# DEVELOPING BLENDED FRUIT PRODUCT UTILISING STORED MANGO PULP

BY

JYOTHI. H.

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1997

Dedicated to

my Parents

## DECLARATION

I hereby declare that this thesis entitled "**Developing blended fruit product uitilising stored Mango pulp**" is a bonafide record of research work done by me during the course of research and that the thesis has not previously formed the basis for the award of any degree, diploma, associateship, fellowship or other similar title, of any other University or Society.

Vellayani,

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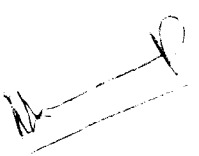
**JYOTHI. H.**

## CERTIFICATE

Certified that the thesis entitled "**Developing blended fruit product utilising stored Mango pulp**" is a record of research work done independently by **Miss. JYOTHI. H.** under my guidance and supervision, and that it has not previously formed the basis for the award of any degree, fellowship or associate-ship to her.



**Dr. (Mrs). MARY UKKURU. P.**
Chairman Advisory Committee
Associate Professor
Department of Home Science
College of Agriculture

Vellayani,
-12-1998

***APPROVED BY:***

**CHAIRMAN**

Dr. (Mrs.) Mary Ukkuru. P.
Associate Professor
Department of Home Science

**MEMBERS**

Dr. (Mrs.) L. Prema
Professor and Head
Department of Home Science

Dr. B.R. Reghunath
Associate Professor
Department of Horticulture

Dr. Sasikumar Nair
Professor
Department of Plant Pathology

***EXTERNAL EXAMINER***

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# INTRODUCTION

# INTRODUCTION

Mango is one of the choicest and most appreciated fruit owing to its aromatic flavour, delicious taste, attractive colour besides being good source of vitamins and minerals (Trippesha, 1997). It is considered as one of the Triphalas and attributed with several superb qualities and hence occupies a very important part in Hindu mythology and religious observances.

Mango is the most important commercial fruit of India. According to a production report of Indian Food Industry (1994) India's production of mangoes is around 10,000 MT which is equvalent to 54 per cent of the world production. In Kerala it is the second important fruit occupying an area of 75,000 ha with an annual production of 2,50,000 tonnes (Srinivas *et al* 1997).

Mango being a tropical climacteric fruit possess a very short shelf life of 3-4 days at ambient conditions and accounts for 17-36 per cent loss in the total production (Puttaraju and Reddy, 1997). The maximum percentage loss occurs in local mango varieties which contributes a major chunk in the total production. Sethi and Malini (1985) remarked that preservation of Inter mediate product of mango in the form of pulp helps in better utilization of fruit and makes this nutritious pulp available all round the year which is of much value to the mango processing industries. Hence the preservation of mangoes as pulp as well as in the processed form is of commercial importance.

Of all the operations used in the food industry drying is probably the most important one, as it is common to all sectors of food processing. Dehydration of fruits is of paramount importance, in order to reduce the spoilage occurring due to glut and poor post harvest handling. Although preservation is still the principle reason for dehydration, other key factors like greater concentration of nutrients in the dried form, reduction in the bulk and prolonged shelf life play an important role in this process. The overall demand and production of dehydrated fruits are increased from 39.38 crore rupees in 1988-89 to 131 crore rupees in 1992-93 (Indian Food Industry, 1994).

This particular study entitled "Developing blended fruit product utilising stored Mango pulp" is selected with due focus on the reduction of post harvest losses which is one of the serious bottle-neck for food processing industries and develop value added products which improves the export potential of the country.

The study is outlined with the following objectives.

1) To standardise the storage of Mango pulp in different conditions.

2) Standardisation and development of blended fruit product utilising the stored pulp.

# REVIEW OF LITERATURE

# REVIEW OF LITERATURE

The research work entitled 'Developing blended fruit product utilising stored mango pulp' is briefly reviewed under the following subtitles.

2.1 Importance of mango as a fruit for processing

2.2 Need for the storage of mango pulp

2.3 Effect of storage on mango pulp

2.4 Drying as a method for fruit processing

2.5 Organoleptic, shelf life and nutritional qualities of dried products on storage

## 2.1 Importance of mango as a fruit for processing

Mango is the most delicious and popular fruit of the tropical and subtropical India and neighbouring countries (Singh *et al.*, 1992).

Renjit Singh (1969) opined that mango occupies the same position in India as it is occupied by apple in temperate climates and grapes in subtropical areas. In area, of production, nutritive value and popularity no other fruit can compete with it.

Hicks (1990) had ascertained that mangoes are highly popular and the vast majority consume the fruit in the fresh

state. Indian Food Packer (1995) consider mango as a produce targetted for the ethnic consumer.

Singh (1960) stated that India alone occupies nearly 70 per cent of the total world area of cultivation under this fruit and exists immense scope for the bulk export to European and American Markets. Kalra *et al*. (1993) reported that India is the largest producer of mango fruit accounting for about 65 per cent share in the world produce.

Indian Food Industry (1996) pointed out that India produces nearly 9 million tonnes of mango annually, however its fresh fruit export hardly amounts to about 23,000 tonnes, valued at about Rs.43.87 crores.

Fruits are no longer considered as a luxury since they belong to an important class of protective foods which provide adequate vitamins and minerals needed for the maintenance of health (Deena and Mary, 1994).

The main constituents of mango are carbohydrate, organic acids, minerals and vitamins (Steaven and Philip, 1980).

According to Bhatnagar and Subramanyam (1973) mango is a good source of carbohydrate. According to Jain (1961) the sugars in mango comprise sucrose, glucose, fructose and maltose. Chaudhari and Farooqui (1969) had reported the

composition of the cultivars, - Sindhry, Bombay alphonso, Benganappalli and some seedling mangoes of sindh province, viz moisture 79.2 - 83 per cent, TSS 12.9 - 20.8 per cent, total sugars 10.0 - 17.3 per cent, non reducing sugars 7.27 - 12.35 per cent, ash content 0.49 - 0.58 per cent, and crude protein 0.38 - 0.62 per cent on fresh basis.

Palaniswamy *et al*. (1974) analysed 29 mango cultivars of Tamilnadu and found that the TSS ranged between 11.8 - 26.8 per cent, total sugar 7.09 - 17.20 per cent and titrable acidity between 0.14 - 0.58 per cent.

Mango is the richest natural source of carotene, which is a precursor of vitamin A. Gowda and Ramanjaneya (1994) opined that ripe mangoes are sweet, rich in provitamin A, moderate in vitamin C and small amounts of vitamin B group.

According to Bhatnagar and Subramanyam (1973) mango is considered to be the richest source of provitamin A and good source of vitamin C. As reported by Gopalan *et al*. (1977) the riboflavin and niacin content of ripe mangoes were 0.08, 0.09 mg/100g pulp respectively.

Singh (1960) opined that, from the nutritional point of view mango is a rich source of vitamin A almost as rich as butter. According to Jain (1961) small amounts of tannin is present in the flesh (0.16 per cent) and skin (0.105 per cent) which is responsible for astringency.

Gopalan *et al*. (1977) reported that the calcium, phosphorous and iron present in mango were equivalent to 14, 16 and 1.3 mg/100g pulp respectively. He further pointed out that Indian ripe mangoes contain small amounts of Magnesium, Sodium, Potassium, Copper, Sulphur and Chlorine.

Nadkarni (1963) reported that iron, calcium, and phosphorous contents of 16 mango cultivars of Tamilnadu ranged between 0.9 - 3.2 mg, 10-20 mg, and 10-30 mg/100g pulp respectively.

Thus a fruit which is packed with nutrients if utilised for processing will definitely be a boon to the farmers as well as to the consumers.

Hicks (1990) reported that mango is processed into pickles and chutneys; particularly in India. Neelima *et al*. (1993) reported that ripe mangoes are used for the preparation of canned slices, puree, nectar, juice concentrate and leather. Raw mango powder is used as a souring agent in kitchen preparations.

Siddappa and Renganna (1961) succeeded in developing strained baby foods, using mango pulp and found useful in milk diet for children. A report published by Beverage and Food world (1994) had revealed that unripe fruits are pickled, used for chutney and powder and ripe fruits are used for jams, jellies, murabha and squash.

Nanjundaswamy (1984) developed several dehydrated mango products such as mango-bars, or leather rolls, mango cereal flakes, mango custard powder, sweetened mango powder and strained baby foods etc.

A report published by Indian Food Packer (1985) indicated that Andra Pradesh is the leading state in India, producing more than 200 tonnes of mango leather per year.

## 2.2 Need for storage of mango pulp

Narayana (1989) has the opinion that mango being a tropial climacteric fruit possess a very short shelf life of 3 to 4 days at ambient condition once, ripening is initiated.

Garg and Ram (1973) stated that since mature mangoes are highly perishable in nature they hardly be stored for 6-7 days after harvest. According to Thakur *et al*. (1995) preservation of mango pulp is of commercial importance, because of its large scale off-season and its utilisation for the manufacture of multi variable processed products.

