation of nectar during the storage period of 6 months are presented in Table 23.

Table 23 Effect of storage on acidity content (percentage) of nectar

Products	Fresh	Storage period (months)						Treatment means
		1	2	3	4	5	6	
N_1	0.51	0.51	0.51	0.51	0.53	0.55	0.57	0.53
N_2	0.76	0.76	0.76	0.76	0.78	0.81	0.83	0.78
N_3	0.21	0.21	0.21	0.21	0.23	0.25	0.25	0.27
F - NS						F - 623.78**		
						SE - 0.01		
						CD - 0.04		

Table 23 picturises that the acidity content of three nectars remain unaltered for the first three months of storage. Acidity was found to increase gradually beyond this

period in all the nectars. Increase in acidity value of nectar was 0.07 per cent in papaya, 0.04 in mango nectar and 0.06 per cent in papaya - mango blend. However, the difference was not statistically significant. The slow increase in acidity observed during the later months of storage was mainly due to the concentration of the product by the evaporation of the moisture on storage (Aruna *et al*., 1997). The increase was found agreeable with the decrease in pH. Kulwal *et al*. (1985) observed a slight increase in acidity after 150 days storage of canned papaya products like juice and nectar. The results are in support of the findings in this experiment. Sheeja (1994) had reported that the acidity of squashes prepared from papaya ranged from 1.60 to 1.80.

When interpreted statistically, it was found that significant difference prevailed among different types of fruit nectar. However the change noticed during the period of storage in three different nectars was nonsignificant.

In tune with this findings Kalra (1991) reported that the acidity of mango papaya blended beverages did not change significantly during twelve months of storage. He also noticed a steady acidity value in market fruit drinks stored for six months.

4.4.1.3 Changes in total soluble solids during storage

The values obtained on periodical analysis of nectar for total soluble solids is depicted in Table 24.

Table 24 Effect of storage on total soluble solids (°brix) of nectar

Products	Fresh	Storage period (months)						Treatment means
		1	2	3	4	5	6	
N_1	15.03	15.03	15.00	14.90	14.90	14.76	14.67	14.91
N_2	19.03	19.03	18.93	18.87	18.77	18.66	18.63	18.85
N_3	17.03	17.03	16.98	16.90	16.82	16.72	16.66	16.88

F - NS

F - 17908.93**

SE - 0.014

CD - 5.093

On critically analysing the soluble solids level of nectar, a tangible decrease in the TSS content with increase in storage period was found. It could also be indicated that the reduction was progressive in the later months. Papaya nectar showed the maximum TSS decrease which was 0.60 per cent followed by mango nectar 0.36 per cent and papaya-mango blend 0.30.

The statistical analysis of the data observed no difference in TSS of the three nectars during the storage period. This is in confirmity to the findings of Vyas (1989) who reported that the analysis of the total soluble solids in RTS nectar from rhodopetals did not show any appreciable change during storage. According to Kalra *et al.* (1991) no

significant change in TSS was noted in mango papaya blended beverage stored over a period of one year at ambient conditions. Similarly there was not much change in total soluble solids on the storage of jamun beverage by Hema (1997).

4.4.1.4 Changes in reducing sugar of nectar during storage

The changes noted in the reducing sugar of nectar during storage is presented in Table 25.

Table 25 Effect of storage on reducing sugar (percentage) of nectar

Products	Fresh	Storage period (months)						Treatment means
		1	2	3	4	5	6	
N_1	12.39	12.39	12.61	12.71	12.82	12.93	13.04	12.70
N_2	15.95	15.95	16.30	16.48	16.85	17.44	17.64	16.66
N_3	12.19	12.19	12.29	12.39	12.61	12.71	12.93	12.48
F - 2.66*							F - 2375.59**	
SE - 0.151							SE - 0.048	
CD - 0.433							CD - 0.166	

As indicated in Table 25 the reducing sugar content increased by 0.65 per cent, 1.69 per cent and 0.74 per cent in respectively in N_1, N_2 and N_3. When the data was interpreted statistically it was found that there was no significant difference in reducing sugar of nectar prepared from

papaya-mango blend and also in mango nectar during the consecutive months of storage. However in papaya nectar, a significant difference was noted from fourth month onwards. The increase in reducing sugar might be due to hydrolysis of sugars by acid which might have resulted in degradation of disaccharides to monosaccharides.

The data corroborate with the results of chemical analysis of papaya nectar by Aruna *et al*. (1997) which indicated an increase in reducing sugar. Analysis on the shelf life quality of amla juice by Tripathi *et al*. (1988) have also indicated an increase of 0.19 per cent in reducing sugar during storage.

4.4.1.5 Changes in the total sugar of nectar during storage

Table 26 Effect of storage on total sugar (percentage) of nectar

Products	Fresh	Storage period (months)					Treatment means
		1	1	3	4	5	6	
N_1	15.63	15.63	15.46	15.16	15.00	14.56	14.28	15.10
N_2	18.53	18.53	18.29	17.65	17.44	17.05	16.67	17.74
N_3	15.46	15.31	15.31	15.00	14.85	14.56	14.42	14.98

F - NS

F - 146.69**

SE - 0.128

CD - 0.444

Table 26 picturise the total sugar content of nectar during storage. It was noted that the total sugar per cent of nectar decreased with the increase in storage period. The reduction in total sugar of nectar with six months was 1.35 per cent, 1.86 per cent and 1.04 per cent respectively in N_1, N_2 and N_3.

Statistical analysis showed that total sugar content of nectar differed significantly with respect to various nectar during storage period. The total sugar decrease was more in N_2 (Papaya nectar) followed by N_1 (Papaya - mango blend) and N_3 (mango nectar). According to Aruna *et al*. (1997) the reduction in total sugar may be due to the increase in reducing sugar content. N_1 and N_3 were statistically observed to be on par with respect to the total sugar content. Thirumaran *et al*. (1992) reported that the chemical analysis of carrot based RTS beverage indicated a decline in total sugar. Total sugar of carrot juice by Bawa and Saini (1992) was found to decline by 0.14 per cent at room temperature. The range of total sugar decrease in the present experiment is almost in tune with the above reports.

4.4.1.6 Changes in vitamin C content of nectar during storage

Periodical testing of nectars for Vitamin C content was carried out and the data obtained is given in Table 27.

Table 27 Effect of storage on Vitamin C (mg/100g) of nectar

Products	Fresh	Storage period (months)						Treatment means
		1	2	3	4	5	6	
N_1	20.83	20.83	20.11	18.42	16.00	16.00	14.25	18.06
N_2	30.21	30.21	28.31	28.31	27.22	27.22	26.03	28.21
N_3	14.25	13.54	11.27	11.27	9.47	9.47	8.28	11.07

F - NS

F - 530.723**

SE - 0.3740

CD - 1.293

Perusal of the recorded data indicated that Vitamin C content decreased on storage for six months with respect to various nectar. The variation in vitamin C ranged between 4.18 mg and 6.63 mg. The values were observed to be decending with the advancement of storage period. This reduction may be explained by the sensitivity to light and atmospheric temperature. The result is in accordance with the study by Tripathi *et al*. (1988) reporting a decrease in the ascorbic acid content of amla squash during storage. Experiment conducted by Kalra *et al*. (1991) on the blended nectar prepared by mixing mango pulps of totapuri, banganapalli, deshahari and chausa with papaya pulp showed 50 per cent decrease in vitamin C content during storage. Whereas the loss in vitamin C found in the present study was very low compared to the above finding

that evidence the processing and storage quality of the products.

From the above findings, the successful storability of nectar developed can be highlighted. Periodical evaluation of the chemical parameters of nectar observed only minor changes upon six months of storage. Chemical constituents like TSS, reducing sugar and acidity were found to increase and pH decreased with the corresponding increase in acidity. There was only a nominal loss in vitamin C content during storage. It was a worth while observation that the changes in chemical constituents on storage of the papaya mango blended nectar was less compared to the changes recorded in papaya nectar. The minimal changes in chemical parameters of blended papaya nectar on storage draws attention to its feasibility for a large scale production.

4.4.2 Assessment of changes in the chemical constituents of fruit butter

In the present investigation, monthly analysis was carried out with respect to changes in chemical components of fruit butter and the results obtained are summarised below.

4.4.2.1 Changes in the pH of fruit butter during storage

pH of fruit butter analysed monthly is depicted in Table 28.

Table 28 Effect of storage of pH of fruit butter

Products	Fresh	Storage period (months)				Treatment means
		1	2	3	4	
B_1	4.46	4.46	4.45	4.44	4.43	4.45
B_2	4.36	4.36	4.35	4.34	4.32	4.35
B_3	4.90	4.90	4.90	4.89	4.88	4.89
F - NS					F - 25246.2**	
					SE - 0.0018	
					CD - 0.006	

It was found that in general there was no noticeable difference in the pH of fruit butter during storage. The pH narrowly declined during storage. The decreased pH value was in accordance to the increase in acidity. The data agrees with the results reported by Sheeja (1994) that a decrease was observed in pH on storage of papaya jam at ambient condition whereas no change in pH was observed by Tripathi *et al*. (1988) in amla jam during storage.

Statistical analysis of the data revealed that there was no significant difference in pH of three fruit butters during storage.

4.4.2.2 Changes in the acidity content of fruit butter during storage

Data concerning the effect of storage on the acidity content of fruit butter in depicted in Table 29.

Table 29 Effect of storage on acidity content (percentage) of fruit butter

Products	Fresh	Storage period (months) 1	2	3	4	Treatment means
B_1	0.17	0.17	0.19	0.19	0.19	0.18
B_2	0.10	0.10	0.14	0.17	0.21	0.14
B_3	0.17	0.17	0.17	0.17	0.17	0.17
F - 1.425*					F - 5.399*	
SE - 0.020					SE - 0.007	
CD - 0.060					CD - 0.027	

The change observed during storage in all the three samples were narrow and was not accountable. In papaya-mango blended butter an ascending fluctuation of 0.02 per cent was noted that need not be considered as a variation. In mango butter, the acidity was unvarying upto four months. While in the case of B_2 (papaya butter) it was observed to have a gradual increase from 0.10 to 0.21 per cent over a period of four months which was statistically non significant. Whereas the change observed from fourth month differed significantly. The increase in acidity may be due to the interaction of organic acid present in the fruit. Increase in acidity during storage was reported in culled apple jelly by Bhatia *et al*. (1983). Similarly studies conducted in amla jam by Tripathi *et al*. (1988) also showed an increase of 0.03 per cent in acidity during storage.

4.4.2.3 Changes in the total soluble solids of fruit butter during storage

The data on TSS content of fruit butter during storage is summarised in Table 30.

Table 30 Effect of storage on total soluble solids (°brix) of fruit butter

Products	Fresh	Storage period (months) 1	2	3	4	Treatment means
B_1	51.03	51.06	51.13	51.17	51.23	51.13
B_2	49.73	49.76	49.83	49.87	50.13	49.87
B_3	58.53	58.53	58.60	58.63	58.66	58.59
F - NS					F - 16019.63*	
					SE - 0.0372	
					CD - 0.128	

It is evident from the table value that the TSS content of fruit butter was increased on storage. The TSS of the plain mango butter (B_3) remained constant initially. The rate of increase observed from the second month for different samples was marginal (0.13 to 0.40°brix). The highest variation was recorded for papaya butter followed by blended butter. The increase observed for mango butter was lowest. The increase in TSS was probably due to partial loss of moisture and partly to the conversion of insoluble constituents

into soluble forms. Ragab (1987) had reported a similar trend of change with regard to TSS of apricot jam during storage.

No significant difference prevailed in the TSS content of fruit butter due to storage.

4.4.2.4 Changes in reducing sugar of fruit butter during storage

Variation noted in the reducing sugar per cent of fruit butter during the storage span are presented in Table 31.

Table 31 Effect of storage on reducing sugar (percentage) of fruit butter

Products	Fresh	Storage period (months)				Treatment means
		1	2	3	4	
B_1	21.43	21.43	22.39	23.08	23.08	22.28
B_2	17.65	17.65	18.07	18.29	18.75	18.08
B_3	13.04	13.04	13.27	13.39	13.39	13.23
F - NS					F - 3466.69**	
					SE - 0.076	
					CD - 0.266	

Data indicated that reducing sugar increased during storage. Increase was noticed from second month onwards in the three samples of fruit butter. The increase was sequential and the lowest percentage of increase was observed in mango butter (B_3). The range of increase in reducing sugar content was 0.35 to 1.65 per cent as observed in various fruit butters.

The variation in reducing sugar in a stored fruit product is reported to be due to index of acid hydrolysis of sucrose by Labuza *et al*. (1970). The results coincides with the findings of Tripathi *et al*. (1988) who reported a rise in reducing sugar of amla jam on storage.

When interpreted statistically it was found that no significant difference existed during storage period.

4.4.2.5 Changes in total sugar of fruit butter during storage

The results of the observation on total sugar of fruit butter during storage is depicted in Table 32.

Table 32 Effect of storage on total sugar (percentage) of fruit butter

Products	Fresh	Storage period (months)				Treatment means
		1	2	3	4	
B_1	25.44	25.44	24.60	24.20	24.20	24.78
B_2	24.60	24.60	24.44	24.20	23.08	23.98
B_3	19.74	19.74	19.48	18.99	18.99	19.39
F - NS					F - 185.72**	
					SE - 0.213	
					CD - 0.73	

Perusal of the recorded data indicated a narrow decrease in total sugar content with increase in storage period. This again may be traced to the increase in acidity and conversion of sugar on storage. The reduction in total sugar percentage was observed to be 1.52 per cent in B_2, 1.24 per cent in B and 0.75 per cent in B_3. This reduction in total sugar have been supported by the work done by Bhatia *et al*. (1983) who found that storage decreased the total sugar significantly in culled apple jelly. Bhatnagar (1991) also reported a decrease in total sugar content in watermelon jam during storage.

In the present study, with respect to the variation noticed in the total sugar content, it could be inferred the blended butter (B_1) developed was more consistent in composition of TSS than plain papaya butter.

Significant difference was observed in papaya butter during the fourth month of storage. While in mango butter and blended butter the values were on par during the entire storage period.

4.4.2.6 Changes in vitamin C content of fruit butter during storage

Table 33 depicts the change in vitamin C content of fruit butter during storage.

Table 33 Effect of storage on vitamin C content (mg/100g) of fruit butter

Products	Fresh	Storage period (months) 1	2	3	4	Treatment means
B_1	12.45	12.45	11.06	11.06	6.92	10.79
B_2	23.52	23.52	22.13	19.37	17.98	21.30
B_3	12.45	12.45	11.06	9.68	9.68	11.06
F - NS					F - 127.9137**	
					SE - 0.529	
					CD - 1.833	

A close watch on the data presented in Table 33 revealed that Vitamin C content of different fruit butters performed downward trend with the advancement in storage period. The decrease in vitamin C content of various fruit butters ranged from 2.77 mg to 5.53 mg. In the present study maximum decline in vitamin C content was noted for papaya butter followed by papaya mango butter.

The analysis of variance showed that B_2 was significantly different from B_1 and B_3. Variation in vitamin C remained statistically non significant over months of storage in all the three products.

The results highlighted that the trends in quality changes of blended butter had close similarity to that of mango butter which performed the best good shelf behaviour. Blended butter had lower variation in pH, acidity, TSS, total sugar and vitamin C contents as compared to papaya butter. Thus blending favoured the production of papaya based fruit butter with better storage qualities than fruit butter using papaya alone.

4.4.3 Assessment of changes in the chemical constituents of fruit leather during storage

Rao *et al.* (1986) reported that fruits like pineapple, pear, papaya can be successfully sundried and stored for future use. Drying involves primarily loss or removal of water and is carried out mainly to ensure the quantitative loss due to bacterial and fungal attack, to prevent deterioration caused by its on enzymes and to stabilize nutrient contents as such in the processed foods (Maini *et al.*, 1985). Fruit leather is an important dried product of commerce in certain areas of India. Stability of the original quality of any product during storage is of paramount importance (Indian Food Packer, 1980). Hence the compositional changes in fruit leather under study were assessed for a period of eight months.

4.4.3.1 Changes in the pH of fruit leather during storage

The pH content of fruit leather was evaluated at monthly interval during its storage period of eight months and the data is summarised in Table 34.