Eckert and Ogawa (1985) reported that ripe mango fruits have low intrinsic resistance to pathogen attack and hence get spoiled very easily.

Singh (1990) opined that in a good fruiting year, market may be glutted with the produce, resulting in a lot of

wastage as well as low price to the orchadist which will deny the farmers the fruit of their labour.

Hence intensified effort to post harvest preservation of mango fruit is highly essential to ensure fair returns to the growers and to improve their economic conditions (Shaw *et al*. 1993).

## 2.3 Effect of storage on mango pulp

Saucedo (1977) reported that refrigerated storage of mangoes seriously impaires its chemical constituents. According to Lakshminarayana (1977) mango is highly succeptable to chilling injury which is characterised by the higher acidity with the lower sugar content.

Mattoo and Modi (1969) and Chatpar and Modi (1974) studied the cause of chilling injury in alphonso mango and found a significant decrease in sugar content, less starch breakdown and ascorbic acid accumulation.

Sudhakar and Maini (1994) were of the opinion that B carotene in foods is easily destroyed during storage and therefore high stability of carotene in canned mango is of special interest to the food technologists.

Indian Food Packer (1985) reported that preheated mango pulp stored at -5±2°C showed a slight decrease in

titrable acidity, TSS and almost 50 per cent reduction in vitamin C content, while reducing and total sugars were not much affected during one year storage.

Renote *et al*. (1994) found that Dashehari mango pulp stored at ambient temperature showed negligible changes in acidity, total sugar, pH, ash and protein contents. However reducing sugars and browning increased during storage.

A study conducted by Sethi and Malini (1985) on mango pulp with different pretreatments such as 1000 ppm $SO_2$ alone and 500 ppm $SO_2$ and 500 ppm sodium benzoate had revealed that samples treated with $SO_2$ alone were found to help in retention of carotenoids during storage.

Sudhakar and Maini (1994) reported that heat processed Totapuri mango pulp with 250 and 500 ppm potassium metabisulphite stored for 4 months showed a gradual decrease in carotenoid pigments.

Thakur *et al*. (1995) opined that storage change in mango pulp was not influenced by the nature of acid used but was more influenced by the nature of packaging employed.

Bhatnagar and Subramanyam (1973) reported that mango pulp prepared from alphonso and pairi varieties with added sugar at 20 per cent level remained in good condition after 12 months of storage at -17°C. According to Dan and Adsule (1979)

sulphited mango pulp with 1000 ppm $SO_2$ was stored for a year in woodden barrel without any detectable deterioration in quality.

Sethi and Malini (1985) noticed that mango pulp preserved with $SO_2$ had good shelf life in glass bottles compared to PVC and HDPE pounches. According to Kalra and Tandon (1992) mango-papaya blended pulps with 1000 ppm $SO_2$ were stored well up to 12 months at ambient temperatures (15-37°C) without much change in acidity and TSS.

Narayana (1989) found that fresh mango pulp could be stored for 9 months without any detectable change in flavour and carotenoids. Thakur *et al*. (1995) opined that browning intensity of mango pulp increased with storage.

Ghosh *et al*. (1985) reported that pasteurised mango pulp in polypropylene pack had a shelf life of 3 months at 5°C and 2 months at 37°C. He further stated that mango pulp preserved with $SO_2$ retain a better quality and had a shelf life of 5 months at ambient temperature. Vijay Sethi (1995) found that amrapali mango pulp stored in glass and PVC containers showed better retention of flavour and carotenoids. The pulp showed a reduction in non enzymatic browning.

George and Mahadeviah (1989) were of the opinion that processed and packed mango juice retained ascorbic acid and B carotene during storage. Kalra *et al*. (1991) reported that

mango-papaya blended beverage showed no significant change in total soluble solids during storage. Teotia *et al*. (1992) found that Muskmelon-mango blended beverage stored at room temperature was acceptable upto 6 months.

## 2.4 Drying as a method for fruit processing

One of the simplest and widely practised technology for processing fruits and vegetables is drying (Riji and Mary, 1995). This method of preserving the food is also of strategic importance in meeting the defence needs over other methods due to its inherent logistic advantages and less energy and capital costs.

According to Goyal and Mathew (1990) sundrying is an age old method used for preserving food and is still in use in many parts of our country and in the world. 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 stabilise nutrient content as such in the processed foods (Maini *et al*. 1985).

Maini *et al*. (1982) stated that more fruits are preserved by drying than any other methods, as this method have major advantages of greater concentration of nutrients in dried form, production with minimal labour, less expensive and economic.

According to Mathur *et al*. (1972) dehydration of fresh fruits and vegetables got momentum during the IInd world war, when the advantages of the dehydrated food-stuffs like less volume, light weight and extended shelf life were realised. Peter *et al*. (1975) stated that dehydrated foods if stored under proper conditions will not spoil due to microbial attack for fairly extended periods of time.

Mathur (1989) opined that efficiency of drying method can be evaluated on the basis of retention of ascorbic acid, loss of moisture and time taken for drying. According to Singh (1990) dehydrated products like mango-leather, mango cereal blakes, and mango powder show great promise for export.

## 2.5 Organoleptic, shelf life and nutritional qualities of dried products on storage

Stability of the original quality of any product during storage is of paramount importance (Indian Food Packer, 1980).

Mango sheet or leather popularly called "ampapar" is an important dried product of commerce in certain mango growing areas of India (Indian Food Packer, 1980).

Nanjundaswamy *et al*. (1976) reported that mango bar prepared by Badami, Benganappalli and Totapuri varieties were considered to have high organoleptic qualities.

Heikal *et al*. (1972) improved the flavour and texture of the mango sheet by the addition of citric acid and pectin. Sagar and Khurdiya (1993) developed dehydrated ripe mango slices with improved solid contents and chewing characteristics.

Nanjundaswamy *et al*. (1976) opined that thicker the consistency of the pulp, the better is the texture of the final product. A report published by CFTRI (1978) stated that variety of the mango and consistancy of the pulp have definite impact on the quality of fruit bar.

Nanjundaswamy (1984) found that mango fruit bar prepared from Alphonso pulp was best in quality having good colour, texture and flavour. Mir and Nath (1993) reported that mango bars stored for 90 days, showed decreasing trend in overall acceptability but the textural changes were found to be minimum.

Mukhtha *et al*. (1992) found that dehydrated pineapple slices stored at room temperature were acceptable based on orgnoleptic qualities. According to Riji and Mary (1995) osmotically dehydrated pineapple slices were organoleptically acceptable for a period of 4 months.

Mohammed *et al*. (1993) developed pineapple candy which was orgnoleptically acceptable. Bindu and Mary (1995)

reported that osmotically dehydrated Jackfruit slices were highly acceptable for a period of 6 months with regard to organoleptic qualities.

Siddappa *et al*. (1968) reported the storage of fruit bars based on banana, guava and mango without any detectable deterioration in organoleptic qualities for 6 months. Seow *et al*. (1991) reported that properly processed fruit products kept well and remained acceptable for more than one year and organoleptically relished by judges.

Bose (1990) had pointed out that jackfruit bulbs can be utilised for making dried products such as fruit leather and thin Jack fruit papads. The products were found to have high organoleptic qualities. Jayaraman and Gupta (1991) standardised the preparation of dried papaya and jackfruit and they were found to be acceptable best in appearance, flavour and texture.

Seow *et al*. (1991) reported that partially dehydrated pomegranate fruits remained acceptable with regard to taste, texture, appearance, and flavour up to 3 months, after which fungal decay was found.

According to Singaravelu and Arumugam (1993) dehydrated sapota fruit flakes attained better scores with respect to quality attributes such as appearance, colour, texture and taste.

Satyaprakash and Susanta (1980) reported the storage of mango sheets of the cultivars viz. Baneshan, Bombaygreen and Dashehari and the products showed increase in acidity and reducing sugar with increase in storage temperature.

Amin and Bhatia (1962) found that dehydrated ripe mango slices with 15 per cent moisture, containing 1500 ppm of $SO_2$ was found to keep well for about 10 months at ambient storage conditions. Jayaraman (1993) standardised mango fruit bar with 13.4 per cent moisture and 1.70 acidity and the product was shelf stable up to 8 months.

According to Nanjundaswamy (1984) dehydrated ripe mango slices with 15 per cent moisture was found to keep well for about 10 months at ambient storage conditions. Mir and Nath (1993) reported that stored mango bars showed increase in reducing sugar but the deteriorative changes were minimum.

Usha and Anand (1981) prepared dehydrated green mango powder with 14.4 - 17.8 per cent acidity and 8.3 - 10.7 per cent reducing sugar. The product can be used as a base material for many preparations. Jasim and Chaudhary (1995) developed osmotically dehydrated papaya slices using soaking solution containing sucrose and potassium sorbate. The dried product remained acceptable up to 6 months at room temperature.