Table 34 Effect of storage on pH of fruit leather

Products	Fresh	Storage period (months) 1	2	3	4	5	6	7	8	Treatment means
L_1	4.21	4.21	4.20	4.18	4.16	4.15	4.13	4.11	4.10	4.16
L_2	4.41	4.41	4.39	4.37	4.34	4.32	4.29	4.29	4.27	4.34
L_3	4.46	4.46	4.45	4.43	4.42	4.40	4.39	4.37	4.35	4.41
F - 2.52*								F - 3751.5**		
SE - 0.0065								SE - 0.002		
CD - 0.018								CD - 0.0073		

As per the table, the pH of fruit leather ranged from 4.21 to 4.10 in L_1 (Papaya - mango leather), 4.41 to 4.27 in L_2 (Papaya leather) and 4.46 to 4.35 in L_3 (mango leather) during storage. The value was observed to be slightly declining with the advancement of storage. The difference in pH content significantly varied in the three fruit leathers. In papaya leather the reduction significantly varied from second month itself. While in blended leather significant variation was noted only from fifth month of storage. However these variations can be considered normal pH reduction at storage of leather had been reported in other studies. Sheeja (1994) reported a decrease in pH during storage of papaya candy. Earlier Tripathi *et al*. (1988) also reported negligible change in pH in dehydrated amla product during storage.

4.4.3.2 Changes in the acidity of fruit leather during storage

The changes in acidity of the fruit leather during storage are presented in Table 35.

Table 35 Effect of storage on acidity (percentage) of fruit leather

Products	Fresh	Storage period (months) 1	2	3	4	5	6	7	8	Treatment means
L_1	0.49	0.49	0.49	0.51	0.55	0.57	0.59	0.61	0.61	0.55
L_2	0.34	0.36	0.42	0.46	0.49	0.53	0.55	0.59	0.64	0.49
L_3	0.42	0.42	0.42	0.46	0.51	0.53	0.53	0.55	0.57	0.49
F - NS										F - 6.496*
										SE - 0.012
										CD - 0.044

It can be observed from Table 35 that there was no change in the acid content of L_1 and L_3 fruit leather during the initial months of storage. A small rise has been observed from third month. While in papaya leather there was increase from first months itself. Acidity increase was 0.12 per cent, 0.28 per cent and 0.15 per cent in L_1, L_2 and L_3 respectively. The minimum increase was observed in L_1 followed by L_3. Acidity level of the different fruit leathers showed a significant difference on each other.

Increase in acidity of certain other products has been ascribed to the formation of sulphurous acid from SO_2, ascorbic acid degradation or hydrolysis of pectin (Cruess, 1958; Sethi, 1985). Acidity increase in dried products during storage have been observed earlier by many workers. Kahtani (1990) reported an increase in acidity in dried pomegranate during storage. Jyothi (1997) observed an increase in acidity during storage of mango - papaya blended bars.

4.4.3.3 Changes in the total soluble solid content of fruit leather during storage

Results of the examination of different fruit leathers for change in TSS during storage period are given in Table 36.

Table 36 Effect of storage on total soluble solids (°brix) of fruit leather

Products	Fresh	Storage period (months) 1	2	3	4	5	6	7	8	Treatment means
L_1	68.03	68.03	68.12	68.17	68.23	68.33	68.37	68.46	68.53	68.26
L_2	65.10	65.17	65.26	65.35	65.43	65.50	65.53	65.57	65.66	65.40
L_3	66.03	66.07	66.17	66.23	66.33	66.37	66.43	66.47	66.57	66.29
F - NS										F - 11052**
										SE - 0.013
										CD - 0.048

From the table, it can be noted that TSS value of fruit leather on storage upto 8 months showed just an unnoticeable upward difference ranging between 0.50 to 0.56 per cent. Even the highest fluctuation that was noticed in papaya leather (L_2) was far below one per cent increase, which reflected the storage stability of the product with respect to this component. According to Sagar and Khurdiya (1996) the increase in TSS may be due to the decreases in moisture content. Thus with a stable TSS it could be assumed that there would be no difference in moisture level of the stored fruit leather samples. Mahajan and Chopra (1994) found that TSS content of dried apple fruits, increased as the storage period advanced, reaching a peak at 150 days and declined thereafter whereas in this study no such deviation was found.

Statistically the TSS of fruit leather did not show any variation during the entire storage period whereas there existed a significant difference among the products.

4.4.3.4 Changes in the reducing sugar content of fruit leather during storage

Data presented in Table 37 on the reducing sugar level on storage of fruit leather disclosed a marginal increase.

Table 37 Effect of storage on reducing sugar (percentage) of fruit leather

Products	Fresh	Storage period (months) 1	2	3	4	5	6	7	8	Treatment means
L_1	32.64	32.64	34.12	34.91	35.63	37.54	39.50	40.55	42.88	36.71
L_2	34.12	34.12	34.91	35.71	36.63	37.54	39.50	40.55	42.88	37.33
L_3	34.92	34.92	36.62	37.54	39.51	40.55	41.84	42.88	44.17	39.22
F - NS									F - 9.614*	
									SE - 0.420	
									CD - 1.454	

The increase in different samples varied from 8.76 per cent to 10.24 per cent increase was more in L_1 followed by L_3. However on close examination the reducing sugar of fruit leather showed no marked difference during the storage period of eight months and thus remained statistically nonsignificant. At the same time between the different samples the difference was significant. Das (1986) reported that during the amount of reducing sugar increases. The increase in reducing sugar was due to the gradual inversion of nonreducing sugars as reported by Saini and Dharmpal (1997) in line with the present observation. Ammu *et al*. (1977) and Rao and Roy (1980) have reported increase of reducing sugar during storage in mango leather and freeze dried mango powder. Mir and Nath (1993)

found that the reducing sugar content of the mango bars increased significantly during storage of 90 days.

4.4.3.5 Changes in total sugar content of fruit leather during storage

The table 38 depicts the changes in total sugar of fruit leather during storage.

Table 38 Effect of storage on total sugar (percentage) of fruit leather

Products	Fresh	Storage period (months) 1	2	3	4	5	6	7	8	Treatment means
L_1	39.53	39.53	39.53	39.53	40.59	40.59	41.66	41.66	42.92	40.62
L_2	40.59	40.59	40.59	41.66	42.92	44.19	45.45	46.97	46.97	43.33
L_3	42.92	42.92	42.92	42.92	44.19	44.19	44.19	45.45	45.45	43.91
F - NS									F -	40.2733**
									SE -	0.276
									CD -	0.957

The above table indicated a slight increase in total sugar during storage. Increase was noticed after third month in L_1 and L_2 whereas slight increase was noted in L_3 leathers after forth month. The increase in sugar content ranged from 2.83 per cent to 6.38 per cent as observed in various fruit leather. The increase was sequential and the lowest percentage

of increase was observed in L_3 followed by L_1. The results corroborates with the findings of Mir and Nath (1993) who found that total sugar content of fruit leather increased during storage. Mohammed *et al*. (1993) reported increase in total sugar in pineapple candy during storage. Storage studies conducted by Tripathi *et al*. (1988) with amla candy and Chavan *et al*. (1991) with ber candy also reported similar increase in total sugar during storage.

When interpreted statistically it was found that L_1 was significantly different from L_2 and L_3 which were found to be on par. However the variation in the sugar content was consistent over the months of storage with respect to various fruit leathers.

4.4.3.6 Changes in the vitamin C content of fruit leather during storage

The variation observed in the vitamin C content of fruit leather due to storage in the present study is presented in Table 39.

It is obvious from the above result that negligible changes occurred in the vitamin C content of fruit leather during storage. Drying is known to reduce the level of ascorbic acid (Gupta *et al*., 1984; Tripathi and Nath, 1989). According to Philippa and Ojimelukwe (1994) sundrying process

resulted in highest loss in ascorbic acid content of tomato products. Among the fruit leathers, mango leather had retained vitamin C content better when compared to blended leather and papaya leather. The vitamin C decline of mango leather was 4.16 mg. While in papaya-mango leather and in papaya leather the vitamin C content decreased at an equal level of 5.21 mg.

Table 39 Effect of storage on vitamin C content (mg/100g) of fruit leather

Products	Fresh	Storage period (months) 1	2	3	4	5	6	7	8	Treatment means
L_1	12.50	11.46	11.46	9.47	9.47	8.28	8.33	8.33	7.29	9.62
L_2	18.75	17.71	17.71	16.57	16.57	15.38	14.58	14.58	13.54	16.15
L_3	9.37	8.33	8.33	8.28	8.28	8.28	7.29	7.29	5.21	7.85
F - NS								F - 45.57305**		
								SE - 0.647		
								CD - 2.241		

Statistical analysis revealed a significant difference in Vitamin C content of different fruit leathers during storage. Rigi (1995) reported a rapid decline of vitamin C during storage of dehydrated pineapple slices. While the change occurred in fruit leather in the present study was gradual. Periodical evaluation of the chemical parameters of fruit leather observed a tangible changes upon eight months of storage in fruit leathers. Chemical constituents like acidity,

TSS, reducing sugar and total sugar were found to increase and pH decreased with the corresponding increase in acidity. Mango leather and papaya mango leather exhibited rather a slight deviation with storage of eight months and rate of increase was more in papaya leather. The more consistent storage results in chemical parameters of blended leather enlightens the scope for its commercial production.

4.4.4 Assessment of changes in the chemical constituents of sauce during storage

Examination of sauce was carried at monthly intervals during six months of storage at room temperature. The product was analysed for pH, acidity, TSS, reducing sugar, total sugar and vitamin C to study the major changes on storage.

4.4.4.1 Changes in the pH of sauce during storage

Influence of storage on pH of the sauce is illustrated in Table 40.

Table 40 Effect of storage on pH of sauce

Products	Fresh	Storage period (months)						Treatment means
		1	2	3	4	5	6	
S_1	3.81	3.81	3.81	3.81	3.80	3.80	3.80	3.81
S_2	4.04	4.04	4.04	4.03	4.03	4.02	4.01	4.03
S_3	3.35	3.35	3.35	3.34	3.34	3.33	3.33	3.34
F - NS						F - 63783**		
						SE - 0.0013		
						CD - 0.004		

The value revealed that pH of sauce samples remained unaltered for the first three months of storage. Then it was found to exhibit a slight change after fourth month of storage. However the decrease was found to be only at a level of 0.01 per cent in S_1, 0.03 per cent in S_2 and 0.02 per cent in S_3 sauce over the six months storage time. Chemical analysis of tomato juice concentrates by Thirumaran *et al*. (1990) showed a decreasing trend in pH on storage by 0.1 per cent. However the storage change of pH noted here in sauce was very minute.

A significant difference prevailed in the pH of sauce with respect to different sauces. While there was no significant difference in pH of sauce between the consecutive month of storage.

4.4.4.2 Change in the acidity of sauce during storage

The fluctuation in the acidity level of the three sauce during storage period is presented in Table 41.

Table 41 Effect of storage on acidity (percentage) of sauce

Products	Fresh	Storage period (months) 1	2	3	4	5	6	Treatment means
S_1	0.64	0.64	0.64	0.66	0.66	0.68	0.70	0.67
S_2	0.37	0.38	0.42	0.46	0.46	0.49	0.53	0.45
S_3	0.69	0.71	0.73	0.74	0.74	0.76	0.80	1.10
F - NS						F - 311.096** SE - 0.019 CD - 0.065		

The values demonstrate the changes in acidity of sauce which revealed that the acidity levels were found to increase at a narrow rate during the six months of storage. The acidity content of blended sauce (S_1) remained constant for the first two months of storage and thereafter a narrow increase was noted. While in the other two sauce there was only a negligible ascending fluctuation from 0.04 per cent to 0.05 per cent within two months of storage. From the second month onwards a slight increase was recorded. The maximum percentage of increase (0.16) was registered by papaya sauce followed by mango sauce (0.11 per cent). The lowest percentage of increase was recorded in blended sauce (0.06 per cent). These findings on acidity variation of sauce during storage is similar to that reported by Joshi *et al*. (1996) on apple pomace sauce stored for six months at room temperature which showed an increase in 0.07 per cent in titrable acidity.

Statistical analysis of the data indicated that the acidity of sauce showed no significant difference during the storage period.

4.4.4.3 Changes in the total soluble solids of sauce during storage

Total soluble solids is the amount of sugar and soluble fruit particles present in the pulp which is an important parameter that decide the quality of the sauce. The

values obtained on periodical evaluation of sauce for TSS is presented in Table 42.

Table 42 Effect of storage on total soluble solid content (°brix) of sauce

Products	Fresh	Storage period (months) 1	2	3	4	5	6	Treatment means
S_1	26.10	26.10	26.10	26.17	26.23	26.23	26.27	26.17
S_2	22.10	22.10	22.10	22.20	22.30	22.30	22.30	22.21
S_3	27.57	27.57	27.51	27.63	27.63	27.66	27.70	27.62
F - NS						F -	22996.64**	
						SE -	0.018	
						CD -	0.063	

It can be noted from the table that TSS did not undergo conspicuous change in brix level of the samples during six months storage. Eventhough the parameter was found to increase during the storage period, the range of increase observed for various sauce was very marginal (0.13 to 0.20°brix). The three sauce samples gave constant value upto 2 months and thereafter a slow increase was recorded in all sauces. It could be noted that the extent of increase in the TSS content coincides with the corresponding increase observed in the total sugar content. These findings were in consonance with Joshi *et al.* (1996) who reported an increase in the TSS of apple pomace sauce during storage.

4.4.4.4 Changes in the reducing sugar of sauce during storage

The effect of storage on the reducing sugar of sauce is depicted in table 43.

Table 43 Effect of storage on reducing sugar (percentage) of sauce

Products	Fresh	Storage period (months) 1	2	3	4	5	6	Treatment means
S_1	11.71	11.71	11.80	11.99	12.09	12.29	12.39	12.00
S_2	12.29	12.29	12.39	12.60	12.71	13.04	13.05	12.62
S_3	6.60	6.63	6.66	6.69	6.72	6.78	6.81	6.69
F - NS						F - 7461.40**		
						SE - 0.037		
						CD - 0.1303		

Above table highlights that upon storage the reducing sugar content of sauce increased considerably. The increase observed in the reducing sugar content between sauces was observed to have not much variation and the range recorded was between 0.21 per cent to 0.76 per cent. Perusal of the recorded data indicated a slow and linear increase in the reducing sugar content in different sauce. The increase was more in S_2 followed by S_1 and was least in S_3. The heat processing in presence of acid might have facilitated the inversion of added sucrose, thereby increasing the reducing sugars (Jain *et al.*, 1988).

Statistical analysis of the data revealed that the difference in reducing sugar content of sauces prepared were on par during the consecutive periods of storage. The results obtained in this study was supported by the finding of Joshi *et al*. (1996) that apple pomace sauce stored at room temperature when evaluated showed increasing trend in reducing sugar.

4.4.4.5 Changes in total sugar of sauce during storage

Table 44 elucidates the changes in total sugar of sauce during the storage period.

Table 44 Effect of storage on total sugar (percentage) of sauce

Products	Fresh	Storage period (months)						Treatment means
		1	2	3	4	5	6	
S_1	14.12	14.12	14.12	14.56	14.70	15.00	15.00	14.65
S_2	15.45	15.45	15.45	15.77	15.95	16.12	16.30	15.78
S_3	7.31	7.31	7.31	7.35	7.39	7.42	7.46	7.37
F - NS						F - 6866.311**		
						SE - 0.055		
						CD - 0.1907		

The table given above clearly shows that the total sugar content sugar content remains steady for the first two months of storage. The values were observed to be ascending

with the advancement of storage period. The highest percentage of increase was observed in papaya sauce (0.85 per cent) followed by blended sauce (0.58 per cent) while mango sauce recorded the least percentage of increase (0.15 per cent) The increase in total sugar could be due to the hydrolysis of polysacharides and inversion of non-reducing sugars Joshi *et al*. (1996) stated increase in total sugar in apple pomace sauce during storage.

Statistical analysis of the data proved that there existed no significant difference in total sugar upon storage and also the difference between the first and last month of storage was on par.

4.4.4.6 Changes in the vitamin C content of sauce during storage

Table 45 displays the effect of storage on vitamin C content of sauce.

Table 45 Effect of storage on vitaMin C content (mg/100g) of sauce

Products	Fresh	Storage period (months)						Treatment means
		1	2	3	4	5	6	
S_1	23.67	23.67	22.48	20.12	18.93	18.93	16.57	11.83
S_2	36.68	36.68	34.32	33.13	29.58	29.58	29.58	32.79
S_3	15.38	15.38	13.02	11.83	9.47	9.47	9.47	11.83
F - NS						F - 553.860**		
						SE - 0.447		
						CD - 1.547		

The table 45 shows that there was a continuous dwindling in ascorbic acid content during storage. A similar decline of 7.1 mg ascorbic acid was recorded in all the three samples. The decrease in Vitamin C content was gradual and steady during the storage period. Reports of Aruna and Thirumaran (1990) indicated the loss of ascorbic acid at a rate of 28.73 per cent in tomato concentrate. Whereas the results on decline of Vitamin C found in this experiment is much below the levels reported in the study reported above. Similarly storage studies of Agarwal *et al*. (1995) who noticed that the ascorbic acid decreased significantly during the six month of storage in tomato concentrate.

Statistical analysis of the data revealed there was no significant difference in ascorbic acid content during the consecutive storage months in blended sauce and in mango sauce. However there was significant decrease in ascorbic acid during storage recorded in papaya sauce.

On examination of the results it was observed that the three types of sauces remained highly sound for a period of 6 months as there was no description of undesirable changes in chemical constituents. In a closer assessment the blended sauce flared the better storage quality in comparison to plain papaya sauce.

4.4.5 Changes in the organoleptic qualities of products during storage

The modern day concept of total quality control involves application of sensory evaluation at all stages of processing right from procurement of raw materials upto the packaging of the finished product (Reece, 1979). According to Rao (1979) the colour, aroma, taste and texture are the important characteristic for acceptability and also these are good indicators for the adverse physico-chemical changes during storage. Among numerous factors which influence quality of products, sensory attributes may be considered as a major factors, and these are susceptible to change during storage.

An attempt has been made to ascertain the influence of storage on the acceptability of the products stored. According to Thakur *et al*. (1995) like chemical changes sensory changes are also influenced by its storage period. Changes in various quality attributes on four different products like nectar, fruit butter, fruit leather and sauce under investigation were carried out periodically by expert judges. The details of which are discussed below.

4.4.5.1 Changes in the organoleptic qualities of nectar during storage

According to Kalia and Sood (1996) quality is the ultimate criterion of the desirability of any food product.

The data pertaining to storage changes on acceptability of nectar are presented and discussed below.

4.4.5.1.1 Appearance attribute

Data on the effect of storage on the appearance scores of various nectar is depicted in Table 46.

Table 46 Effect of storage on appearance of nectar (mean scores)

Nectar samples	Storage period (months)						Treatment means
	1	2	3	4	5	6	
N_1	5.0	5.0	4.9	4.9	4.8	4.8	4.90
N_2	4.6	4.6	4.5	4.5	4.5	4.5	4.53
N_3	3.8	3.8	3.7	3.7	3.6	3.5	3.70
F - NS					F - 101.95**		
					SE - 0.05		
					CD - 0.169		

The results revealed (Table 46) that all nectars prepared from papaya - mango blended nectar (N_1), papaya nectar (N_2) and mango nectar (N_3) remained unaltered during the first and second months of storage. A slight decrease in appearance score was noted from third months in all the three nectars. The lowest decrease of 2 per cent was recorded by plain papaya nectar followed by blended nectar. According to Hicks (1990) for maximum acceptability the drink must look fresh and should

have good fruit appearance. In the case of mango nectar the reduction in score was more (7.89 per cent). The loss of colour in mango nectar due to the browning reaction might have influenced the appearance of the product. It is known that appearance and colour of a product are interrelated.

On statistical analysis the changes on appearance during storage period of the different nectar were found to be on par.

4.4.5.1.2 Colour attributes

Variation in score for the colour intensity of the nectar during storage are summarised in Table 47.

Table 47 Effect of storage on colour of nectar (mean scores)

Nectar samples	Storage period (months)						Treatment means
	1	2	3	4	5	6	
N_1	4.80	4.80	4.80	4.80	4.80	4.80	4.80
N_2	4.90	4.90	4.90	4.90	4.90	4.90	4.90
N_3	3.80	3.80	3.70	3.60	3.60	3.50	3.76
F - NS					F - 81.99**		
					SE - 0.073		
					CD - 0.215		

The mean score value on colour of three nectars retained well during storage. The colour value was constant throughout the storage period in papaya nectar and blended

nectar. The results coincides with the report of Sandhu *et al*. (1988) the evaluation of colour in stored grape juice had shown particularly no change in colour during storage. According to Aruna *et al*. (1997) colour score of papaya nectar deteriorated only after six month storage. A minimum decline was observed for mango nectar initially. But the decrease was more pronounced in the later stage in mango nectar. The effect of non enzymatic browning in this product might have changed the colour to a dull tinge. The formation of brown pigments in the stored RTS is also attributed to the degradation of the products of sugar, ascorbic acid and protein as reported by Ranote (1992). Saini *et al*. (1985) observed decline in colour score of bottled kinnow juice stored under room temperature for a period of six months.

Statistical analysis of the data proved that there is no significant difference in the colour attributes of all nectars between the storage period.

4.4.5.1.3 Flavour attributes

Table 48 depicts the data obtained for the flavour profile of nectar during storage.

Table 48 Effect of storage on flavour of nectar (mean scores)

Nectar samples	Storage period (months)						Treatment means
	1	2	3	4	5	6	
N_1	4.80	4.80	4.70	4.70	4.70	4.60	4.72
N_2	3.20	3.20	3.10	2.90	2.90	2.90	3.03
N_3	4.90	4.90	4.90	4.80	4.70	4.60	4.80
F - NS						F -	477.91**
						SE -	0.046
						CD -	0.135

It is evident from the table that flavour scores for the plain mango nectar was constant for three months and upto two months in blended nectar and plain papaya nectar. There after a slow decrease was observed in the scores at the end of storage. Flavour reduction as per score level of judges varied only from 4 to 6 per cent. Flavour loss in blended nectar was 4 per cent followed by mango and papaya nectar with a decrease of 6 per cent each. Even then, these nectars recorded a highly appreciable value for flavour at the termination of storage study. According to Thorner (1978) the RTS beverage during shelf life precipitates and this precipitated material contribute to flavour change. However no such development of off odour was noted in the present study.

Statistical analysis of the data revealed that there was no significant difference in flavour in the nectars during the storage period.

4.4.5.1.4 Taste attributes

Scores pertaining to the taste performance of nectar with storage is presented in Table 49.

Table 49 Effect of storage on taste of nectar (mean scores)

Nectar samples	Storage period (months)						Treatme-t means
	1	2	3	4	5	6	
N_1	4.40	4.40	4.40	4.30	4.20	4.10	4.30
N_2	3.10	3.00	3.00	2.90	2.70	2.70	2.90
N_3	4.90	4.90	4.90	4.80	4.70	4.10	4.71
F - NS					F - 175.70**		
					SE - 0.071		
					CD - 0.210		

The periodical evaluation of nectar recorded fluctuation in taste performance during the storage perio The taste attribute scores of mango nectar was constant up three months. Blended nectar and papaya nectar showed a stea level upto two months. Thereafter a slow decrease w observed. The minimum percentage decrease of 6 and 8 per ce was observed in blended nectar and papaya nectar. A high decrease of 16 per cent was noted for mango nectar. Mukherj (1963) had stated that taste of a product change considerab during storage. A similar trend of decline in organolept taste was also reported by Dube (1984) in bael beverage Investigation on storage of bottled pear juice developed

Mukherjee (1963)at 24°C to 30°C gave a peculiar disagreeable taste towards the end of one year. In the present study no perceptible off taste was found in nectars upto six months.

No significant difference was existed in taste of three different nectars during the six months storage period.

4.4.5.1.5 Consistency attributes

The scores obtained for the sensory characteristic, consistency of the various nectar is presented in Table 50.

Table 50 Effect of storage on consistency of nectar (mean scores)

Nectar samples	Storage period (months)						Treatment means
	1	2	3	4	5	6	
N_1	4.90	4.90	4.90	4.70	4.60	4.60	4.76
N_2	3.90	3.80	3.80	3.80	3.70	3.60	3.76
N_3	3.80	3.70	3.70	3.60	3.50	3.50	3.63
F - NS						F -	126.85**
						SE -	0.054
						CD -	0.158

It is evident from the results that the consistency of different nectars was not affected noticably. There was only a minimum decrease of 6 per cent. Consistency effect of

all the nectars were constant upto three months and a slow decrease was observed in scores at the end of storage. While storing for six months, the reduction in consistency score were in an equal range noted in three nectars.

Statistical analysis of the data revealed no significant changes in the consistency attribute of different nectar during the storage period.

4.4.5.1.6 Overall acceptability

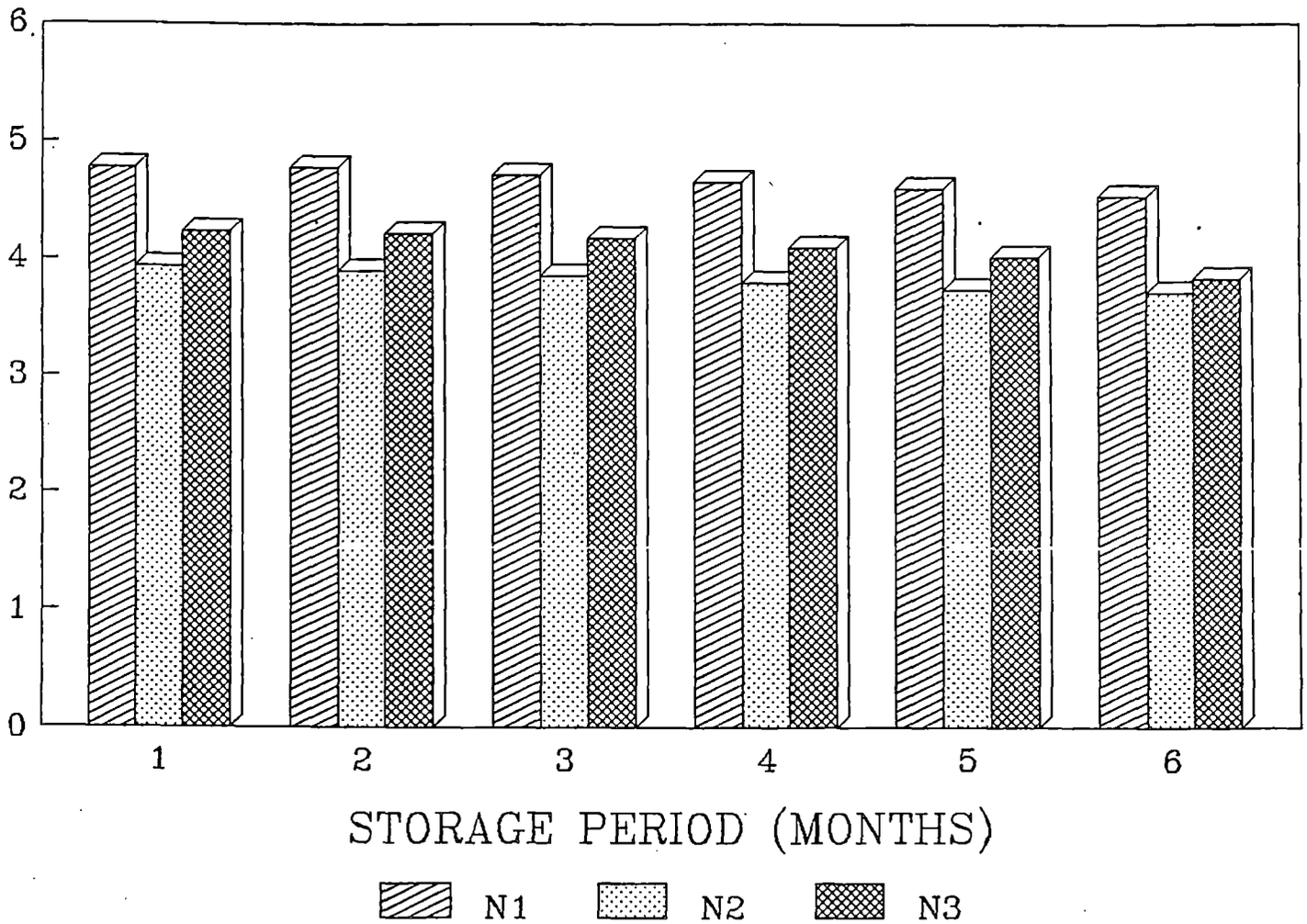
The data on overall acceptability of stored nectar evaluated based on quality changes is presented in Table 51.

Table 51 Effect of storage on overall acceptability of nectar (mean scores)

Nectar samples	Storage period (months)						Treatment means
	1	2	3	4	5	6	
N_1	4.78	4.78	4.72	4.66	4.60	4.54	4.68
N_2	3.94	3.90	3.86	3.80	3.74	3.72	3.83
N_3	4.24	4.22	4.18	4.10	4.02	3.84	4.10
F - NS					F -		212.31**
					SE -		0.029
					CD -		0.085

Overall acceptability of nectars marked a slight decreasing change with storage upto six months as revealed by the sensory scoring. The percentage of decline observed for

Fig. 10 OVERALL ACCEPTABILITY OF NECTAR DURING STORAGE



blended nectar was 3.6 per cent, papaya nectar 4 per cent and for mango nectar 4.4 per cent. The decrease in overall acceptability of mango nectar could be accounted mainly for its colour degradation due to browning reaction. On perusal of the scores obtained at the end of storage period it was clear that all the products remained fairly well acceptable. Kalra *et al*. (1991) reported that the beverage made from mango papaya pulp preserved for one year was organoleptically acceptable.

Statistical analysis of the data proved no significant difference of acceptability during the storage period in three nectars.

From the foregoing discussion, it may be concluded that the sensory attributes namely appearance, colour, flavour, taste consistency of nectar was well retained on storage. There was only a marginal degradation during storage. Among the different nectar stored, the lowest percentage reduction in most of the sensory attribute and overall performance were in favour of blended nectar closely followed by papaya nectar. The loss in sensory aspects of mango nectar was slightly above with the enhancement of the storage period. The difference in storage performance was statistically non significant. The storage quality of the formulated blended nectar is highlighted by the results obtained and this points out scope on the large scale production and popularisation.

4.4.5.2 Changes in the organoleptic qualities of fruit butter during storage

Sensory criteria of quality have however been considered as highly variable an art to be practised by special tasters (Govindarajan, 1981). The data on storage behaviour of the sensory parameters of fruit butter studied for four months are presented and discussed below.

4.4.5.2.1 Appearance attribute

Appearance of any product is of prime importance in its acceptability. The scores on appearance attribute of fruit butter samples assessed monthly are given in Table 52.

Table 52 Effect of storage on appearance of fruit butter (mean scores)

Butter samples	Storage period (months)				Treatment means
	1	2	3	4	
B_1	4.30	4.20	4.00	4.00	4.12
B_2	4.00	3.90	3.70	3.60	3.80
B_3	3.70	3.50	3.50	3.40	3.52
F - NS				F - 9.06*	
				SE - 0.102	
				CD - 0.299	

On examining it was indicated that there was a slight decrease in appearance score of fruit butter in tune with the advancement of storage. Reduction in appearance score on storage of papaya butter was 8 per cent. Mango butter and blended butter attained an equal decrease of 6 per cent.

Statistical analysis of the data revealed that the change in appearance attribute during storage was found to be nonsignificant in all the three types of fruit butter.

4.4.5.2.2 Colour attribute

Colour change is the major factor that usually occur in the processed products which affects the appearance of the product (Stillman, 1993). Results of the colour appeal of fruit butter at various periods of storage are given in Table 53.

Table 53 Effect of storage on colour of fruit butter (mean scores)

Butter samples	Storage period (months)				Treatment means
	1	2	3	4	
B_1	4.20	4.10	4.00	3.80	4.025
B_2	4.40	4.20	4.10	3.90	4.15
B_3	3.80	3.70	3.50	3.50	3.62
F - NS				F - 7.225**	
				SE - 0.107	
				CD - 0.314	

The mean panelist score for colour of fruit butter under storage indicated that the colour attraction of fruit butter diminished at marginal levels. There was a decrease of 6 per cent to 10 per cent in the visual performance of different fruit butter by four months. Reports by Bhatnagar (1991) supports this observation since stated that the colour of watermelon jam decreased with storage. Colour retention during storage period was more in papaya-mango blended sample. It may be stated that colour loss on storage of fruit butter samples was not prominant.

On statistical interpretation there was no significant difference in colour of fruit butter samples during storage.

4.4.5.2.3 Flavour attributes

Variation in score for the flavour profile of fruit butter during storage are summarised in Table 54.

Table 54 Effect of storage on flavour of fruit butter (mean scores)

Butter samples	Storage period (months)				Treatment means
	1	2	3	4	
B_1	4.20	4.00	3.80	3.80	3.95
B_2	2.20	2.20	1.80	1.80	2.00
B_3	4.80	4.60	4.60	4.50	4.63
F - NS				F - 176.81^{**}	
				SE - 0.101	
				CD - 0.299	

The fruit butter samples under observation were stored at room temperature and this might have influenced for the minute reduction of flavour as noticed in the values obtained for flavour. The score values on flavour of fruit butter marked the decreasing change from second month of storage. The percentage of decrease in the flavour scores varied from 6 per cent in mango butter to 8 per cent in papaya butter. Mir and Nath (1982) hypothesise that flavour change in fruit products could be due to alteration in chemical composition.