Satyaprakash and Susanta (1980) reported that the ideal moisture content required for storage stability in the

dried product was found to be 15 per cent or a little more with a relative humidity between 63-70 per cent. 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.

Salunkhe *et al*. (1973) found lesser loss of carotenoids from dehydrated vegetables. According to Tripathi *et al*. (1988) the TSS content of dehydrated amla remained unchanged during storage. Sheeja (1995) reported that TSS content of Karonda candy remained unchanged during storage.

Labuza and Salunkhe (1990) reported that minimum loss of ascorbic acid in sundried samples of vegetables after 3 months of storage. Mukhtha *et al*. (1982) found that the dehydrated pineapple slices stored at room temperature were acceptable based on chemical composition.

Pawar *et al*. (1985) reported that dehydrated onion flakes exhibited a progressive decrease in ascorbic acid, total sugars and reducing sugars during storage periods. Pruthi (1988) studied the role of vitamin C in the discolouration of processed products and has reported that there was 10-15 per cent loss of ascorbic acid during storage.

According to Anjela *et al*. (1987) dehydrated blueberry products had a shelf life of 16-64 months depending on the storage temperature. Riji and Mary (1995) reported that

osmotically dehydrated pineapple slices showed an increasing trend in reducing sugars and a decreasing trend in acidity, during 4 months of storage.

Nanjundaswamy,*et al*.(1978) developed dehydrated apple slices with 23.9 - 30.9 per cent reducing sugars and 59.5-66.6 per cent total sugars. CFTRI (1987) standardised papya fruit bar with 0.5 per cent citric acid and 0.3 per cent KMS and dried to 15 per cent moisture. The product remained well for about 8 months,

Bindu and Mary (1995) reported that osmtically dehydrated jackfruit slices with a shelf life of 6 months showed a slight increase in sugars and deep destruction in vitamin C.

According to Renganna (1968) canned guava stored at room temperature found to keep well for 6 months. Jellink (1985) observed that there was loss of ascorbic acid in the processed food products under the influence of atmospheric oxygen during storage. Tripathi *et al*. (1988) studied the various chemical changes related to processing in dehydrated amla. The loss in ascorbic acid content during processing and storage was very significant.

Deena and Mary (1994) standardised osmotically dehydrated banana slices, which showed a decrease in acidity and increase in reducing sugar during storage of 4 months.

# MATERIALS AND METHODS

# MATERIALS AND METHODS

The ultimate goal of the present study on 'Developing blended fruit product utilising stored mango pulp was to explore the suitability of locally grown Kottukonam mango variety for the development of blended fruit bars.

## 3.1 Fruit selection

Among various fruits cultivated in Kerala, mango was selected for this study because of the following reasons:-

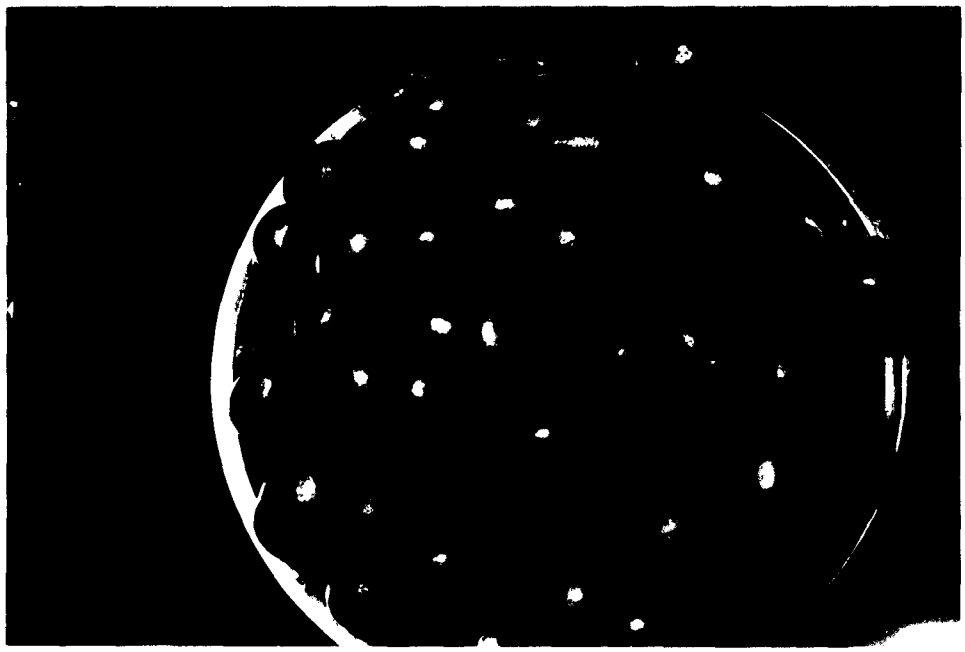
Among the various fruits cultivated, mango is in the top position with an annual production of about 10 million tonnes (Eipeson *et al*. 1992). And it is considered as the king of fruits.

Out of the total production of mangoes 17.1 - 36.7 per cent is lost due to inadequate post harvest facilities and processing opportunities (Indian Food Industry, 1994).

Chadha (1995) reported that mango fruit is important from the processing point of view since they are rich in vitamins and minerals.

Mango is relished for its succulence, exotic flavour, and delicious taste and has considerable export potential both in its processed and raw forms (Indian Food Packer, 1995).

PLATE 1



KOTTUKONAM MANGO

Pruthi (1992) pointed out that mango fruit can be blended well with other fruits. Hence more value added products can be prepared out of it.

Mango fruit processing would not only avoid the huge wastage of the produce but would also go a long way in improving the employment potential for the local people and contribute to the overall progress of the region.

No systematic data is now available on the chemical composition of the locally grown mango varieties and their suitability for processing. Local varieties contribute a major chunk in the total production of mangoes. Considering the above facts Kottukonam variety grown in and around Trivandrum district was selected for the present study.

The study was carried out as two experiments. The first experiment was to explore the possibility of the storage of mango pulp under different treatments using two types of containers.

**EXPERIMENT I**

## 3.2 Assessment of physico chemical and organoleptic characteristics of the fruit

Physical characteristics like shape of the fruit, fruit weight, colour of the outerskin, stone weight and pulp

yield were recorded. Various chemical parameters and nutrients analysed are listed below.

### 3.2.1 Reducing sugar

Reducing sugar was analysed by the method suggested by Krishnaveni and Sadasivam, 1984.

### 3.2.2 Total sugar

Total sugar was analysed by the procedure suggested by AOAC 1960.

### 3.2.3 Acidity

Acidity was estimated by the procedure suggested by Renganna, 1984.

### 3.2.4 Total soluble solids

Total soluble solids was estimated by the method suggested by Renganna, 1977.

### 3.2.5 pH

pH was determined by the method suggested by Renganna 1984.

### 3.2.6 Vitamin C

Vitamin C content was determined by using the method suggested by Sadasivam *et al*. 1984.

The organoleptic qualities of mango such as colour of the flesh, texture, and consistency and fleshiness of the pulp were assessed.

### 3.3 Selection of storage media

Kalra *et al*. (1991) reported that mango cultivars viz. Totapuri, Benganappalli, Dashehari and Chausa with papaya blends were preserved for 1 year in glass bottles under ambient conditions. According to Singh *et al*. (1995) glass bottles were found to be more suitable than PVC bottles for longterm storage.

Renote *et al*. (1992) had observed that glass containers are better tolerated than metallic pounches for storing kinnow RTS since the former was superior in sensory quality. Singh *et al*. (1995) has the opinion that PVC bottles may go a long way in the distribution for short periods of storage with the added advantage like, light weight, nonfragility and easy handling.

In the light of the above findings, for the present study, glass and PVC containers were selected for pulp storage.

### 3.4 Storage of mango pulp by different pre-treatments

Any treatment given before processing are generally considered as pre-treatments. Pretreatments are used to enhance the quality and shelf life of the product.

According to Clydesdale (1979) potassium metabisulphite is the most commonly used preservative as the source of sulphur dioxide. It prevents enzymatic browning, unwanted microbial growth, and produces a mild bleaching action also. Perlette (1992) found that sulphur dioxide improved the colour of grape juice during storage.

Arya (1997) opined that sulphur dioxide was observed to have some technological functions such as protection against oxidative, enzymic and nonenzymic browning reactions and inhibition of chemically induced colour and vitamin losses.

Pearson (1973) found that citric acid retard the microbial growth during storage of mango jam.

For the present study potassium metabisulphite, sodium benzoate, and citric acid was selected as preservatives and the different levels of their combinations were the pretreatments applied.

Clydesdale (1979) found that sodium benzoate added to dark colour fruit juices retain the colour during storage.