Statistical analysis indicated significant difference between flavour of different fruit butters. But the flavour changes during storage was found to be nonsignificant.

4.4.5.2.4 Taste attributes

On examination of the results, it was found that a small reduction in taste was exhibited on storage of fruit butter (Table 55).

A reduction in taste by just 4 per cent was noted in blended butter and also in mango butter. While a loss of 8 per cent score in taste was recorded in Papaya butter. When papaya was blended with mango the taste retention on storage of fruit butter maintained and performed an equal status to that of plain mango butter. However in the present study no

perceptible off taste was found in the different fruit butter during storage. The slight downfeel in taste appreciation occured was quite a natural process when fruit products were stored. In agreement to this Bhatia *et al*. (1983) have reported a decrease in taste attribute of culled apple jelly during storage.

Table 55 Effect of storage on taste of fruit butter (mean scores)

Butter samples	Storage period (months)				Treatment means
	1	2	3	4	
B_1	4.20	4.10	4.00	4.00	4.07
B_2	2.50	2.40	2.40	2.10	2.40
B_3	4.90	4.80	4.70	4.70	4.75
F - NS				F - 159.184**	
				SE - 0.095	
				CD - 0.279	

Statistical analysis indicated a difference in taste attribute among the fruit butter. While storage had no significant effect in taste of the fruit butter samples.

4.4.5.2.5 Consistency attributes

Generally a reduction in consistency was exhibited on storage of fruit butter (Table 56) which ranged from 4 to 8 per cent. The percentage of decline observed for mango butter and blended butter was found to be minimal with 4 and 6 per cent

respectively. The decrease in percentage observed for papaya butter was at the level of 8 per cent. It may be noted that the texture changes of fruit butter on storage was not prominent. Bhatnagar (1991) reported that the texture of watermelon jam decreased with increase in storage time. The performance observed in the study on consistency of fruit butter was also similar to the above findings.

Table 56 Effect of storage on consistency of fruit butter (mean scores)

Butter samples	Storage period (months)				Treatment means
	1	2	3	4	
B_1	4.50	4.40	4.20	4.20	4.32
B_2	2.70	2.60	2.50	2.30	2.52
B_3	3.50	3.40	3.30	3.30	3.37
F - NS				F - 61.85**	
				SE - 0.111	
				CD - 0.326	

Results of analysis of variance of the data showed no significant difference in consistency score during the storage period of various fruit butter.

4.4.5.2.6 Overall acceptability

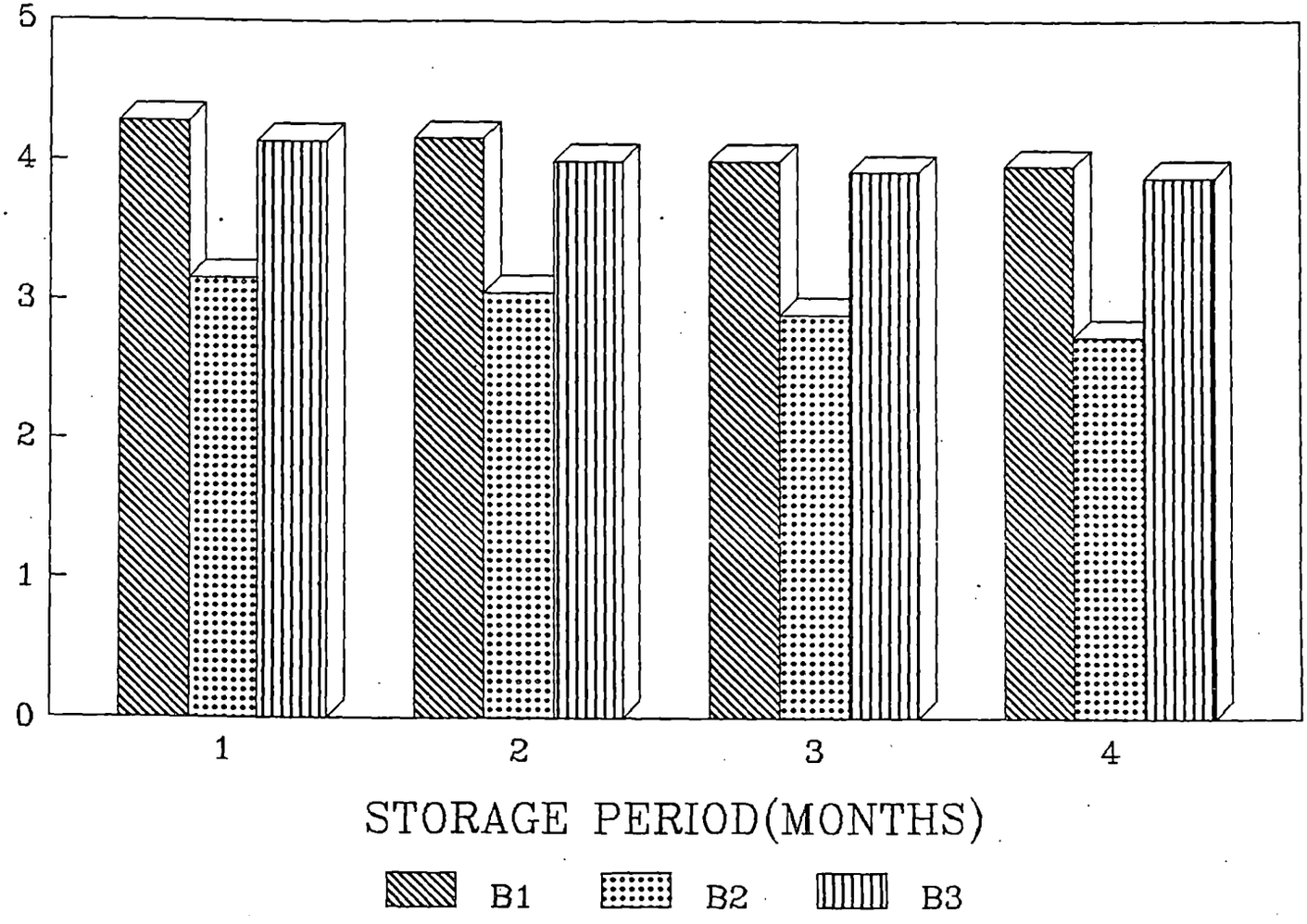
The variation in the overall acceptability level of the stored fruit butter was also computed based on the scores of quality parameters and are presented in Table 57.

Table 57 Effect of storage on overall acceptability of fruit butter (mean scores)

Butter samples	Storage period (months)				Treatment means
	1	2	3	4	
B_1	4.28	4.16	4.02	3.96	4.10
B_2	3.16	3.06	2.90	2.74	3.00
B_3	4.14	4.00	3.92	3.88	3.95
F - NS				F - 168.205**	
				SE - 0.045	
				CD - 0.132	

The table revealed that due to storage there was only very little effect on the overall acceptability of fruit butter formulated in the present study. The percentage of decrease in overall acceptability scores was merely to an extent from 5.2 to 8.4 per cent. The lowest percentage of reduction was noted on mango leather with 5.2 per cent followed by blended butter having 6.5 per cent. This deviation in overall acceptability had been supported by the work donw by Mir and Nath (1993) who reported that storage decreases overall acceptability of fruit products resulting in colour, flavour, taste and textural changes. However since the changes in quality parameters were very low, the storage had thus imposed only a minimal effect on the overall acceptability also. The papaya-mango blended

Fig.11 OVERALL ACCEPTABILITY OF FRUIT BUTTER DURING STORAGE



butter formulated in the study presented an appreciably good acceptance even after storage.

Statistical analysis revealed that the overall acceptability of the various fruit butter remained significantly different from one another. But there was no significant difference on acceptability due to the storage.

It may be concluded that the changes in sensory quality attributes viz. appearance, colour, flavour, taste, consistency and overall acceptability upon storage of fruit butter was nominal. Mango butter and blended butter retained an equal rate of sensory appreciation with storage. The percentage rate of quality deterioration was slightly more in papaya butter, but had statistically no variation. The blended fruit butter from papaya and mango formulated in the study possessed good storage qualities on par with mango butter and thus could be consider worthy of commercialisation as a new product in the market.

4.4.5.3 Changes in the organoleptic qualities of fruit leather during storage

Effect of storage on the organoleptic qualities of fruit leathers was assessed for a period of 8 months. The data on quality change on different parameters are presented.

4.4.5.3.1 Appearance attributes

The data obtained on monthly observation related to the appearance of fruit leather on storage is presented in Table 58.

Table 58 Effect of storage on appearance of fruit leather (mean scores)

Leather samples	Storage period (months)								Treatment means
	1	2	3	4	5	6	7	8	
L_1	4.70	4.70	4.60	4.60	4.50	4.50	4.40	4.20	4.52
L_2	4.30	4.30	4.30	4.30	4.10	4.00	3.60	3.60	4.06
L_3	3.20	3.00	3.00	3.00	2.70	2.70	2.60	2.60	2.85

F - NS

F - 73.59**

SE - 0.100

CD - 0.295

The mean score value on appearance of fruit leather remained unchanged for two months in blended leather and four months in plain papaya leather. However, the appearance value decreased in general with the progression of time in all fruit leathers. Blended leather was observed to have the lowest percentage of decrease for its appearance attribute (10 per cent) followed by mango leather (12 per cent). The maximum percentage decrease of 14 was observed for papaya leather. The

degradation of colour during storage might have diminished the appearance appeal. The decrease observed was more pronounced in the later stage in papaya leather. Sheeja (1995) was of the opinion that appearance of the processed products decreased with storage. Kertesz (1980) from his studies concluded that appearance of the pear candy decreased with increase in storage period. In the present study the variation in this attribute was very less.

Statistical analysis of the data revealed that there was no significant difference in appearance quality of fruit leather with storage.

4.4.5.3.2 Colour attributes

Results of the colour appeal of fruit leather at various periods of storage are given in Table 59.

Table 59 Effect of storage on colour of fruit leather (mean scores)

Leather samples	Storage period (months)								Treatment means
	1	2	3	4	5	6	7	8	
L_1	4.80	4.80	4.70	4.70	4.70	4.50	4.40	3.90	4.56
L_2	4.20	4.20	4.10	4.10	3.90	3.90	3.60	3.10	3.88
L_3	3.40	3.40	3.40	3.30	3.20	2.80	2.60	2.50	3.07
F - NS							F - 79.80**		
							SE - 0.082		
							CD - 0.240		

The periodical evaluation of fruit leather recorded a gradual decreasing fluctuation in colour attractiveness during storage. Colour value was constant during the initial period in all the leather samples. On storage the colour diminished affecting the attractiveness of the fruit leather. The range of decline in colour score in the fruit leather samples was from 18 to 22 per cent. The percentage of decline observed for blended leather and mango leather was 18 per cent. Colour intensity reduction was more in papaya leather (22 per cent). The observation lends support to the findings of Karim (1992) who reported that reduction in colour was observed in Chikku leather during storage. On storage of dehydrated fruits, the first indiscernible change occurred was in colour before change in flavour as found by Nuri (1962). However these changes were statistically nonsignificant upto eight months.

4.4.5.3.3 Flavour attributes

Table 60 illustrates the analytical data on flavour attributes of fruit leather.

As seen from table the values for flavour profile of mango leather was maintained at cent per cent level during the first three months. A gradual and linear decrease was noted from the third month. The lowest percentage of decrease was observed for blended leather (12 per cent). The percentage of decline observed for mango leather and papaya leather were slightly higher being 22 per cent and 24 per cent respectively.

Table 60 Effect of storage on flavour of fruit leather (mean scores)

Leather samples	Storage period (months)								Treatment means
	1	2	3	4	5	6	7	8	
L_1	4.20	4.10	4.10	4.00	4.00	3.80	3.70	3.60	3.93
L_2	2.70	2.70	2.40	2.30	2.30	2.10	1.90	1.50	2.23
L_3	5.00	5.00	5.00	4.70	4.70	4.60	4.40	3.90	4.66
F - NS								F - 242.604** SE - 0.07 CD - 0.230	

Statistical analysis of the data revealed that there was no significant difference in flavour of fruit leather during the storage period.

4.4.5.3.4 Taste attributes

Data on effect of storage on the taste performance of fruit leather is presented in Table 61.

Table 61 Effect of storage on taste of fruit leather (mean scores)

Leather samples	Storage period (months)								Treatment means
	1	2	3	4	5	6	7	8	
L_1	4.80	4.70	4.60	4.60	4.60	4.50	4.40	3.90	4.51
L_2	2.70	2.70	2.60	2.50	2.30	2.20	2.10	1.50	2.33
L_3	4.80	4.80	4.70	4.70	4.70	4.70	4.30	4.00	4.58
F - 15.79* SE - 0.197 CD - 0.546								F - 175.15** SE - 0.07 CD - 0.23	

Mukherjee (1963) had stated that the taste of a product change considerably during storage. The periodical evaluation of fruit leathers recorded a fluctuation in taste performance during the storage period. The maximum percentage of decrease of 24 per cent was recorded for plain papaya leather. The taste of blended leather was proved to be very good upto seven month of storage where 88 per cent of the scores were maintained. However taste attribute during the eight month was lowered by 10 per cent. Mango leather was observed to have the lowest percentage of decrease (16 per cent). Even then the score count revealed the high acceptability of the product at the eighth month. It has been reported by Tripati *et al*. (1988) that a decrease in taste was noted in amla candy during storage. This statement stands right as seen by the decrease in taste on storage of fruit leather in this study.

On statistical analysis of data it was found that L_2 was significantly different from L_1 and L_3 which was found to be on par. However the taste of fruit leather on storage did not vary.

4.4.5.3.5 Texture attributes

The score vlaues on texture of fruit leather are presented in Table 62.

Table 62 Effect of storage on texture of fruit leather (mean scores)

Leather samples	Storage period (months)								Treatment means
	1	2	3	4	5	6	7	8	
L_1	5.00	5.00	4.80	4.70	4.70	4.70	4.50	4.10	4.67
L_2	2.70	2.60	2.60	2.50	2.50	2.20	2.10	1.60	2.35
L_3	4.50	4.50	4.50	4.50	4.50	4.50	4.40	4.10	4.43
F - 18.17**									F - 242.108**
SE - 7.09									SE - 0.165
CD - 0.207									CD - 0.459

On examining the scores, it was clearly evident that the textural qualities of all fruit leather was affected with the advancement of storage period. However no texture loss was recorded during the first 6 months in L_3 (mango leather) and for two months in L_1 (blended leather). Thereafter a reduction was observed. Textural score loss in L_2 (papaya leather) was recorded for initial period itself. The percentage of decline observed for L_3 was 8 per cent. Texture quality reduction in L_1 was 18 per cent while 22 per cent textural score loss was recorded in L_2.

Statistical analysis of the data proved that the texture character of different fruit leather had no significant difference for first six months. But a difference was observed between the seventh and eighth months of storage in all the three leathers.

4.4.5.3.6 Overall acceptability

The overall acceptability values of stored fruit leathers are presented in Tabe 63.