Table 1 Pretreatments selected for the study

| Treatments | Level of preservatives used |
|---|---|
| $T_1$ | Pulp with 0.1 per cent potassium metabisulphite |
| $T_2$ | Pulp with 0.05 per cent potassium metabisulphite and 0.05 per cent sodium benzoate |
| $T_3$ | Pulp with 0.1 per cent potassium metabisulphite and 1.0 per cent citric acid |
| $T_4$ | Plain pulp |

Fresh mango pulp was extracted using a pulper. 20 per cent sugar was added to the mango pulp and heated up to 65-80°C for 20 minutes to ensure microbial safety. The prepared pulp was stored in glass and PVC containers after subjecting to the pretreatments.

### 3.5 Assessing the chemical and shelf life qualities of the stored mango pulp

The chemical characteristics like reducing sugar, total sugar, acidity, pH, TSS and vitamin C were analysed in the treated and stored pulp. The shelf life of the stored pulp was assessed based on the changes in sensory qualities and also on the basis of occurance of microbial growth in the pulp.

**EXPERIMENT II**

The pulp which proved to have maximum shelf stability was selected for the second experiment. The second experiment was aimed to develop blended mango bars utilising the best stored pulp.

### 3.6 Fruit selection for blending purpose

Kalra *et al*. (1991) reported that papaya fruit blend very well with mango for the preparation of beverages. According to Gopalan *et al*. (1992) regular consumption of papaya will ensure a good supply of vitamin A and vitamin C which are essential for good health. Besides, papaya fruit possess certain characteristics such as uniformity in colour, appeal and is available in plenty at relatively low cost.

Considering all the above facts papaya fruit was selected for blending with mango pulp for the preparation of fruit bars in the present study.

### 3.7 Preparation of blended fruit bars

Uniformly ripened papaya fruit was selected and the pulp was prepared using a pulper. The best stored mango pulp was blended with papaya pulp in three proportions viz. 1:1 (B1), 2:1 (B2) and 3:1 (B3) (mango-papaya). This was then

spread on steel trays with 4 cm thickness and covered with a nylon net, inorder to prevent insect attack and avoid flies. The spread out pulp was dried till an optimum moisture level (below 10 per cent) is obtained. Bar prepared using the plain pulp serves as the control (B4). After drying the products were packed using polypropylene covers, sealed and kept for storage studies.

### 3.8 Assessing the organoletic, chemical and microbial contamination of the blended fruit bars

Organoleptic evaluation of the products were carried out by selecting 10 subjects randomly. The products were evaluated periodically based on quality attributes viz, appearance, colour, flavour, taste and texture upto 6 months. Scores were assigned for each quality parameter ranging from 1-4. Evaluation card for organoleptic qualities is presented in the appendix (I).

Chemical characteristics such as reducing sugar, total sugar, acidity, TSS, pH and vitamin C were assessed in the products soon after drying and thereafter periodically till 6 months.

The contamination of the product with microbes were analysed by examining under the microscope.

### 3.9 Assessing the consumer preference of the products

The acceptability of the product is determined by consumer testing as reported by Elezabath (1993). Consumer preference of the products was assessed with the help of suitable score cards which were served to 25 randomly selected consumers. Quality attributes assessed were appearance, colour, flavour, taste and texture.

### 3.10 Cost benefit analysis

Cost of the product was analysed taking into account of the expenditures incurred on food materials, namely mango, papaya sugar along with overhead charges labour cost etc.

### 3.11 Statistical analysis

The experimental data were analysed by applying the technique of analysis of variance using 2 factor CRD in split plot design suggested by Panse and Sukhatme (1995).

# RESULTS AND DISCUSSION

# RESULTS AND DISCUSSION

Major findings of the study entitled "Developing blended fruit product utilising stored mango pulp" are presented and discussed under the following headings.

**EXPERIMENT I**

4.1. Assessment of physical, chemical and organoleptic characteristics of mango and its pulp.

4.2 Changes in chemical components of mango pulp during storage.

4.3 Impact of containers on the storage stability of mango pulp.

**EXPERIMENT II**

4.4 Assessment of drying characteristics, chemical and organoleptic qualities of mango bars.

4.5 Assessment of consumer preference of the products.

4.6 Assessment of microbial contamination of the products.

4.7 Cost benefit analysis of the mango bars.

## EXPERIMENT I

### 4.1 Assessment of physical, chemical and organoleptic characteristics of mango and its pulp

The physical characteristics of the mango cultivar (Kottukonam) was assessed to understand the fruit nature so that it could be easily identified. The major physical characteristics assessed were shape of the fruit, fruit weight, colour of the outerskin, stone weight and pulp yield.

The selected mango variety Kottukonam was observed to have an oblong shape. The average fruit weight of the mango variety Kottukonam was found to be 204.5 g. Palaniswamy *et al.* (1974) found that average mango fruit weight ranged between 101 g to 670 g. Irene and Mary (1997) in their analytical study on different mango cultivars observed the average fruit weight of Kottukonam variety as 237.9 g. Seasonal variations are likely to occur in the fruit weight.

Depending on the cultivar, a wide range of variations are seen to exist in the colour of the outer skin of the fruits. The variety Kottukonam was observed to have an orangish yellow colour for its outerskin.

The stone weight of mango was observed to be 35.85g. In the present study the pulp yield of the mango was found to be 74.3 per cent. Pulp yield is an important factor to be considered as far as product development is concerned. Palaniswamy *et al*. (1974) found that the pulp yield of different mango cultivars of Tamilnadu ranged between 53 to 83 per cent.

Rao, *et al*. (1989) had pointed out that fruits are the richest source of essential nutrients like vitamin C and B carotene whose intake in majority of our population are already below adequate levels. According to Manson (1994) the people who eat more fruits have 54 per cent lower risk of getting heart strock, when compared with those who eat the least. Hence fruits are considered to have a high dietary importance as far as the food stuffs are concerned.

In the present study, the chemical components present in the fresh Kottukonam mango and the extracted pulp were assessed with regard to its reducing sugar, total sugar, acidity, TSS, pH and vitamin C.

As indicated in Table 2 (Fig. 1) the reducing sugar content of fresh Kottukonam mango variety was 4.5 per cent. Lakshminarayana (1980) screened different mango varieties and found that the reducing sugar content ranged between 3.23 - 6.00 per cent. Irene and Mary (1997) observed the reducing

sugar content of fresh Kottukonam mango variety as 6.7 per cent. The variation observed in reducing content might be due to seasonal and environmental factors that affected fruit maturity and ripening.

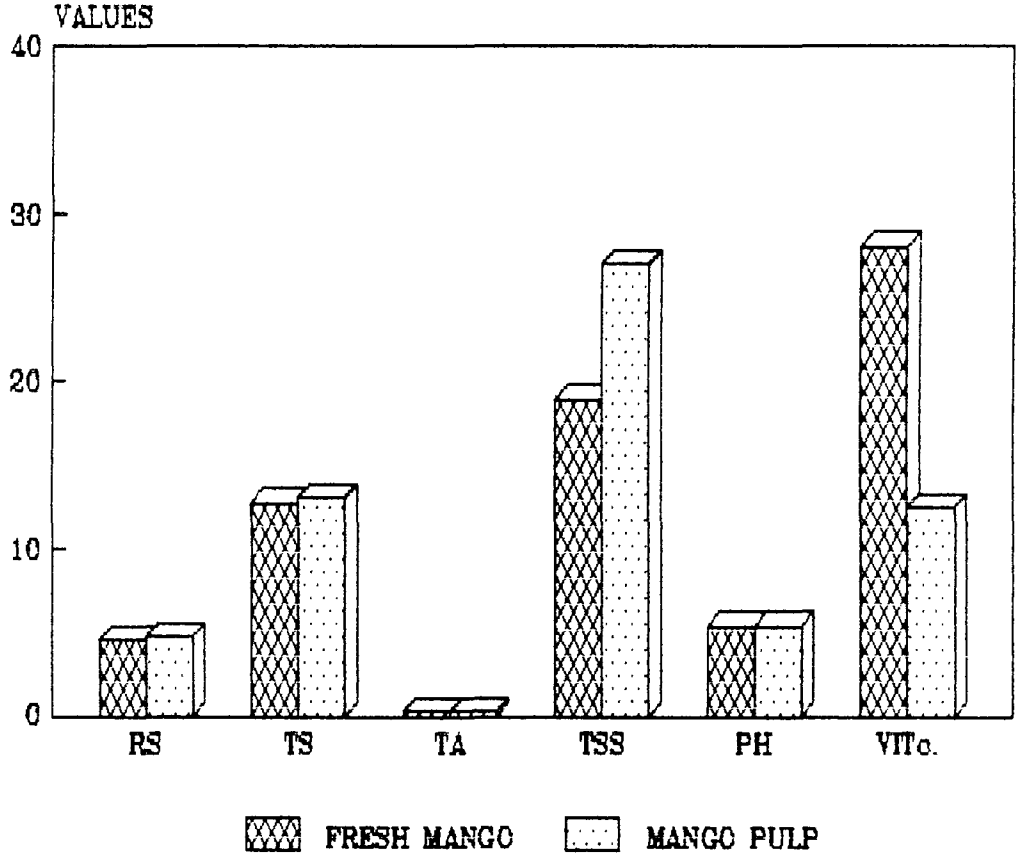
The reducing sugar content of mango pulp was found to be 4.8 per cent. Sudhakar and Maini (1994) reported that the Totapuri mango pulp contain 5.1 per cent reducing sugar.