Table 63 Effect of storage on overall acceptability of fruit leather (mean scores)

Leather samples	Storage period (months)								Treatment means
	1	2	3	4	5	6	7	8	
L_1	4.70	4.66	4.56	4.52	4.50	4.38	4.28	3.94	4.40
L_2	3.32	3.30	3.20	3.14	3.02	2.88	2.66	2.28	2.96
L_3	4.18	4.14	4.12	4.04	3.96	3.86	3.74	3.40	3.68

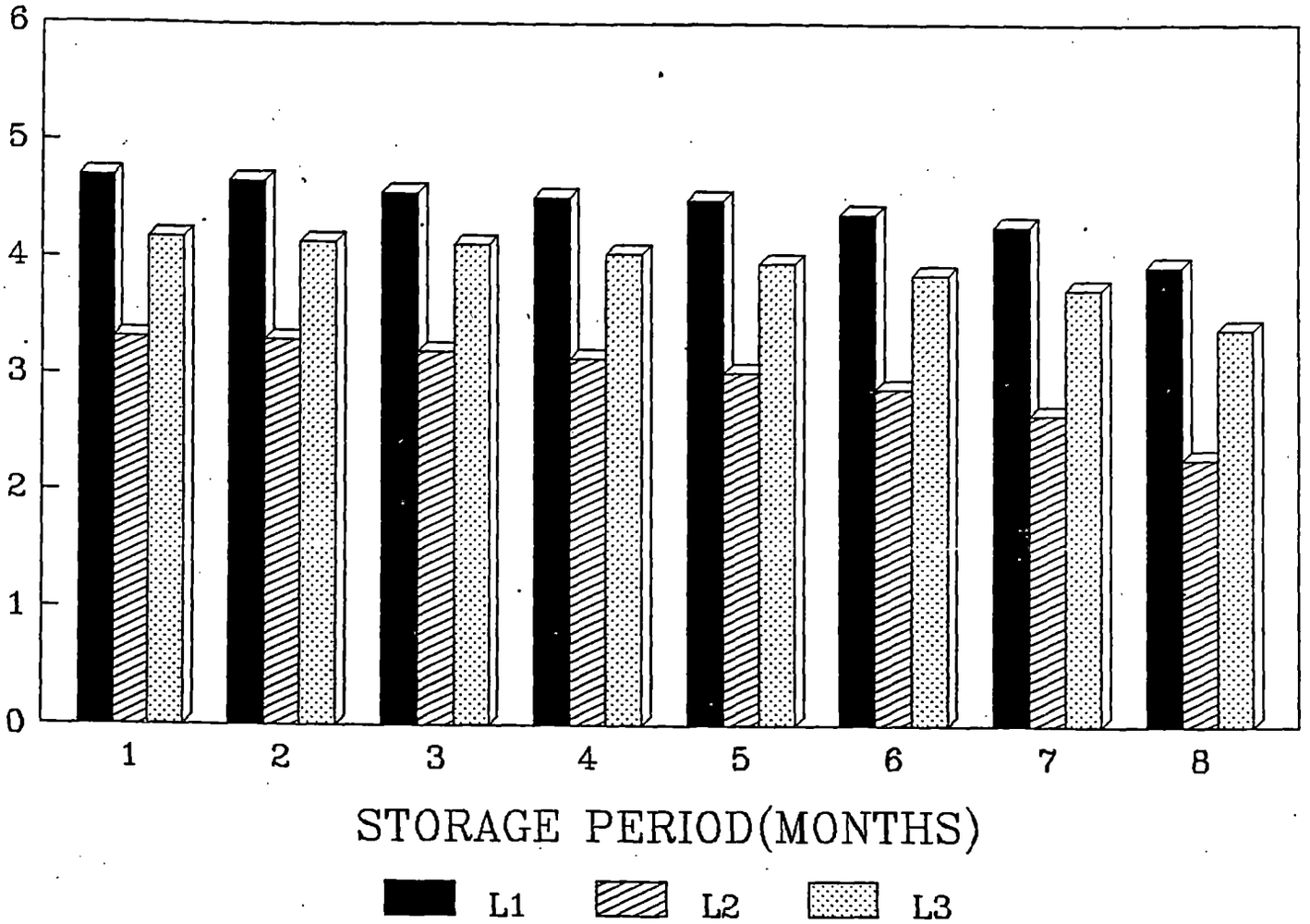
F - 2.259* F - 187.84**

SE - 0.084 SE - 0.055

CD - 0.234 CD - 0.161

Corresponding with the storage changes in sensory parameters there was a little downfall in overall acceptability which ranged with a loss in score from 15.2 to 20.8 per cent. The lower percentage of decrease was maintained by blended leather. While papaya leather remained at the higher acceptability loss based upon the absolute score there was no drastic changes during storage and the products remained within the range of well accepted product over a period of eight months. It was observed that changes were pronounced only during the later stage of storage in all the fruit leather

Fig.12 OVERALL ACCEPTABILITY OF FRUIT LEATHER DURING STORAGE



samples. This deviation in overall acceptability has been supported by the reports on amla candy by Tripathi *et al*. (1988) stating that storage decreased the overall acceptability. Similarly storage studies on chikku leather by Taufik (1992) also showed a significant difference in overall acceptability.

Results of analysis of variance of the data gave a significant difference in overall acceptability of blended leather and papaya leather from seventh month onwards. But mango leather exhibited no variation.

Attention made to study the storage behaviour of different fruit leather indicated that all the sensory attributes of fruit leather showed degradation on storage. Even though the acceptability between the various fruit leathers differed; the trend observed during the storage was almost similar. Storage quality of blended leather remained ahead of others and was notably better than papaya leather in many parameters with a period of eight months. This favours the feasibility for a valuable venture of producing papaya blended fruit leather with good shelf life and acceptability.

4.4.5.4 Changes in the organoleptic qualities of sauce during storage

The results on sensory analysis of sauce on storage of six months are presented and discussed below.

4.4.5.4.1 Appearance attributes

The appearance attribute scores of sauce are furnished in Table 64.

Table 64 Effect of storage on appearance of sauce (mean scores)

Sauce samples	Storage period (months)						Treatment means
	1	2	3	4	5	6	
S_1	4.5	4.4	4.4	4.4	4.3	4.2	4.37
S_2	4.4	4.3	4.3	4.2	3.9	3.8	4.15
S_3	3.4	3.3	3.3	3.2	3.2	3.1	3.25
F - NS						F - 96.27**	
						SE - 0.057	
						CD - 0.168	

The table shows that there was a small degrading influence in the visual quality score obtained for various sauces. A decrease of only 6 per cent was observed for blended sauce and for mango sauce, while storage affected the appearance quality of papaya sauce more making a decrease by 12 per cent.

But statistically data revealed no significant difference in the appearance quality of various sauces for the consecutive months of storage.

4.4.5.4.2 Colour attributes

Changes pertaining to the colour attributes of sauce during storage as per score value is presented in Table 65.

Table 65 Effect of storage on colour of sauce (mean scores)

Sauce samples	Storage period (months)						Treatment means
	1	2	3	4	5	6	
S_1	4.2	4.2	4.2	4.0	3.9	3.8	4.05
S_2	4.8	4.7	4.6	4.6	4.4	4.3	4.56
S_3	2.9	2.8	2.7	2.6	2.5	2.3	2.63
F - NS						F - 278.76**	
						SE - 0.057	
						CD - 0.169	

From the results, it could be seen that the colour of sauce was not affected to an extent that degrade its attractiveness. Scores were found to be in the declining trend from 4.2 to 3.8 in S_1 (blended sauce), 4.8 to 4.3 in S_2 (papaya sauce) and 2.9 to 2.3 in S_3 (mango sauce) during storage. Decrease in colour scores of blended sauce was low showing 8 per cent and the same was 10 per cent in papaya sauce. Decline in colour appeal of mango sauce was 12 per cent. However no particular reason that could claim for the difference in colour was noted. More over the decrease in

colour perception of the three types of sauce was not discouraging throughout the storage period.

Statistically the colour score of sauce with storage did not vary significantly.

4.4.5.4.3 Flavour attributes

Variation at the flavour richness of sauce at storage are given in table 66.

Table 66 Effect of storage on flavour of sauce (mean scores)

Sauce samples	Storage period (months)						Treatment means
	1	2	3	4	5	6	
S_1	4.40	4.30	4.20	4.20	4.10	4.10	4.21
S_2	2.60	2.40	2.30	2.20	2.20	2.20	2.31
S_3	4.60	4.60	4.50	4.40	4.40	4.30	4.46
F - NS						F - 171.46**	
						SE - 0.086	
						CD - 0.253	

The mean panellist score for flavour profile of sauce under storage indicated a lowering trend of 6 to 8 per cent in different sauce samples. Encouraging result on storage of sauce with respect to flavour was noted in the case of blended sauce and plain mango sauce the loss being only 6 per cent each. Though there was a little deviation from the original

flavour, the flavour was still appreciable upto six month in all the three sauces.

The flavour of sauce did not differ significantly during storage.

4.4.5.4.4 Taste attributes

Table 67 depicts the taste performance values of sauce during storage.

Table 67 Effect of storage on taste of sauce (mean scores)

Sauce samples	Storage period (months)						Treatment means
	1	2	3	4	5	6	
S_1	4.70	4.60	4.50	4.40	4.20	4.20	4.43
S_2	2.80	2.60	2.50	2.40	2.30	2.20	2.46
S_3	4.30	4.30	4.20	4.00	3.90	3.70	4.06
F - NS						F - 309.76**	
						SE - 0.058	
						CD - 0.172	

On verifying the values, it could be seen that there was no marked deviation in the taste, performance of sauce with storage upto six months. The percentage of reduction in taste attribute scores varied from 10 to 12 per cent. Papaya - mango blended sauce observed 10 per cent loss in taste appraisal and performance of both the plain sauces were similar showing a reduction of 12 per cent scores each.

The taste values on storage of sauce made no significant difference to statistical interpretation.

4.4.5.4.5 Consistency attributes

Data on effect of storage on the consistency of sauce is presented in Table 68.

Table 68 Effect of storage on consistency of sauce (mean scores)

Sauce samples	Storage period (months)						Treatment means
	1	2	3	4	5	6	
S_1	5.00	4.90	4.70	4.60	4.40	4.40	4.66
S_2	3.20	3.10	2.70	2.60	2.50	2.50	2.76
S_3	3.80	3.70	3.60	3.60	3.50	3.30	3.58
F - NS						F - 301.73**	
						SE - 0.055	
						CD - 0.162	

A close watch on the consistency values proved that the performance on storage remained without much variation. A gradual and linear decrease was noted in all the sauce samples. Consistency value was lowered by 10, 12 and 14 per cent respectively in mango sauce, blended sauce and papaya sauce.

Analysis of variance of the data indicated no significant difference in the consistency aspect of sauce due to storage.

4.5.5.4.6 Overall acceptability

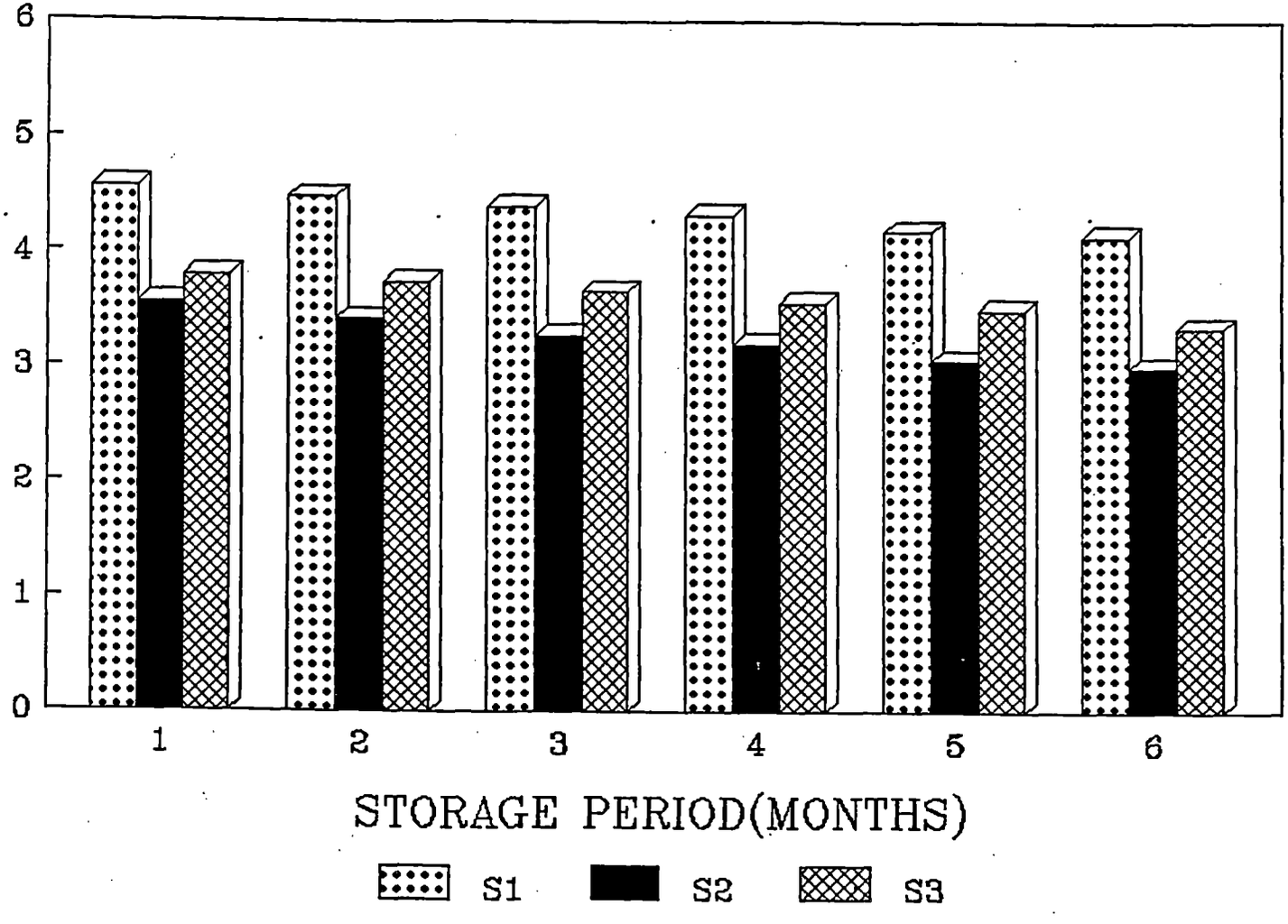
The overall acceptability of the sauces was worked out on averaging the values of different sensory characters studied.

Table 69 Effect of storage on overall acceptability of sauce (mean scores)

Sauce samples	Storage period (months)						Treatment means
	1	2	3	4	5	6	
S_1	4.56	4.48	4.4	4.32	4.18	4.14	4.34
S_2	3.56	3.42	3.28	3.20	3.06	3.00	3.25
S_3	3.80	3.74	3.66	3.56	3.50	3.34	3.60
F - 5.05*							F - 256.274**
SE - 0.068							SE - 0.028
CD - 0.189							CD - 0.083

On perusal of the pooled data on table 69 it could be evident that there was no considerable wavering in the general acceptability of sauce over a storage period of six months. In accordance with the trend exhibited by the various quality attributes the overall acceptability of sauce decreased making a minimum variation of 8.4 per cent in blended sauce. The variation observed in acceptability mango sauce was a decrease of 9.2 per cent and papaya sauce with 11.2 per cent.

Fig.13 OVERALL ACCEPTABILITY OF SAUCE DURING STORAGE



Statistical analysis of the data revealed that there was no significant difference in overall acceptability value of blended sauce and plain papaya sauce on the storage. But a significant difference existed between fifth and sixth month of storage in mango sauce.

To conclude, it may be stated that all the quality parameters namely appearance, colour, flavour, taste, consistency and overall acceptability turned to be degraded on longer keeping. It has to be highlighted that the blended sauce from papaya and mango under detailed study in this experiment possessed good storage qualities revealed better results as per the sensory scoring of judges compared to plain papaya sauce or mango sauce in certain properties. This gives an indication to the successful processing potentialities of papaya by way of a blended sauce preparation.

4.4.6 Assessment of microbial examination of processed products during storage

Microbial food safety is an essential component of food quality. Quality is a combination of characteristics that have significance in determining the degree of acceptability of the product to a consumer (Sardana and Vaidya, 1994). Although the products remained edible for long storage, unless the microbiological wholesomeness or safety of these product is elevated, they remain unsafe for consumption. Hence the

products prepared from papaya and mango viz. nectar, fruitbutter, fruit leather and sauce were examined for microbiological contamination to study the presence of bacteria, mould and yeast.

All the isolations were carried out following serial dilution technique. Bacteria, fungi and yeast were identified by colony morphology and microscopic observations. The Products were analysed at regular monthly intervals.

Observation of nectar indicated absence of any type of microbial growth. There was no acid or gas production even with a storage upto six months. The nutritional and chemical composition of nectar were also proved to be at satisfactory levels which evidenced the quality aspects maintained by products. The safe storage span of nectar at ambient conditions showed in this study coincides with the results by Aruna *et al*. (1997) who stated that bacterial counts were detected in papaya nectar only after 6 months storage.

Examination on fruit butter samples revealed that upto four months period all the samples were free of contamination. The presence of yeast was detected in papaya butter during the 8th month period. While colonies of *Pencillium* and *Aspergillus* were detected in papaya-mango blend and in mango butter during the period of six months. Pradnya *et al*. (1992) while isolating microorganisms from house made

mango jam had found that the fungus *Aspergillus niger* was responsible for the spoilage in the jam samples. In the present observation the shelf life of plain papaya butter was found to be less than the other. This may be explained by the composition of the fruit having low acidity compared to mango. In general the shelf life of any fruit butter was considered lesser than jams due to the use of lesser quantity sugar in butter preparation (Srivastava and Kumar, 1994). Bhatnagar *et al*. (1984) have observed microbial attack on muskmelon jam during the seventh month of storage. Therefore the storage life of fruit butter observed in the present study can be considered satisfactory. However the shelf period of blended butter gave better results than that of plain papaya butter.