It was observed that the total sugar content of fresh mango was 12.8 per cent and that of mango pulp was 13.1 per cent. The pulp was prepared by adding 20 per cent sugar in order to improve its quality, which was reflected in the slight increase in total sugar content of pulp. Chaudhary and Farooqui (1969) had reported that the total sugar content of 4 different mango cultivars ranged between 10.0 to 17.3 per cent. Irene and Mary (1997) reported the total sugar content of fresh Kottukonam mango as 14.75 per cent, Whereas Sudhakar and Maini (1994) observed the total sugar content of Totapuri mango pulp as 13.5 per cent.

Table 2 Chemical components present in fresh mango and mango pulp

| | Reducing sugar | Total sugar | Titrable acidity | TSS | pH | Vitamin C |
|---|---|---|---|---|---|---|
| Fresh mango | 4.5 | 12.8 | 0.256 | 19 | 5.4 | 28.13 |
| Mango pulp | 4.3 | 13.1 | 0.256 | 27 | 5.4 | 12.45 |

# FIG. 1. CHEMICAL COMPONENTS PRESENT IN FRESH MANGO AND MANGO PULP




RS - REDUCING SUGAR

TS - TOTAL SUGAR

TA - TITRABLE ACIDITY

TSS - TOTAL SOLUBLE SOLIDS

VITc - VITAMIN C

The titrable acidity of the fresh mango as well as that of mango pulp was found to be 0.256. Irene and Mary (1997) observed the titrable acidity of Kottukonam mango as 0.22.

The total soluble solids present in the Kottukonam variety was found to be 19°Brix, while, that of mango pulp was 27°Brix. Chaudhari and Farooqui (1969) reported that the TSS content of 4 different mango varieties ranged between 12.9 to 20.8 per cent. According to Irene and Mary (1997) the TSS content of fresh Kottukonam mango was 19.90°Brix. The higher value observed for TSS content of mango pulp was due to the addition of sugar.

The pH of both fresh mango and the mango pulp was recorded as 5.4 Steaven and Philip (1980) analysed the pH of some varieties of mango and found to range between 3.8 to 5.8. Sudhakar and Maini (1994) had reported the pH of Totapuri mango pulp as 5.0.

Apart from the above components vitamin C content of the mango and pulp was also analysed. Fresh mango observed to have 28.13 mg/100g of vitamin C. Palaniswamy *et al*. (1974) analysed vitamin C content of 29 cultivars of mango and found that it varied from 3.2 to 62.9 mg/100g of pulp. Irene and Mary (1997) observed the vitamin C content of fresh Kottukonam mango as 28.20 mg/100g pulp. The mango pulp was found to have

lesser vitamin C content, (12.45 mg/100 g pulp). Depletion of vitamin C occurs as a result of the heat treatment and that was the reason for the lower vitamin C content in the processed mango pulp. According to Nath and Gupta (1984) a significant destruction of vitamin C was observed in heat treated fruits.

Considering the organoleptic qualities of the variety, Kottukonam had a dark orange coloured flesh and was observed to be moderately fleshy. This variety is slightly fibrous and observed to have thick pulp, mildly flavoured and moderately sweet.

It can be concluded that, chemical components present in mango fruit varies with the cultivar and difference were also observed in the same variety grown in different seasons and regions. In the present study slight variation in chemical components were observed in fresh mango as well as in the extracted pulp particularly in reducing sugar, total sugar, TSS and vitamin C.

## 4.2 Changes in chemical components of mango pulp during storage

Periodical assessment with regard to chemical components was carried out, the results of which are presented in the following tables. Plain mango pulp without any

treatment got spoiled after 13-14 days and hence further analysis was carried out in the treated pulp only.

### 4.2.1 Changes in reducing sugar content of mango pulp during storage

Table (3) picturise the reducing sugar content of mango pulp under three preservative treatments during storage.

As indicated in the table the reducing sugar content increased from 4.77 to 5.47 per cent in treatment T1, 4.23 to 5.26 per cent in T2 and 5.05 to 5.5 per cent in T3. The percentage increase was found to be highest (16 per cent) in $T_2$ while that of T3 was the least (8.2 per cent).

Table 3 Changes in reducing sugar content of mango pulp during storage

| Treatments | Reducing sugar content g/100g<br>Storage period in months | | | Treatment Means |
|---|---|---|---|---|
| | 1 | 2 | 3 | |
| T1 (0.1% KMS) | 4.77 | 5.00 | 5.47 | 5.08 |
| T2 (0.05% KMS 0.05% sodium benzoate) | 4.23 | 4.38 | 5.26 | 4.62 |
| T3 (0.1% KMS 1% citric acid) | 5.05 | 5.31 | 5.50 | 5.29 |
| F - $7.51^{**}$ | | | | F - $68.03^{**}$ |
| SE - 0.078 | | | | SE - 0.041 |
| CD - 0.242 | | | | CD - 0.143 |

A significant difference existed in the reducing sugar content of the mango pulp, subjected to different treatments during storage.

On comparing the CD values it was observed that in the treatment T1 and T2 a significant difference was observed between 2nd and 3rd month but during 1st and 2nd month the reducing sugar content was on par both in T1 and T2. In contrast, in T3 a significant difference was observed between 1st and 2nd month.

In support of the above result Kalra and Revathi (1981) reported an increase in reducing sugar in guava pulp during storage. Shantakrishnamurthy and Gopalakrishna Rao (1982) reported an increase in reducing sugar in mango pulp during 12 months of storage. Similarly an increase in reducing sugar during storage was reported in mango pulp by Kalra and Tandon (1985). Saini and Dharmpal (1997) opined that the increase in reducing sugars was due to the gradual inversion of non reducing sugars.

A significant difference was also observed in differently treated pulp with respect to reducing sugar content. Comparison with CD values showed that all the treatments differ significantly each other. Treatment T3 observed to have the highest reducing sugar. This is well explained by Aruna *et al*. (1997) who opined that the significant increase in reducing

sugars might be due to the hydrolysis of sugars by acid as in T3 which might have resulted in degradation of disaccharides to monosaccharides.

### 4.2.2 Changes in total sugar content of mango pulp during storage

The changes in total sugar content of the stored mango pulp is presented in Table (4).

The total sugar content of the mango pulp in treatment T1 was observed to increase from 13.05 to 13.93 per cent. In T2 and T3 also the total sugar content increased from 11.79 to 13.14 and 13.96 to 14.56 per cent respectively.

Results indicated negligible difference in total sugar during storage. Kalra and Tandon (1985) reported an increase in total sugars in mango pulp stored under ambient conditions.

Sethi (1985) reported that litchi pulp during 6 months of storage showed an increasing trend in total sugar. Manan *et al*. (1982) observed an increase in total sugar in apricot pulp during 9 months of storage.

Statistical analysis revealed that a significant difference in total sugar content between the treatments on comparing the CD values, it was observed that all the three

treatments differ significantly each other in total sugar content. The treatment T3 had the highest total sugar content, the reason being the same as reported by Aruna *et al*. (1997).

Table 4 Changes in total sugar content of during storage of mango pulp

| Treatments | Total sugar content g/100g | | | Treatment Means |
|---|---|---|---|---|
| | Storage period in months | | | |
| | 1 | 2 | 3 | |
| T1 | 13.05 | 13.47 | 13.93 | 13.48 |
| T2 | 11.79 | 12.61 | 13.14 | 12.52 |
| T3 | 13.96 | 14.07 | 14.56 | 14.19 |
| F - 1.196 NS<br>SE - 0.193 | | | | F - 87.838**<br>SE - 0.089<br>CD - 0.311 |

**4.2.3 Changes in acidity content of mango pulp during storage**

The changes in acidity in the stored mango pulp is depicted in Table (5).

The titrable acidity during storage ranged between 0.43 - 0.47 in T1, 0.40 - 0.46 in T2 and 0.49 - 0.53 in T3. Statistical analysis found a negligible difference in acidity during storage. According to Shah and Bains (1992) peach and apricot pulp stored for 24 weeks showed negligible changes in acidity.