The periodical testing of microbial count in papaya leather on storage revealed complete absence of any contaminated microorganisms upto the eighth month of storage. Their presence was detected only from nine month in plain papaya leather but the count was negligible. While in the case of papaya-mango and in mango leather complete absence of microflora was observed. This is a positive indication that papaya-mango blended leather exhibited prolonged shelf life equal in status to mango leather. This result enable us to speculate that moisture content of mango and papaya-mango was approximately below 11 per cent. This low moisture content may be the reason for safe storage of the products like papaya -

mango and mango leather upto ten and twelve months respectively.

In the case of papaya leather the moisture content was higher than the other two samples (13 per cent). This may be the reason for a comparitively lesser storage life of papaya leather added with the lower acidity of the fruit. CFTRI (1987) standardised papaya fruit bar with 0.5 per cent citric acid and 0.3 per cent potassium metabisulphite and drying to 15 per cent moisture that remained well for eight months. The similar result was obtained in this present investigation also since papaya leather was shelf stable only upto eight months. During the ninth month *Pencillium* and *Aspergillus* species were detected in papaya leather. According to Jyothi (1997) the microorganisms responsible for the decay of mango-papaya bar was *Aspergillus* and *Pencillium*.

The stored samples of sauce failed to show any evidence to microbial deterioration during the entire study period of six months storage. The addition of acid, salt and spices in the product along with mild dose of preservative have contributed in this storage quality. It is evident from this result that the blended sauce formulated was upto the quality standards of other sauces standardised.

It could be inferred from the results that papaya-mango blended products are highly shelf stable when compared

with that of papaya products. The results of the microbial analysis upholds that papaya-mango butter showed storage stability of ambient conditions for a period of 6 months. Microorganism responsible for spoilage of processed food products were found to be absent in nectar and sauce indicating that they were safe for consumption during the entire period of storage. Papaya-mango leather remained unaffected by microorganims even at ten month storage.

SUMMARY AND CONCLUSION

SUMMARY AND CONCLUSION

The present study entitled "Development of papaya (*Carica papaya* L.) based blended products" was undertaken to develop innovative products viz. nectar, fruit butter, fruit leather and sauce from the less utilised papaya fruit. The study was mainly aimed at formulation of fascinating blended products from papaya in order to over come the poor consumer appraisal and low popularity of plain papaya products.

A view on the physico-chemical aspects of papaya fruit CO-2 variety selected for the study revealed that the fruit is bestowed with an attractive colour and good taste. Fruits are large sized with low wastage and high flesh per cent. The fruit has TSS content of 10.5° brix, an appreciable vitamin C level of 56 mg/100g, 2401 IU of Betacarotene and high pectin content. These outstanding properties enable to recommend the fruit for processing into various fruit products.

Using standardisation as the yardstick for the improvement in product quality, four novel blended products were standardised namely nectar, fruit butter, fruit leather and sauce. Investigation was carried out to optimise the blending ratios of papaya pulp in combination with mango for formulation of highly acceptable products. Product

standardisation was undertaken by experimenting three different proportion of papaya and mango pulp such as 55:45, 60:40 and 65:35. In the preparation of nectar and fruit leather, the best acceptable blend of harmonised flavour was obtained by mixing 60 parts papaya pulp with 40 parts of mango pulp. In the formulation of blended fruit butter the proportion with 55:45 papaya and mango pulp contributed the best quality. While for sauce the ratio with higher quantity papaya pulp in the mix ie. 65:35 presented a superior result.

The four products prepared from the selected blends following the procedure standardised in the study were subjected to further detailed scrutiny. A comparative analysis of fresh blended products and the respective plain products from these fruits were undertaken. Parameters like organoleptic qualities, chemical composition, FPO requirements, cost analysis, fruit product yield ratio and consumer level testing were studied on plain and blended products.

Organoleptic evaluation of nectar evidenced that blended nectar was found to be highly superior to that of plain papaya and even mango nectar in most of the quality attributes. The overall acceptability score of blended nectar was high as 4.8, while it was only 3.9 in plain papaya and 4.2 in plain mango nectar. The ameleoration of papaya pulp and mango pulp contributed outstanding qualities to the new formulated nectar.

In sensory assessment of fruit butter, the overall acceptability performance of blended butter and plain mango butter were equally good with a mean score of 4.4. But the rating for papaya butter was only at a score of 3.2.

Results of the organoleptic evaluation of leather clearly indicated that papaya fruit has a potential for processing into blended leather bearing an overall acceptability value of 4.7. With an attempt of blending this product turned to outbeat mango leather that scored an overall value of 4.2. The score for papaya leather was found to remain at the position 3.3.

Best results in overall quality of sauce was also attained by papaya-mango blended sample. The appearance, taste and consistency of blended sauce was found more attractive by the judges than these attributes of mango sauce and papaya sauce. The average overall marks were 4.5, 3.8 and 3.6 respectively for blended, plain mango and plain papaya sauce.

Nutritional and chemical parameters of the fresh products were assessed with regard to pH, acidity, TSS, reducing sugar, total sugar and vitamin C. Values of the chemical composition of fresh nectar indicated higher levels with respect to papaya nectar in all components. But a better balancing of the various constituents favouring its acceptability could be framed when adjusted by blending fruits for nectar than the preparation of plain fruit nectars.

The chemical parameters of fruit butter when analysed, it was found that the products remained highly satisfactory in their nutritional and chemical composition. The blended butter presented an improved compositional level than papaya butter while maintaining a harmony in most of its quality aspects with the butter made from mango - the king of fruits.

Compositional analysis of fruit leather could also reveal a good chemical and nutritional position of leather samples studied. On drying into leather the TSS content of blended sample was observed better which is an important criteria in quality assessment.

On observation of the chemical qualities of sauce, the results were worthy enough to state that mixing papaya and under ripe mango pulp in sauce making, could profitably be utilised for the distribution of nutrients rich in these fruits at a fairer balance in blended sauce. Papaya sauce registered highest values in most of the components.

The products developed were studied for FPO requirements. The compositional data pertaining to the four blended products in this respect were found to have good quality standards in agreement with FPO.

Cost benefit of the products highlighted that the production expense of plain papaya products were low due to the

lower wastage, high juice yield and the year round availability of papaya fruit at lesser cost. Production cost of these four items from mango alone was the highest. Since plain papaya products failed to establish as well competing items in the consumer market, the slightly elevated cost incurred on account of blending with mango compared to plain papaya products cannot be considered a disadvantage.

When the fruit product yield ratio of different blended products developed were compared with the plain products of mango and papaya, it was clear that the product yield on blending was slightly lower to that obtained with papaya alone but higher than the yield observed on plain mango products. Inspite of the good production ratio and cost viability of plain papaya items, its poor market feasibility suggests ultimate need for processing papaya by blending into attractive items like nectar, fruit butter, fruit leather and sauce that would help to raise the prospects of papaya considerably in processing industry.

Consumer acceptance study of nectar indicated that blended nectar showed a higher acceptance by the common group with a score value of 4.6. This performance suggests that papaya blended nectar was liked by them more than the mango nectar and papaya nectar which received consumer score of 3.9 and 3.8. The formulation of blended nectar thus promises more consumer attraction than plain papaya drinks.

Consumer remarks on fruit butter evidenced that the overall performance of blended butter stood close to mango butter with scores 4.2 and 4.3. The flavour and taste of papaya butter could not make an appealing sense in them, the score being 3.6. However the qualities could be precisely improved by blending bringing the overall acceptability level higher.

Acceptability of leather by consumers proved that the blended leather was relished by them attaining the mean score 4.2 that remained parallel to the acceptance level of mango leather (4.3). The score value of papaya leather was low (3.4). Consumer study disclosed that the popularity of papaya leather could be substantially increased by blending with other fruits.

Consumer impression on sauce also proved that in its overall effect they welcomed blended sauce in top priority (4.5) with close preference to mango sauce having a score 4.3. At the same time papaya sauce failed to catch a consumer fascination upto the level of either mango or blended sauce since the score level was only 3.6.

Consumer preference ranking of blended papaya products developed in this study revealed that a bigger consumer group of 70 per cent preferred leather to be chosen as the most promising blended papaya product for commercialisation. Nectar was selected for the second choice by a

majority of 68 per cent consumer. 80 per cent of the consumers identified blended sauce as their third preferred item. Blended butter was placed at the forth preference by 90 per cent consumers.

The products stored at ambient conditions were assessed periodically for its shelf life performance on chemical, organoleptic and microbial changes.

Periodical evaluation of the nectar or six month revealed that there was only minor changes upon storage in chemical constituents. Reducing sugar and acidity were found to increase and pH was decreased with the corresponding increase in acidity. There was only a nominal loss in vitamin C content during storage. It was a worthwhile observation that the changes in chemical constituents on storage of the papaya-mango blended nectar was less compared to the changes recorded in papaya nectar.

All the sensory attributes namely appearance, colour, flavour, taste and consistency of nectar was well retained on storage being observed only a marginal degradation in the scores. Among the different nectar assessed, the lowest percentage reduction in most of the sensory attributes and overall performance were in favour of blended nectar closely followed by papaya nectar.

The negative results observed in microbial count was a positive indication of the safe storage quality of the blend nectar developed over six months under ambient condition Microbial observation of plain nectar were similar.

The results of the observation for four months on fruit butter highlighted that the trend in quality changes of blended butter had close similarity to that of mango butter which performed the best shelf behaviour. Blended butter had lesser variation in most of the chemical constituents as compared to papaya butter.

The changes in sensory quality parameters of fruit butter on storage was found to be nominal. Both mango and blended butter retained an equal rate of sensory appreciation on storage with lesser changes than papaya butter.

Examination on fruit butter samples revealed that upto four months period all the samples were free of deteriorative organism. On further observation while colonies of yeast count was detected in papaya butter at the fifth month, *penecillium* and *aspergillus* were detected in blended and mango butter on sixth month.

The evaluation of the chemical parameters of fruit leather observed only tangible changes upon eight months of storage. Both mango and blended leather exhibited a minimum

compositional deviation and this changes were more in papaya leather.

Corresponding with the storage changes in each sensory parameter there was a little downfall in overall acceptability. However the lower percentage of decrease was maintained by blended leather. Eventhough papaya leather showed the higher acceptability loss as per the score, the changes during storage were not drastic.

The products also confirmed its safety upto eight months as proved in the microbial examination conducted. *Pencillium* and *Aspergillus* species were detected during ninth month in leather constituted with plain papaya pulp.

Monthly evaluation of sauce for six months revealed that there was only a negligible fluctuation in pH and acidity. The products remained highly sound upto six months as there was no description of undesirable changes in chemical constituents. In a closer assessment the blended sauce remained with better storage quality in comparison to plain papaya sauce.

In certain major quality parameters viz. appearance, colour, flavour, taste and consistency storage quality of blended sauce excelled that of mango sauce and papaya sauce with minimum percentage of quality loss.

The stored samples of sauce failed to show any evidence to microbial deterioration upto six months.

The study highlighted the feasibility of introducing papaya-mango blended products into the market with promising consumer demands thereby contributing value addition to papaya fruit otherwise its processed items are constrained with less demand. This handicap of plain papaya products facing a poor consumer appeal because of its weak flavour and less attractive aroma could be solved to a great extent in the present attempt. The basic requisite of making a product acceptable and affordable has been achieved in this work concentrating on a unique fruit papaya.

Standardisation efforts to diversify papaya products successfully worked out in this investigation can be adopted to make the papaya products globally competitive. The introduction of such diverse forms of processed products can offer variety to consumers along with creating competition in the market. This again necessitates a need to evolve new ways to process our fruits using newer technologies.

REFERENCES

REFERENCES

Abraham, K.O., Raghavan, B., Sankaranarayana, M.I. 1993. Role of flavours in food product development. *Food Technology* 6-7

A.O.A.C. 1965. Methods of Analysis. The Association of the official Agricultural Chemists, Washington. p.426-427

Adsule, R.N., Kotecha, P.M. and Kadam, S.S. 1992. Preparation of wine from pomegranate. *Beverage and Food World* 18(2): 13-14

Adsule, P.G. and Roy, S.K. 1975. Studies on some important commercial varieties of mango of North India in relation to canning, freezing and chemical preservation of pulp. *Journal of Food Science and Technology* 12: 257

Agarwal, P., Singh, B. and Sindhu, J.S. 1995. Studies on the physico-chemical and processing characteristics of some newly involved tomato cultivars for making juice and concentrate. *Indian Food Packer* 49(2): 45-53

Alian and Muringe. 1980. *Journal of Food Science and Technology* 1(1): 29

Almeida, M.E.M. and Nogueira, J.N. 1995. The control of polyphenol oxidase activity in fruits and vegetables. *Plant Food for Human Nutrition* 47: 256

Ammu, K., Radhakrishna, K., Subramanian, V., Sharma, T.R., Nath, H. 1977. Storage behaviour of freeze dried fruit juice powders. *Journal of Food Technology* 12: 541-554

Annapurna, R.G., Vaidehiswamy and Vijayamma, R. 1977. Utilization of unconventional fruit for the preparation of RTS beverage part I. *Indian Food Packer* 31: 38-60

Anvilla, S., Poornima, M. and Mehrotra, N.N. 1993. A study of consumers attitude towards processed foods. Industrial Toxicology Research Centre. *Indian Food Packer* 47: 2

Aparnath, K.D., Bindal, M.P. 1995. Colourful, Naturally *Food Technology*, 26

Arriola, M.C., Mandrid, M.C. and Rolz, C. 1975. Some physical and chemical changes in papaya during its storage. *Proc. Trop. Reg. Am. SOC. Hortic. Sci.* 19: 97

Aruna, M., Seralathan, A. and Thirumaran, S. 1990. Studies on packaging and storage of tomato concentrate. *South Indian Horticulture* 38(4): 229-231

Aruna, K., Vimala, V., Giridhar, N. and Rao, D.G. 1997. Studies on preparation and storage of Nectar prepared from papaya (*Carica papaya* L.) *Beverage and Food World* 24(1): 29-30

Aykroyd, W.R. 1951. The nutritive value of Indian Foods and the planning of satisfactory diets. Government of India Press. New Delhi

Bansal, M. and Dhawan, S.S.1993. Preservation and keeping quality of Bhandri lemon juice (Citrus lemon L Bulm). *Haryana Journal of Horticultural Science* 22(3):188-194

Bawa, A.S. and Saini, S.P.S. 1987. Effect of method of preservation on the storage quality of carrot juice. *Indian Food Packer* 41(1): 42-46

Bawa, A.S. and Saini, S.P.S. 1988. Studies on processing and utilisation of Kumkaut (Wild citrus fruit). *Indian Food Packer* 42(2): 7-9

Begum, J.A., Shams-ud-Din, M. and Nural Islam, M. 1983. A study on the shelf life and consumers acceptability of mixed squash prepared from pineapple juice and mango pulp. *Bangladesh Journal of Science and Industrial Research* 48-54

Berry, R.E. 1979. Subtropical fruits of the Southern United States. In : Tropical Foods : Chemistry and Nutrition. Academic Press, New York 1 : 34

Bhatia, B.S., Shah and Ghulam, H. 1983. Studies on processing of culled apples. *Journal of Food Science and Technology* 20(5): 101

Bhatia, B.S. 1994. Sensory quality of passion fruit juices and reconstituted concentrates. *Indian Journal of Agricultural Science* 26: 403-414

Bhatnagar, D.K., Dhawan, S.S., Kainsa, R.L. and Gupta, O.P. 1984. Studies on the preparation of muskmelon jam. *Indian Food Packer* 45(1): 46-47

Bhatnagar, D.K. 1991. Utilization of watermelon rind for jam making. *Indian Food Packer* 45(1): 46-48

Birch, G.G., Brennan, J.G. and Parker, K.J. 1977. Sensory property of foods. Applied Science Publishing Ltd. p. 77

Bhowmik, S.R. and Eipison, W.E. 1992. Indian Fruit and Vegetable Processing Industry. *Indian Food Packer* XLVI(5): 5

Bhuyan, M.A. and Irabagon, J.A. 1992. Effect of fertilizer, potassium nitrate sprays and irrigation on the physico chemical composition of mango (*Mangifera indica*. L.) fruits cv carabao. *South Indian Horticulture* **40**(1): 9-15

Bourne, M.C. 1986. Proper care of foods needed after harvest. *Agricultural Information. Development Bulletin.* **10**(1): 11-14

Brekke, J.E., Cavaletto, C.G., Nakayama, I.T.O.M. and Suehisa, R. 1976. *Journal of Agricultural Food Chemistry* **24**: 341

Burhan Uddin, M. 1993. Suitability of selected fruit and vegetable pulps for jam preparation Pakistan J. Sci. and Ind. Res. 36(1): 46-49