Table 5 Changes in acidity content of mango pulp during storage

| Treatments | Acidity content (citric acid) g/100g | | | Treatment means |
|---|---|---|---|---|
| | Storage period in months | | | |
| | 1 | 2 | 3 | |
| T1 | 0.43 | 0.43 | 0.47 | 0.441 |
| T2 | 0.40 | 0.41 | 0.46 | 0.412 |
| T3 | 0.49 | 0.51 | 0.53 | 0.512 |
| F - 0.147 NS | | | | F - 11.168** |
| SE - 0.022 | | | | SE - 0.015 |
| | | | | CD - 0.053 |

Studies conducted by Sethi (1985) found an increase in acidity during storage of litchi pulp.

Shantakrishnamurthy and Gopalakrishna Rao (1982) reported an increase in acidity during storage of mango pulp. In contract Salunkhe and Desai (1984) reported that acidity decreased with the advancement of storage period in fruits.

Considering the preservative treatments on acidity content a significant difference was observed. Comparison with CD values showed that the treatment T2 and T3 were significantly different, but T1 and T2 and T1 and T3 were on par. The highest acidity content was observed in T3. This might be due to the addition of citric acid while stored.

### 4.2.4 Changes in TSS content of mango pulp during storage

The total soluble solids of the mango pulp was analysed periodically and the values obtained are presented in Table (6).

Table 6 Changes in TSS content on mango pulp during storage

| Treatments | TSS content - °Brix | | | Treatment Means |
|---|---|---|---|---|
| | Storage period in months | | | |
| | 1 | 2 | 3 | |
| T1 | 27 | 29 | 29 | 28.33 |
| T2 | 28 | 31 | 31 | 30.00 |
| T3 | 28 | 31 | 31 | 30.00 |
| F - 1.701NS | | | | F - 1.704 NS |
| SE - 0.011 | | | | SE - 0.012 |

The TSS content of the mango pulp in T1 was 27°Brix during first month while that of T2 and T3 was 28°Brix. A slight increase was noted after first month, after which the values remained constant in all the treatments. Statistical analysis indicated no significant difference in TSS content of mango pulp during storage.

In contrast to the above finding Sethi and Malini (1985) reported slight increase in TSS content during storage of mango pulp. Christafaro (1990) also observed a slight increase in

TSS during storage of apple fruit juice. However Renote *et al*. (1992) observed negligible change in TSS during storage of kinnow juice.

Statistical analysis revealed that no significant difference in TSS content between the treatments.

### 4.2.5 Changes in pH of mango pulp during storage

As indicated in the Table (7) the pH of the mango pulp ranged from 3.96 to 3.90 in T1, 3.95 to 3.90 in T2 and 2.88 to 2.80 in T3 during storage.

A significant difference was observed in pH between the treatments and storage period. pH of the mango pulp showed a linear decrease during storage. On comparing the CD values it was observed that a significant difference was observed between 1st and 2nd month in all the treatments. The decrease in pH is attributed to increase in acidity, as observed earlier. The acidity and pH had an indirect effect on each other.

Sethi (1985) reported a decrease in pH during storage of litchi pulp. Thirumaran *et al*. (1990) reported a decrease in pH during storage of tomato concentrate. Negligible to slight changes in pH was reported by Renote *et al*. (1993) in kinnow juice during storage. In contrast Manan *et al*. (1982) found an increase in pH during storage of Apricot pulp.

Table 7 Changes in pH of mango pulp during storage

| Treatments | pH content | | | Treatment Means |
|---|---|---|---|---|
| | Storage period in months | | | |
| | 1 | 2 | 3 | |
| T1 | 3.96 | 3.90 | 3.90 | 3.92 |
| T2 | 3.95 | 3.90 | 3.90 | 3.92 |
| T3 | 2.88 | 2.80 | 2.80 | 2.83 |
| F - 10.5** | | | | F - 140.439** |
| SE - 0.0029 | | | | SE - 0.0016 |
| CD - 0.0089 | | | | CD - 0.005 |

Considering the preservative treatments, a significant difference was observed in between the treatments with regard to pH. A significant difference was observed between T2, T3 and T1 and T3 but T1 and T2 were on par. pH content was lowest in the treatment T3.

### 4.2.6 Changes in vitamin C content of mango pulp during storage

As indicated in the Table (8) the vitamin C content of the treatment T1 decreased from 13.83 to 9.68, from 12.45 to 9.10 in T2 and 12.45 to 8.30 in T3.

Statistical analysis revealed that a significant difference was existed in the vitamin C content of the mango

pulp subjected to different treatments with regard to storage period. On comparing the CD values it was observed that all the treatments during 1st, 2nd and 3rd month were significantly different, except in the treatment T2 during 1st and 2nd month.

Table 8 Changes in vitamin C content of mango pulp during storage

| Treatments | Vitamin C content mg/100g. Storage period in months | | | Treatment Means |
|---|---|---|---|---|
| | 1 | 2 | 3 | |
| T1 | 13.83 | 11.29 | 9.68 | 11.60 |
| T2 | 12.45 | 11.29 | 9.10 | 10.95 |
| T3 | 12.45 | 10.71 | 8.30 | 10.49 |
| F - 1.123NS | | | | F - 0.646 NS |
| SE - 0.359 | | | | SE - 0.696 |

The vitamin C content of the pulp decreased gradually during storage. This finding was supported by Balakrishnan *et al.* (1974). Salunkhe and Desai (1984) found a decrease in vitamin C during storage of fruits.

Sethi (1985) reported a decrease in Vitamin C content during the storage of litchi pulp. According to Sethi and Malini (1985) a decrease in vitamin C was observed in mango pulp during storage. However no significant difference was observed in between treatments with regard to vitamin C content.

Thus it can be inferred that the reducing sugar, total sugar and acidity of all the 3 treatments increased with storage, while pH and vitamin C contents of all the treatments showed a decreasing trend in stored mango pulp.

### 4.3 Impact of containers on the storage stability of mango pulp

#### 4.3.1 Comparison of glass and PVC container for the storage of mango pulp

Impact of containers on storage stability of mango pulp was studied and the result revealed significant difference in the shelf life of mango pulp stored in glass and PVC containers irrespective of the preservative treatments.

As indicated in Table (9) the treated mango pulp stored in glass containers were in good condition for 49 days while in PVC containers it stayed stable only for lesser days. Thus it can be inferred that glass containers are superior to PVC containers for the storage of mango pulp.

Table 9 Comparison of glass and PVC container for the storage of mango pulp

| Glass container | PVC container |
|---|---|
| 49 days | 47 days |
| F - 14.66** | SE - 0.338 |
| CD - 0.717 | |

Vijay Sethi (1995) observed that glass bottles were found to be more suitable than PVC bottles for the storage of mango pulp. She further opined that the increaed shelf life in glass bottles was due to the nonpermeability of glass containers which helped in better retention of $SO_2$ for preserving pulp.

Kalra and Revathi (1981) also supported the above finding. They found that guava pulp stored in glass bottles had more shelf life than PVC bottles. Sethi and Malini (1991) noticed that mango pulp kept for storage studies had good shelf life in glass bottles compared to PVC as well as HDPE pounches.

### 4.3.2 Effect of preservative treatments on storage of mango pulp

Table (10) elucidates the effect of preservative treatments on storage of mango pulp, irrespective of the containers. The mango pulp under different preservative treatments remained shelf stable for 14-96 days. A significant difference was observed in between the treatments with regard to shelf life.

Table 10 Effect of treatments on storage of mango pulp

| Treatments | Means |
|---|---|
| T1 | 36 days |
| T2 | 45 days |
| T3 | 96 days |
| T4 | 14 days |

F - 5285.29**

SE - 0.478

CD - 1.014

The shelf stability of the mango pulp was highest in Treatment $T_3$ (96 days) in which 0.1 per cent KMS and 1 per cent citric acid was used, followed by the one treated with 0.05 per cent KMS and 0.05 per cent sodium benzoate (shelf stability - 45 days).

The treatment T1 (0.1 per cent KMS) was found to be less shelf stable (36 days) while the control sample got spoiled after a period of 14 days. Results confirmed that the preservative treatment had a direct and significant impact on the shelf stability of the stored pulp. The treatment with 0.1 per cent KMS and 1 per cent citric acid proved to be the best and can be recommended for higher shelf stability.

Vijay Sethi (1995) reported that mango pulp with 500 ppm $SO_2$ could be stored for 8-9 months at ambient temperature.

She further reported that pulp stored at lower temperature could be stored for 10-12 months without any detectable deterioration.

Table (11) shows the interaction effect of preservative treatments and containers on the stored mango pulp.

As indicated in the table all the preservative treatments except $T_2$ and $T_4$ had the same shelf life in both glass and PVC containers ($T_1$ - 36 days and $T_3$ - 36 days).

Table 11 Preservative treatments and container interaction during storage

| Treatments | Glass container | PVC container |
|---|---|---|
| T1 | 36 days | 36 days |
| T2 | 49 days | 41 days |
| T3 | 96 days | 96 days |
| T4 | 13 days | 14 days |

F - 18.546**

SE - 0.677

CD - 1.435

On comparing with CD values, a significant difference was observed in the treatments T2 and T4 in glass and PVC containers. The treatment T2 in glass container was shelf stable upto 49 days while in PVC it was stayed only 41 days. The treatment T4 in glass and PVC containers had a storage life of 13 days and 14 days respectively.

Thus as per the above results we can come to the conclusion that the mango pulp stored in glass containers were more shelf stable when compared with storage of pulp in PVC containers. Among the different pretreatments applied KMS along with citric acid was found to be the most effective preservative treatment.

**EXPERIMENT II**

## 4.4 Assessment of drying characteristics, chemical and organoleptic qualities of mango bars

### 4.4.1 Drying characteristics of mango bars

Out of the stored pulp which was organoleptically acceptable and had the longest shelf life ($T_3$) was utilised for product development. The mango pulp was blended with papaya pulp in different proportions and dried under sun.

Drying characteristics of the prepared mango bars were determined and is presented in Table (12).

According to Garg and Ashok (1989) the most important factor which determines the extent of deterioration in dried products is the moisture content of the final product.

Orejana *et al*. (1984) stressed the need for keeping the moisture level of the dried products below 10 per cent to ensure prolonged shelf life. In the present study all the

treated products had a moisture content below 10 per cent. The moisture content of 1:1 mango papaya bar was 8.8 per cent with a weight loss of 68 per cent. The 2:1 mango papaya bar was found to have a moisture content of 9.0 per cent and the weight loss was found to be 65 per cent.

Table 12 Effect of temperature, relative humidity and time taken on the moisture content and weight loss of the mango bars

| Products | Average temperature °C | Relative humidity (%) | Time taken (h) | Moisture % | | Initial wt. (g) | Final wt. (g) | Weight loss (%) |
|---|---|---|---|---|---|---|---|---|
| | | | | Fresh | Dried | | | |
| 1:1 mango papaya bar (B1) | 31.4 | 76 | 53 | 80 | 8.8 | 900 | 288 | 68 |
| 2:1 mango papaya bar (B2) | 31.4 | 76 | 45 | 78 | 9.0 | 900 | 315 | 65 |
| 3:1 mango papaya bar (B3) | 31.4 | 76 | 41 | 77 | 9.2 | 900 | 330 | 63 |
| Plain mango bar (B4) | 31.4 | 76 | 40 | 75 | 9.3 | 900 | 342 | 62 |

The moisture content of 3:1 mango-papaya bar was 9.2 per cent and the weight loss was 63 per cent. The plain mango bar was found to have slightly high moisture content (9.3 per cent) and a minimum weight loss was observed (62 per cent).

From the table it is clear that papaya blended fruit bars take more time for drying than the plain mango bar. This is due to the excessive amounts of water present in papaya. 1:1 mango papaya was found to take the maximum time for drying (53 hours) followed by 2:1 mango papaya bar (45 hours), 3:1 mango papaya bar (41 hours) and plain mango alone bar (40 hours).

Riji and Mary (1995) reported the moisture content of dehydrated pineapple slices as 9.05 and 9.08 respectively in solar dried and sun dried samples.

Bindu and Mary (1995) reported the moisture content of dried jack fruit bulbs ranged between 9.0 to 9.6 per cent in soft flesh variety and 8.7 to 9.6 per cent in firm flesh variety.

Mudambi (1991) had the opinion that temperature and relative humidity has less or negligible control on sun drying. The present study indicate that atmospheric temperature and relative humidity does not have much impact on the difference in moisture content, and weight loss of the dried mango bars, but it influenced the time taken for drying.

### 4.4.2 Changes in the chemical components of mango bars during storage

#### 4.4.2.1 Changes in reducing sugar content of mango bars during storage

The chemical components present in mango bars such as reducing sugar, total sugar, acidity, TSS, pH and Vitamin C were analysed.

The Table (13) shows the effect of reducing sugar content of mango bars during storage. The reducing sugar content of the product B1 ranged between 26.79 to 28.86 per cent during storage. The reducing sugar content of B2, B3 and B4 were 30.72 - 32.02, 26.79 - 31.25, 27.83 - 33.00 per cent respectively. Results proved that changes in the reducing sugar content of the mango bars during storage was not significant, still showed an increasing trend. Till 3rd month of storage, the reducing sugar content of the mango bars remained same but later, it showed a linear increase.

This study proved right with the findings of Das (1986) who reported that during drying the amount of reducing sugars increases. The increase in reducing sugars was due to the gradual inversion of non reducing sugars as reported by Saini and Dharmpal (1997). Aruna *et al*. (1997) also reported the same. Increase in reducing sugar during storage was

reported by many food technicians and scientists. Pawar *et al*. (1985), Thirumaran *et al*. (1986) reported increase in reducing sugar during storage of dehydrated jackfruit products.

Mir and Nath (1993) found that the reducing sugar content of the mango bars increased significantly during storage of 90 days.

Riji and Mary (1995) also reported an increase in reducing sugar during storage of dehydrated pineapple slices.

The results of the present study revealed a significant difference in reducing sugar between the differently treated mango bars. The highest reducing sugar content was observed in 2:1 mango papaya bar (B2) and the least in 1:1 mango papaya Bar (B1).

Table 13 Reducing sugar content of mango bars during storage

| Products | Reducing sugar g/100g. Storage period in months | | | | | | Treatment means |
|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | |
| B1 1:1 | 26.79 | 26.79 | 26.79 | 27.28 | 27.28 | 28.86 | 27.29 |
| B2 2:1 | 30.72 | 30.72 | 30.72 | 31.25 | 31.33 | 32.02 | 31.12 |
| B3 3:1 | 26.79 | 26.79 | 26.79 | 29.48 | 29.48 | 31.25 | 28.43 |
| B4 (Control) | 27.83 | 27.83 | 29.41 | 29.48 | 31.94 | 33.00 | 29.91 |
| F - 1.87 NS | | | | | | F - 19.94** | |
| SE - 0.646 | | | | | | SE - 0.370 | |
| | | | | | | CD - 1.209 | |

### 4.4.2.2 Changes in total sugar content of mango bars during storage

The Table (14) depicts the changes in total sugar of mango bars during storage.

Table 22 Total sugar content of mango bars during storage

| Products | Total sugar g/100g. Storage period in months | | | | | | Treatment means |
|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | |
| B1 | 32.64 | 34.92 | 34.92 | 37.54 | 37.54 | 37.54 | 35.85 |
| B2 | 34.92 | 37.12 | 37.54 | 40.59 | 40.59 | 41.66 | 38.73 |
| B3 | 37.54 | 40.59 | 40.59 | 44.19 | 44.19 | 45.45 | 42.09 |
| B4 | 40.59 | 40.59 | 40.59 | 42.82 | 42.82 | 42.82 | 41.70 |
| F - 1.344 NS | | | | | | F - 8.16** | |
| SE - 0.754 | | | | | | SE - 1.030 | |
| | | | | | | CD - 3.359 | |

The total sugar content of the product B1 ranged between 32.64 to 37.54 per cent during storage of 6 months. The total sugar content of B2, B3 and B4 was 34.92 - 41.66, 37.54 - 45.45 and 40.59 - 42.82 per cent respectively.

A slight increase was noted in the total sugar content of the mango bars, however the increase was not statistically significant.

Heikal *et al.* (1964) and Sarhan *et al.* (1971) reported gradual increase in total sugars during storage.

Mir and Nath (1993) found that total sugar content of the mango bars increased during storage. Mohammed *et al.* (1993) reported increase in total sugar in pineapple candy during storage.

Total sugar content of the differently treated mango bars showed a significant difference. The highest total sugar content was observed in 3:1 mango papya bar (B3) followed by plain mango bar (B4). The least total sugar content was observed in 1:1 mango papaya bar (B1).

#### 4.4.2.3 Changes in acidity content of mango bars during storage

The changes in acidity in the mango bars during storage are presented in Table (15).

The acidity ranged between 1.19 to 1.49 in R1, 1.49 to 1.60 in B2, 1.49 to 1.53 in B3 and 1.49 to 1.60 in B4 during storage of 6 months.

Changes in the acidic content of mango bars was found to be significantly different during storage, with an increasing trend.

Table 15 Acidity content of mango bars during storage

| Products | Acidity in per cent (Storage period in months) | | | | | | Treatment Means |
|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | |
| B1 | 1.19 | 1.30 | 1.34 | 1.36 | 1.36 | 1.49 | 1.34 |
| B2 | 1.49 | 1.49 | 1.51 | 1.51 | 1.53 | 1.60 | 1.52 |
| B3 | 1.49 | 1.49 | 1.53 | 1.53 | 1.53 | 1.53 | 1.51 |
| B4 | 1.49 | 1.49 | 1.51 | 1.51 | 1.53 | 1.60 | 1.52 |
| F - 3.92** | | | | | | | F - 110.74** |
| SE - 1.888 | | | | | | | SE - 8.507 |
| CD - 0.053 | | | | | | | CD - 0.027 |

Kahtani (1990) reported an increase in acidity in dried pomegranate during storge. In contrast Riji and Mary (1995) observed a slight decrease in acidity during storage of dried pineapple slices. Deena and Mary (1994) and Bindu and Mary (1995) reported the same results in acidity during storage of dried banana and dried jackfruit respectively.