CFTRI. 1978. Studies on preparation of fruit slabs from papaya. CFTRI, Mysore

CFTRI. 1987. Papaya in India. Industrial Monograph Series. CFTRI. Mysore 31

CFTRI Monograph. 1990. Mango in India p.21

CFTRI. 1990. Home scale processing and preservation of fruits and vegetables. CFTRI, Mysore

Chakraborthy, S., Bisht, H.C. and Agarwal, M.D. 1991. Studies on varietal screening of mangoes of Uttarpradesh for their suitability for production of canned nectar juice and pulp. *Indian Food Packer* XLV(5): 49-56

Chakraborthy, S., Agarwal, M.S. and Shukla, I.C. 1993. Studies on preparation of Ready to serve beverages from Watermelon (*Citrus vulgaris*) juice. *Beverage and Food World* 20(3): 30-32

Chauhan, G.S., Suresh, I and Singh, D. 1993. Formulation of fruit juice beverage from pulp. *Beverage and Food World* 20(2): 17-18

Chavan, V.D., Kadam, S.S. and Dhotre, V.A. 1991. Processing of Ber preparation of RTS. *Beverage and Food World* 18(3): 13-14

Cheman, Y.B. and Taufik. 1995. Development and stability of jackfruit leather. *Tropical Science* 35: 245-250

Chopra, R.N. 1958, Indigenous Drugs of India, 2nd edition V.N.Dhur, Calcutta p. 319-311

Civetta, A., Gaitan, F. and Muller, C. 1965. Some physical and chemical changes in papaya during its storage and ripening. *Rev. Inst. Invest. Technol.* 7: 33-45

Clement, C.T. and Kubena, K.S. 1989. Factors influencing food selection by students in university food services, JADA 89(9): 39

*Cruess, W.V. 1958. Commercial fruit and vegetable products. Mc Graw Hill Book Co. New York

Crusius, V.C. 1984. Quantity food management principles and applications. Subject publications K. Kamala Nagar, Delhi p. 75-78

Dan, A. 1985. Sapodilla-A delicious Dehydrated products. *Indian Horticulture* 30(3): 13

Dang, R.L., Singh, R.P., Bhatia, A.L. and Verma, S.K. 1979. Canning of apple rings. *Indian Food Packer*. 31(4): 9-14

Dang, R.L., Varma, S.K. and Singh, B.P. 1979. Studies on Kashmir apples. III. *Indian Food Packer* 33(3): 4

Das, S.K. 1986. A Text Book on Food Science, First Edition p. 252

Das and Jain. 1986. A text book on Food Science First Edition. p. 252

Donchenko, L.V. and Associates. 1983. Effect of active acidity on strength of jam and jelly. Horticultural abstracts. *Indian Food Industry* 13(5): 17

Dube, K.P. 1984. Studies on preparation and preservation of bael beverage : Thesis submitted to Horticultural Department. N.D.U.A.T. Faizabad for award of Masters degree in Horticulture

Food and Agricultural Organisation (FAO). 1991. FAO Production Year Book 45: 164-170

FPO. 1955. Department of food ministry of Agriculture, Government of India

Gao, X.M., Reynolds, A. and Lee, J.Y. 1993. A structural latent variable approach to modelling consumer perception. A case study of orange juice. Agribusiness, New York 9(4): 317-324

Geetha, G. 1982. The fruitful fruits. Kissan world: 33

Geetha and Shivaleela, H.B. 1982. Ascorbic acid content of commercial fruit and vegetable products. *Indian Food Packer* 36(2): 64-66

Ghanta, P.K. 1994. Physico chemical changes in papaya cv. Ranchi during fruit development and maturity. *South Indian Horticulture* 42(4): 231-235

Ghosh, S.K., Dhua, R.S. and Mitra, S.K. 1985. *Indian Food Packer* 39: 46-50

Goodwin, T.W. and Goad, L.J. 1970. Carotenoids and triterpenoids. In : The Biochemistry of Fruits and their products. A.C. Hulme (Editor) Academic Press, New York

Govindarajan, V.S. 1981. Problems and possibilities of sensory evaluation. Proceedings 2nd Indian convention of food scientists and technologists p. 2

Hayes, W.B. 1960. Fruit growing in India. 3rd kitabistan, Allahabad

Heikal, H.A. El-sanafiri, N.Y., Shooman, M.A. 1972. Some factors affecting quality of dried mango sheets. *Agric. Res. Rev.* 50: 185-194

Hicks, D. 1990. Production and packaging of non-carbonated fruit juices and fruit beverages. Van Nonstrand Reinhold. New York. Tropical fruit juice ed by Hopper, J. p. 118, 122

How, B.R. 1990. Marketing Fresh fruits and vegetables. Van Nostrand reinhold. Newyork p. 117-120

Indian Food Packer. 1980. Studies on dehydration of mango pulp. XXIV(3): 64-72

Indian Food Industry. 1994. Data Bank 13(5): 17-48

Indian Food Industry. 1995. Technology, quality and scope of fruit wines especially apple beverages. 14(1)

Indian Council of Medical Research. 1989. Nutritive value of Indian Fruits. National Institute of nutrition. Hyderabad p.

Irulappan, I. 1992. Papaya a fruit of the tropics. *Indian Horticulture* 37(3): 33-34

Jack, F.R., Paterson, A. and Piggott, J.R. 1995. Perceived texture; direct and indirect methods for use in product development. *International Journal of Food Science and Technology* 30: 1-12

*Jagtani, J., Chan, Jr. H.T., Sakai, W.S. 1988. Tropical Fruit Processing. Academic press. *Inc*. New York p. 45-97

Jain, N.L. 1961. Chemistry and Technology of mango. *Rev. Food Technolgy*. 3: 31-36

Jain, S.P., Tripathi, V.K., Ram, H.B. and Surjeet Singh. 1986. Effect of storage conditions on storage life of some important squashes - part 2 studies on the storage life of phalsa, Kaphal and Litchi squashes. *Indian Food Packer* 40(2): 36-41

Jain, S.P., Tripathi, V.K., Ram, H.B. and Singh, S. 1988. Varietal suitability of litchi for squash making. *Indian Food Packer* 42(1): 29-33

Jayaprakash, R., Bojappa, K.M., Seenappa, K. and Ramanjini, P.H. 1989. The Effect of Irrigation and Fertilizers on yield and Quality of solo papaya (C.P.L.) *Progressive Horticulture* 21(3-4): 239-243

*Jayaraman, K.S. 1988. Development of intermediate moisture tropical fruits and vegetable products - Tecnological problems and prospects. In : Seow, C.C. Preservation by moisture control. Elsevier applied sciences, London and New York p.255-258

Jayaraman, K.S. and Gupta, D.K.D. 1991. Quality characteristics of some vegetable dried by direct and indirect sunlight. *Indian Food Packer* 45: 16-23

Jeans, H. 1972. Papaya - The Medicine tree In : About Tropical fruits. Thorsens publishers Ltd., London p. 50-51

Jellink, G. 1985. A text book on evaluation of food. p. 17-21

Joshi, V.K. and Attri, B.L. 1990. Importance and scope of fruit based fermented beverage in India. *Beverage and Food World* 19(5): 16-17

Joshi, V.K., Kaushal, N.K. and Thankur, N.S. 1996. Apple pomace sauce development and quality of fresh and stored products. *Journal of Food Science and*

Joshi, V.K. 1991. Importance and scope of fruit based fermented beverage in India. *Beverage and food world*. 17(4): 9-10

Jyothi, H. and Ukkuru, M. 1997. Developing blended fruit product utilising stored mango pulp. MSc. Thesis. Kerala Agricultural University, Thrissur

Kadam, S.S.,Adsub, R.N., Chougle, B.A. and Kotecha, P.M. 1991. Processing of Ber preparation of wine. *Beverage and Food World* 19(5): 16-17

Kahtani, H.A. 1990. Intercultivar difference in quality and post harvest life of pomegranate. *Beverage and Food World* 19(4): 13-15

Kalia and Sood, S. 1996. Food preservation and processing. Kalyani publishers. New Delhi p. 222

Kalra, S.K., Tandon, D.K. and Singh, B.P. 1991. Evaluation of mango - papaya blended beverage. *Indian Food Packer* 41: 7-13

Kalra, S.K., Tandan, D.K. and Singh, B.P. 1991. Evaluation of mango papaya blended beverage *Indian Food Packer* 45(1): 33-36

Kapoor, B.L. 1993. The Indian Food standards under PFA and FPO relating to Fruit and Vegetable products - Anomalies and problems. *Indian Food Packer* 7: 39-45

Karim and Taufik. 1992. Storage and stability of chikku leather. *Food Journal* 7(1): 53-55

Kaur, C. and Khurdiya, D.S. 1993. Studies on Mango Sauce. *Beverage and Food World* 20(4): 25-26

Kaur, C., Sahni and Khurdiya, D.S. 1989. Effect of ripening and storage temperature on the quality of mango nectar. *Indian Food Packer* XXXXIII(6): 5-10

Kerterz. 1980. Studies on pear candy processing. *South Indian Journal of Horticulture.*

Khurdiya, D.S. and Roy, S.K. 1984. Storage studies on jamun (syzigium cumini) juice and nectar. *Journal of Food Science and Technology* 22(3)

Kordylas, J.M. 1990. Processing and Preservation of Tropical and subtropical foods p. 172-359

*Krammer, A. and Twigg, B.A. 1970. Quality control for the food industry 3rd Vol. I publishing Co., West Port, Connecticut p. 116

Krishnamurty, G.V. and Varma, V.K. 1978. Studies on preparation of fruit slabs from papaya. CFTRI, Mysore

Kulkarni, C.Y. and Bharati, P. 1994. Microflora of West Indian Cherry products. *Current Research* 23(11): 140-142

Kulwal, L.V., Patwardhan, M.V. and Salladnath, V.V. 1985. Studies on chemical changes and corrosion in canned products of papaya. *Indian Food Packer* **39**(4): 33-37

Kumar, M. Pramod, K. 1993. Fruit Export : Prospects and constraints. Economic Times 23rd June p. 7-8

Labuza, T.P., Tannenbaum, S.R., Karel, M. 1970. Water content and stability of low moisture and intermediate moisture foods. *Food Technology* **24**: 35-42

Lal, G., Sidappa, G.S. and Tandon, G.L. 1986. Preservation of fruits and vegetables. Published by ICAR, New Delhi

Lapedes, D.N. 1977. Mc Graw Hill Encyclopedia of Food Agriculture and Nutrition p. 304

Larmond, E. 1977. Laboratory methods for sensory evaluation of food. Canada Department of Agriculture, Ottawa publication 1637

Mahajan, B.V.C. and Chopra, S.K. 1994. Processing of wild pomegranate - effect of thermal treatments and drying modes on quality. *Food Science and Technology* **29**: 5

Maini, S.B., Brijesh Diwan, Gupta, S.K. and Anand, J.C. 1982. A solar drier for fruits and vegetables. *Indian Horticulture* Abstracts **27**(1): 21

Maini, S.B. and Anand, J.C. 1985. Improved fruit and vegetable products. *Indian Horticulture* 30(2): 10-11

Malathi, D., Seralathan, A.M., Thirumaran, S.A. and Rajan, S.S. 1986. Utilisation of papaya in South Indian Cookery. *South Indian Horticulture* 34(4): 258

Majeed, S.K. and Cheriyan, S. 1995. Development of karonda based products. MSc. Thesis, Kerala Agricultural University, Thrissur

Manan, J.K., Kulkarni, S.G. and Sukla, I.C. 1992. Studies on preparation and storage of pulp, squash, nectars and Reddy to serve beverages from two varieties of Apricot (Gola and Chapta) grown in Kumaon Region of Uttarpradesh. *Beverage and Food World* 18(2(): 9-12

Manimegalai, G., Saravanakumari, R., Ponmalai, S.S. and Tamilselv, N. 1995. Studies on mango papaya blended squash 3 day National Seminar Horti. National p. 55

Mathur, V.K., Das, S.A., Jayaraman, K.S., Bhaha, B.S. 1972. Preparation of fruit bars for use in combat rations. *Indian Food Packer* 26: 33-35

Matz, S.A. 1962. Food texture. The AVI publishing company. Inc. p. 34

Mc Dornett, J. 1992. The importance of Sensory analysis for evaluation of quality. *Food Technological*. Abstracts 27: 5-167

Mc Williams, M. and Paine, H. 1977. Modern Food Preservation. North Gilbert Fullerton CA 92633

Mehta, V. and Bajaj, S. 1983. Effects of storage and methods of preservation on the physico-chemical characteristics of citrus juices. *Indian Food Packer* 37: 42-51

Mir, M.R. and Nath, N. 1993. Storage changes in fortified mango bars. *Journal of Food Science and Technology* 30(4): 279-282

Mohammed, S., Kyi, K.M. and Sherif, Z.M. 1993. Protective effect of system Hcl on vitamin C in dehydrated pickled/candied pineapple and guava. *Food Science and Technology*. Abstracts 25(6): 756

Mukherjee, K.K., Tandon, G.L. and Siddappa, G.S. 1963. Some tropical fruit product from hard pear. *Indian Food Packer* 17(5): 13

Muthukrishnan, C.R. and Palaniswamy, K.P. 1972. A study on West Indian cherry products. *Indian Food Packer* 26(4): 34-37

Naik, H.R., Mir, M.A. and Masoodi, F.A. 1996. Preparation of acceptable apple juice blend from Maharaji cultivar (White dotted red) cultivar. *Beverage and food world* 23(5): 26

Nanjudaswamy, A.M. Setty. L and Siddappa, G.S. 1964. Preparation and preservation of guava juice. *Indian Food Packer* 18(4): 17

Nanjundaswamy, A.M., Shetty, G.R. and Saroja, S. 1976. Studies on the development of newer products from mango. *Indian Food Packer* 30(5): 95-103

Nath, N. and Ranganna, S. 1981. Determination of thermal process schedule for acidified papaya. *Journal of Food Science* 46: 201-206

Navani, S.K. 1965. Blended beverages. *Indian Food Packer* 19(5)

Nuri, F.S. 1963. Unpublished data

Nwanekezi, E.C., Alawuba, O.C.G. and Mkpolulu, C.C.M. 1994. Characterization of pectic substances from selected tropical fruits. *Journal of Food Science and Technology* 31(2): 159-161

Okoli, E.C. and Ezenweke, L.O. 1990. Formulation and shelf life of bottled papaya juice beverage. *International journal of Food Science and Technology* 25(6): 706-710

Orr, K.J., Dennings, H. and Miller, C.D. 1953. The sugar and ascorbic acid content of papayas in relation to fruit quality. *Food Res.* 18: 532-537

Pal, D., Sachdeva, S. and Singh, S. 1995. Methods for determination of sensory quality of foods. A Critical Appraisal. *Journal of Food Science and Technology*. 32(5): 357-367

Pal, D. and Ukkuru, M. 1995. Development, diversification and shelf life studies of passion fruit products. MSc Thesis, Kerala Agricultural University, Thrissur

Palaniswamy, K.P., Muthukrishnan, L.R. and Shanmugavelu, K.G. 1974. Studies on evaluation of mango varieties. *Indian Food Packer*. 28: 12-19

Pant, G.B. 1996. *Journal of Dairying Food and Home Science* 15(2): 71-80

Pareek, O.P. and Sharma, S. 1993. Utilisation of fruits. *Indian Horticulture* p. 47-49

Perlette. 1992. Grape juice - Effect of extraction method, sulphurdioxide concentration and storage on the physico-chemical composition. *Indian Food Packer* 46(6): 5-13

Philippa, C. and Ojimelukwe. 1994. Effects of processing methods on ascorbic acid retention and sensory characteristics of tomato products. *Journal of Food Science and Technology* 31(3): 247-248

Pradnya, K., Seema, S. and Neetha, J. 1992. Sugar and acid tolerant microorganisms causing spoilage in Mango jam (muramba). *Journal of Food Science and Technology* 29(5): 278-280

Pruthi, J.S. and Sondhi, S.P. 1978. *Beverage and Food World* 5

Pulley, G.N. and Von Loesecke. 1941. H.W. fruit product J. 21-37

Purushothaman. 1996. *Food digest* 19(2)

*Quisumbig, E. 1951. Medicinal plants of Philippines. Bureau of print manica p. 632-637

Raab, C. and Oehler, N. 1976. Making dried fruit leather. Fact sheet 232 Oregon State University Ext. service

Ragab, M. 1987. Characteristics of apricot jam sweetened with saccharin and Xylitol. *Food Chemistry* 23: 55-64

Raghuvanshi, R.S. 1995. Fruits for Human Health. *Indian Farmers Digest* XXVIII(5): 29-31

Rajalakshmi. 1993. Sensory methods for quality assurance programme in food industry. Food Technology update Souveniar - IFCON 1993

Ram, M. 1982. Some aspects of genetics cytogenetics and breeding of papaya. *South Indian Horticulture* **30**(1): 34

Ranganna, S. 1991. Hand book of Analysis and Quality control for fruit and vegetable products. 1056

Ranganna, S. 1977. Manual of analysis of fruit and vegetable products. Tata Mc Graw - Hill Publishing Company Ltd. p. 281

Ranganna, B. and Raghavan, G.S.U. 1997. Packaging Technology for fruits. Kisan World 35-37

Rao, M.R., Rao, S.N. and Reddy, E.N. 1979. Utilisation of Rangapur limes for preparation of beverages. *Indian Food Packer* **33**(1): 33-34

Rao, V.S. and Roy, S.K. 1980. Studies on dehydration of mango pulp and storage studies on mango sheets/leather. *Indian Food Packer* **34**: 72-79

Rao, B.S. 1991. Nutritional consideration of food processing. **12**(37): 9

Rarrales, J.F. 1958. *Plant Ind. Dig.* **21**: 16-19

Reece, R.N. 1979. A quality assurance perspective of sensory evaluation. *Food Technology* **33**(9): 37

Renote, P.S., Bawa, A.S. and Saini, S.P.S. 1992. Thermal process for Kinnow RTS. *Indian Food Packer* **46**(4): 16-24

Rigi, H. and Ukkuru, M. 1995. Developing partially dehydrated pineapple products using solar drier. MSc Thesis, Kerala Agricultural University, Thrissur

Ronald, T. and Cruess. 1956. Experiments on candying of fruits. *Fruit Product Journal* **28**: 229

Roy, S.K. and Singh, R.N. 1979. Studies on utilisation of Bael fruit (*Aegle marmelos* correa) for processing III - Preparation and preservation of Bael fruit products. *Indian Food Packer* **33**(5): 17-20

Sagar, V.R. and Khurdiya, D.S. 1996. Effect of ripening stages on quality of Dehydrated Ripe Mango Slices. *Journal of Food Science and Technology* **33**(6): 527-529

Sagar, V.R., Khurdiya, D.S. and Balakrishnan, K.A. 1998. Effect of storage temperature and period on quality of dehydrated ripe mango slices. *Journal of Food Science and Technology* **35**(2): 147-150

Sahini, C.K. and Khurdiya, D.S. 1989. Physico-chemical changes during ripening of Deshehari, Chausa, Neelum and Amrapali mango. *Indian Food Packer* **43**: 36-41

Saini, S.P.S., Renote, P.S, Midhar, G.S., Bhatia, B.S. and Singh, K.K. 1985. Studies on processing of citrus fruits of Punjab. Fifth convention of food scientist and Technologists, New Delhi. p. 125

Saini, S.P.S. and Wani, M.A. 1993. Enzymatic clarification of plum pulp for higher concentration. *Research and Industry* 38(1): 19-22

Saini, S.P.S. and Dharmpal. 1997. Storage stability of kinnow juice. *Beverage and Food World* 24(1): 25-26

Sandhi, S.P. and Pruthi, J.S. 1978. *Beverage and Food World* 5

Sandhu, G.S., Bawa, A.S. and Bains, G.S. 1988. Studies on the effect of variety processing and storage on the quality of grape juice. *Indian Food Packer* 42(4): 36-42

Sarain, K.P. 1992. Theme paper. *Indian Food Packer* 46(5): 59-63

Sardana, V. and Vaidya, R. 1994. Quality problems in agro-industries challenges and approaches. *Indian Food Packer* 94: 29-30

Saxena, A.K., Teotia, N.S. and Berry, S.K. 1996. Studies on the development of grape-mango and grape-pineapple beverage blends. *Indian Food Packer* 50(4): 26-29

Seow, C.C., Shanmugam, G. 1991. Storage stability of canned jack fruit juice at tropical temperature. *Journal of Food Science and Technology* **29**(6): 371-374

Sethi, V. 1993. Prospects and constraints for export of indigenous fruit and vegetable products. *Indian Food Packer* **47**(5): 37-44

Sethi, V. 1985. A simple and low cost preservation of litchi fruit. *Indian Food Packer* **39**(4): 42-48

Sethi, V. 1994. Efficiency of various preservative for preserving whole tomato concentration. *Indian Food Packer* **48**(1): 11-15

Sethi, V. 1996. Appropriate post harvest technology of Horticultural crops. *Beverage and Food World* **23**(1): 41

Sharma, J.R. and Kumar, J.C. 1995. Pumpkin varieties suitable for ketchup. *The Punjab vegetable Grower* **30**: 64-65

Sharma, B.D. and Sarfaraz, A.W. 1995. Sensory attributes of meat and meat products. *Indian Food Industry* **14**(3): 22

Shah and Bains, G.S. 1992. Storage studies on canned peach and Apricot pulps. *Indian Food Packer* **46**(6): 15-17

Sharma and Wani. 1995. Sensory attributes of meat and meat products. *Indian Food Industry* **14**(3): 22-27

Shaw, A., Mathur and Mehrotra, N.N. 1993. A study of consumers attitude toward processed food. *Indian Food Packer* **47(2)**: 29

Sheeja, N. 1994. Impact of pretreatments and processing on the shelf life quality of papaya products. MSc Thesis. Kerala Agricultural University, Thrissur

Sheela,K.B., Raju, V.K. and Narayanankutty, M.C. 1995. Value addition in papaya. *Hortinational* **95**: 3 day National Seminar p. 20

Shiro. 1971. Sugar confectionery

Singaravelu, M. and Arumugam, R. 1993. Solar drier. *Food Digest* **16(3)**: 140-142

Siddappa, G.S. 1967. Preservation of fruits and vegetables. Scope for development. *Indian Horticulture* **2(4)**: 37

Siddappa, G.S. and Tandon. 1986. Preservation of fruits and vegetables. Publications and information Division, ICAR. p. 321

Singh, R. 1969. Papaya. In : Fruits. National Book Trust. New Delhi p. 95-101, 147

Singh, I.D. 1990. Papaya. Oxford and IBH publishing Co. Ltd., New Delhi p. 1-56

Singh, R.P., Gupta, A.K. and Beerh. 1992. Suitability of apricot cultivars for canning. *Indian Food Packer* **XLVI**(6): 31

Srivastava, R.P. and Kumar, S. 1994. Fruit and vegetable preservation. International Book Distributing Company, Lucknow p. 140, 273

Sreeja, K.C. 1996. Qualitative changes in cashew apple products in storage with special reference to vitamin C. MSc Thesis, Kerala Agricultural University, Thrissur

Stillman, A.J. 1993. Colour influences flavour, identification of fruit flavour in beverages. *Journal of Food Science* **58**(4): 810

Subrahmanyam, K.V. 1993. Impact of agriculture and economic policies on export of horticulture produce from India. *Indian Journal of Agricultural Marketing*

Sudhakar, D.V. and Maini, S.B. 1995. Pectins from fruit processing waste - A review. *Indian Food Packer* **49**(1): 39

Susanta, R.K. and Singh, R.N. 1978. Processing of bael fruit (Aegla marmelos correa) for edible products. Indian Agriculture Research Institute, New Delhi

Stone, H., Sidel, J. 1993. Sensory Evaluation Practics, Academic Press Inc., London. In : *Journal of Food*

Swaminathan, M. 1974. Diet and nutrition in India. Essentials of food and nutrition - applied aspects. Ganesh and Company, Madras 361-367

Tajuddin, E., Menon, R., Charles, J.B. and Pillai, S.J. 1996. Banana. The directorate of extension, Kerala Agricultural University, Thrissur

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

Teotia, M.S., Berry, S.K. and Sehgal, R.C. 1991. Beverage development from fermented (S. cerevisiae) Muskmelon (C. mèlo) juice. *Indian Food Packer* **45**(4): 49-59

Teotia, M.S., Saxena, A.K. and Berry, S.K. 1992. Studies on the development of muskmelon mango beverage blends. *Beverage and Food World* **19**(4): 29-30

Thakur, B.R., Mohan, M.S. and Arya, S.S. 1995. Studies on preservative action of some conjugated fatty acids in mango pulp. *Indian Food Packer* **49**(6): 37-44

Thirumaran, A.S., Seralathan, M.A. and Malathi, D. 1985. A simple processing technique for papaya candy. TNAU Newsletter **15**(6): 3

Thirumaran, A.S., Seralathan, M.A. and Sundarajan, S. 1986. Utilization of papaya in South India. *South Indian Journal of Horticulture* **39**(4): 158-262

Thirumaran, A.S., Seralathan, M.A. 1990. Studies on packaging and storage of tomato concentrate. *South Indian Journal of Horticulture* 38(4): 228-231

Thirumaran, A.S., Seralathan, M.A. and Malathi, D. 1992. Preparation of carrot based RTS. *South Indian Journal of Horticulture* 40(1): 49-52

Thirumaran, A.S. and Seralathan, M.A. 1993. A paper on the scope of the export of papaya and mango products. Times of India March 27

Thorner, M.E. and Herzaberg, R.J. 1978. Non-alcoholic food service beverage handbook. The AVI publishing company. Inc. Vol. Forth Edition

Tolule. 1984. Standardization of recipe. IADA SOD 90(8): 565

Tripathi, V.K., Singh, M.B. and Singh, S. 1988. Studies on comparative composition changes in different preserved products of Amla var. Banarasi. *Indian Food Packer* 42(4): 60-65

Vaidehiswamy, Annapoorna, R., Gowda, R. and Vijayamma. 1979. Utilisation of unconventional fruits. *Indian Food Packer* 31(3): 38

Vaidya, R.N., Kotecha, P.M. and Kadam, S.S. 1998. Studies on mixed fruit juice beverages based on Ber pomegranate and guava. *Beverage and food world*. 25(2): 41

Varsanyl. I. 1993. Packaging of food interaction between the food and package and predicting shelf life of food. Proc. of 3rd International food convention. Mysore. p. 143

Varghese, I. and Ukkuru, M. 1997. Suitability of local mango cultivars for pulp based products. MSc Thesis, Kerala Agricultural University, Thrissur

Veeraraghavathathum, D., Jawaharlal, M., Jeeva, S., Rabindran, R. 1996. Scientific Fruit Culture. Suri Associates. p. 91-92

Vyas, K.K., Sharma, P.C., Joshi, V.K. and Srivastava, M.P. 1989. Standardization of a method for juice extraction and preparation of RTS from Rhodopetals. *Indian Food Packer* **43**(4): 12

Vyas, K.K. and Kochar, A.P.S. 1993. Studies on cider and wine from culled appled fruit available in Himachal Pradesh. *Indian Food Packer* **47**(4): 15-21

Vyavasaya Keralam. 1994. Bureau of Industrial promotion 28(8):7

Watt, B.M., Ylimaki, G.L., Jeffery, L.E. and Elias L.G. 1989. Basic sensory methods for food evaluation. International Research Centre

Williams, C.T. 1964. Chocolate and confectionary 185

Wood roof, J.G. 1974. Beverages, carbonated and noncarbonated, Ed. J.G. Wood roof and Philips, G.F. 1972. p. 42

Wood roof, T.J. and Luh, B.S. 1975. Commercial fruit processing. The AUI Publishing Company, West Port, Conneticut

Yadav, S.S. 1995. Problems and prospects of Export of Fruit and vegetables. *Indian Journal of Agricultural Marketing*. 9(2): 127-137

* Originals not seen

APPENDICES

APPENDIX - I

EVALUATION CARD FOR TRIANGLE TEST

In the triangle test three sets of sugar solution o different concentration were used. Of the three sets tw solutions were of identical concentrations and the members wer asked to identify the third sample which was of differen concentration.

Name of the product : Sugar solution

Note : Two of the three samples were identical, identify th odd sample

Sl. No.	Code No. of the samples	Code No. of the identical samples	Code No. of the
1	XYZ		
2	ABC		

APPENDIX - II

SCORE CARD FOR THE ASSESSMENT OF ORGANOLEPTIC QUALITIES OF NECTAR, FRUIT BUTTER, FRUIT LEATHER AND SAUCE

	Score	1	2	3
Appearance				
Very good	5			
Good	4			
Fair	3			
Poor	2			
Very poor	1			
Colour				
Very good	5			
Good	4			
Fair	3			
Poor	2			
Very poor	1			
Flavour				
Very pleasant	5			
Pleasant	4			
Moderately pleasant	3			
Less pleasant	2			
Unpleasant	1			
Taste				
Very good	5			
Good	4			
Fair	3			
Poor	2			
Very poor	1			
Consistency				
Highly acceptable	5			
Acceptable	4			
Moderately acceptable	3			
Less acceptable	2			
Not acceptable	1			
Texture				
Very good	5			
Good	4			
Fair	3			
Poor	2			
Very poor	1			

DEVELOPMENT OF PAPAYA (CARICA PAPAYA L.) BASED BLENDED PRODUCTS

BY

BEENA CHERIAN

ABSTRACT OF THE THESIS

SUBMITTED IN PARTIAL FULFILMENT

OF THE REQUIREMENT FOR THE DEGREE

MASTER OF SCIENCE IN HOME SCIENCE

(FOOD SCIENCE AND NUTRITION)

FACULTY OF AGRICULTURE

KERALA AGRICULTURAL UNIVERSITY

DEPARTMENT OF HOME SCIENCE

COLLEGE OF AGRICULTURE

VELLAYANI, THIRUVANANTHAPURAM

1998

ABSTRACT

The present study entitled "Development of papaya (*Carica papaya* L.) based blended products" was undertaken to develop innovative products viz. nectar, fruit butter, fruit leather and sauce from the less utilised papaya fruit. The study was mainly aimed at formulation of fascinating blended products from papaya inorder to overcome the poor consumer appeal and low popularity of plain papaya products.

Papaya is a highly nutritious and less expensive fruit. CO-2 variety which is good in taste and attractive in colour was selected for the study.

Product standardisation was undertaken by experimenting three different proportion of papaya and mango pulp such as 55:45, 60:40 and 65:35. In the preparation of blended nectar and blended fruit leather, the formula with 60:40 ratio was most acceptable. In the formulation of blended fruit butter the proportion with 55:45 papaya and mango pulp contributed the best quality. While for sauce 65:35 ratio presented a superior result.

The organoleptic qualities of the standardised blended papaya products were found to be highly superior to that to plain papaya products. Blended papaya leather, nectar

and sauce were even better than plain mango items in their overall sensory attributes, while blended butter was well comparable.

The chemical composition of blended products remained highly satisfactory and better balancing than plain products in various constituents. The products developed were found to have good quality standards in agreement with FPO specification.

The cost analysis of the products highlighted that the expense for the production of plain papaya products was identified as the cheapest followed by blended products. While the cost for mango products were found to be the highest. The fruit product yield ratio when calculated indicated that the product yield on blending was slightly lower to that obtained with papaya alone but higher than the yield observed on plain mango products.

Consumer acceptance study disclosed that papaya-mango blended products bagged much wider acceptability among the consumers than the similar plain papaya products. When nectar and sauce were developed by blending papaya and mango, the acceptability of end users to these products remained even higher to that of mango nectar and sauce. So also the blended butter and blended leather catched a similar appreciation to that of mango butter and leather. Consumer preference ranking

of blended papaya products revealed that fruit leather was then most preferred product. For second and third preference the consumers identified nectar and sauce respectively. While blended butter was placed at the forth choice.

The products developed were assessed periodically for its shelf life performance on chemical, organoleptic and microbial changes.

The evaluation of nectar for six month revealed that there was only minor changes in chemical composition upon storage. Sensory attributes namely appearance. colour, flavour, taste and consistency of nectar were well retained on storage being observed only a marginal degradation in the scores. Negative results were obtained on microbial examination.

Observation on storage behaviour of fruit butter for four months revealed its stability with respect to chemical constituents. The changes in sensory quality parameters of fruit butter on storage was found to be nominal. Samples studied were free of deteriorative organism during storage.

Storage performance on chemical parameters of fruit leather observed only tangible changes with eight months. Corresponding with the storage changes in each sensory parameter there was a little downfall in overall acceptability

The products also confirmed its safety upon eight months as proved in the microbial examination conducted.

Monthly evaluation of sauce samples remained highly sound up to six months as there was no description of undesirable changes in chemical constituents. Storage favoured all sensory attributes of blended sauce better than that of mango and papaya sauce with the minimum percentage quality loss. The stored product failed to show any evidence to microbial deterioration.

The study highlighted the feasibility of introducing blended papaya products into the market with promising consumer demands thereby contributing value addition to papaya fruit. The introduction of such diverse forms of processed products can offer variety to consumers along with creating competition in the market.