Acidic content of the differently treated mango bars also showed a significant difference between each other. The highest acidic content was observed in plain mango bar (B4) and 2:1 mango papaya bar (B2).

#### 4.4.2.4 Changes in TSS content of mango bars during storage

The Table (16) shows the TSS content of mango bars during storage of 6 months.

Table 16 TSS content of mango bars during storage

| Products | TSS content of mango bars °Brix | | | | | | Treatment Means |
|---|---|---|---|---|---|---|---|
| | Storage period in months | | | | | | |
| | 1 | 2 | 3 | 4 | 5 | 6 | |
| B1 | 32.00 | 32.00 | 32.00 | 32.00 | 32.00 | 32.33 | 32.05 |
| B2 | 29.00 | 29.00 | 29.00 | 29.00 | 29.00 | 29.00 | 29.00 |
| B3 | 29.00 | 29.00 | 29.00 | 29.00 | 29.00 | 29.00 | 29.00 |
| B4 | 29.00 | 29.00 | 29.00 | 29.00 | 29.00 | 29.00 | 29.00 |
| F - 0.900 NS | | | | | | F - 621,43** | |
| SE - 0.109 | | | | | | SE - 6.202 | |
| | | | | | | CD - 0.202 | |

The product B1 recorded a TSS content of 32°Brix whereas all the other products recorded 29°Brix. The observed value remained constant throughout the storage period. This constant value can be considered as a noticing factor for the good storage performance of dried mango bars. In support of the above Sheeja (1995) reported that TSS content of canonda candy remained constant during storage. Tripathi (1988) found that the TSS content of dehydrated amal remained unchanged during storage.

In contrast Mahajan and Chopra (1994) found that TSS content of dried apple fruits increased during 150 days of storage.

Results indicated that a significant difference in TSS content between the products. The highest TSS content was observed in B1 whereas B2, B3 and B4 were on par.

**4.4.2.5 Changes in pH of mango bars during storage**

The Table (17) depicts the pH of mango bars during storage.

Table 17 pH of mango bars during storage

| Products | pH content of mango bars | | | | | | Treatment Means |
|---|---|---|---|---|---|---|---|
| | Storage period in months | | | | | | |
| | 1 | 2 | 3 | 4 | 5 | 6 | |
| B1 | 4.60 | 4.60 | 4.41 | 4.40 | 4.40 | 4.40 | 4.50 |
| B2 | 4.00 | 4.00 | 3.91 | 3.91 | 3.90 | 3.80 | 3.92 |
| B3 | 4.00 | 4.00 | 3.90 | 3.90 | 3.90 | 3.90 | 3.91 |
| B4 (Control) | 4.03 | 4.00 | 3.90 | 3.90 | 3.90 | 3.90 | 3.92 |
| F - 104.65** | | | | | | | F - 3539.22** |
| SE - 0.276 | | | | | | | SE - 0.012 |
| CD - 0.022 | | | | | | | CD - 0.013 |

As per the Table, the pH of mango bars ranged from 4.60 to 4.40 in B1, 4.00 to 3.80 in B2, 4.00 to 3.90 in B3 and 4.03 to 3.80 in B4 during storage.

A significant difference was observed in pH during storage with slight decreasing trend. Sheeja (1994) reported a

negligible in pH during storage in papaya candy. Tripati *et al*. (1988) reported no change in pH in dehydrated amla product during storage.

In contrast of the above studies Torregian (1993) and paul (1986) reported an increase in pH in dried products during storage.

Results proved that a significant difference existed in pH between the products. The highest pH was observed in B1 (4.5) whereas the pH of B2, B3 and B4 were 3.92, 3.91 and 3.92 respectively.

#### 4.4.2.6 Changes in vitamin C content of mango bars during storage

The Table (18) shows the changes in vitamin C during storage of mango bars.

The vitamin C content ranges from 37.35mg to 33.97mg in B1, 36.73mg to 33.00mg in B2, 37.35mg to 34.73mg in B3 and 36.50mg to 33.00mg in B4.

Statistical analysis revealed negligible difference in vitamin C during storage. However slight decrease was noted after 4th month onwards. A rapid decline in ascorbic acid during storage was reported by Saini and Dharampal (1997).

Table 18 Vitamin C content of mango bars during storage

| Products | Vitamin C content of mango bars g/100 — Storage period in months | | | | | | Treatment means |
|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | |
| B1 | 37.35 | 36.73 | 36.73 | 36.12 | 34.73 | 33.97 | 35.93 |
| B2 | 36.73 | 36.73 | 36.73 | 36.12 | 32.20 | 33.00 | 35.41 |
| B3 | 37.35 | 37.35 | 37.35 | 36.73 | 35.97 | 34.73 | 36.58 |
| B4 (Control) | 36.50 | 36.50 | 34.73 | 33.97 | 33.20 | 33.00 | 34.65 |
| F - 0.85 NS | | | | | | F - 9.41** | |
| SE - 0.587 | | | | | | SE - 0.288 | |
| | | | | | | CD - 0.942 | |

Destruction of Vitamin C during processing and storage was reported by Das (1986). However Benkhemmar *et al*. (1993) found that properly processed grapes had retained vitamin C content during the storage period of 3 to 4 months.

Riji and Mary (1995) reported a rapid decline of vitamin C during storage of dehydrated pineapple slices.

Results further indicated a significant difference in vitamin C content between the products. The highest vitamin C content was observed in B3 and B1 (37.35).

From the results obtained it can be concluded that the reducing sugar, total sugar and acidity content of the

mango bars increased during storage of 6 months. While the pH decreased during storage. A slight decrease in vitamin C was observed in mango bars, after 4th month onwards.

### 4.4.3 Organoleptic assessment of mango bars during storage

Sensory analysis of food depends on evaluation through the use of senses by applying exact scientific testing methods (Skelton 1984). According to Singh *et al*. (1992) assessment of organoleptic qualities was done mainly to draw conclusions about a particular product from a large population through the selection of a limited number of panel members.

The prepared mango papaya bars were subjected to organoleptic evaluation the results of which are shown below.

Table (19) depicts the meanscore obtained for different quality attributes in the prepared mango bars.

In the case of appearance attribute of the mango bars, the mean score ranged between 3.3 to 4.0 with the corresponding score percentage between 82.5 to centum. A significant difference was observed in between the fruit bars with regard to appearance. 1:1 mango-papaya bar scored maximum for appearance.

Considering the colour attribute the meanscore ranged between 3.3 to 3.9 and the corresponding score percentage

ranged between 82.5 to 97.5 per cent. A significant difference was observed in between the mango bars regarding colour attribute and 1:1 mango-papaya bar scored maximum. Dark orange colour of the papaya, improved the colour of the dried mango bar and hence was more acceptable for the judges.

Table 19 Meanscore obtained to mango bars for different quality attributs

| Products | Appear-ance | Colour | Flavour | Taste | Texture | Overall score |
|---|---|---|---|---|---|---|
| 1:1 (B1) | 4.0 | 3.9 | 3.4 | 3.4 | 3.3 | 3.60 |
| | (100) | (97.5) | (85) | (85) | (82.5) | (90) |
| 2:1 (B2) | 3.8 | 3.8 | 3.7 | 3.5 | 3.1 | 3.58 |
| | (95) | (95) | (92.5) | (87.5) | (77.5) | (89.50) |
| 3:1 (B3) | 3.5 | 3.5 | 3.8 | 3.8 | 3.0 | 3.52 |
| | (87.5) | (87.5) | (95) | (95) | (75) | (88) |
| Control(B4) | 3.3 | 3.3 | 4.0 | 4.0 | 2.8 | 3.48 |
| | (82.5) | (82.5) | (100) | (100) | (70) | (87) |
| F | 5.612** | 2.999** | 2.77NS | 4.199** | 3.391** | |
| SE | 0.131 | 0.158 | 0.154 | 0.134 | 0.113 | |
| CD | 0.266 | 0.32 | | 0.270 | 0.230 | |

(Figures in parentheses give percentage score)

In flavour, the meanscore obtained ranged between 3.4 to 4.0 and percentage score between 85 to centum. No significant difference was observed with regard to flavour between the products. Plain mango bar was proved to be the best in flavour, which may be due to the pleasant inherent flavour of the mango.

In the case of taste, the score ranged between 3.4 to 4.0 with a score percentage ranged between 85 to centum. A significant difference was observed between the products, with regard to taste. In taste also plain mango bar scored maximum.

Mean score obtained for texture attribute, between 2.8 to 3.3 and the score percentage ranged between 70 to 82.5 per cent. A significant difference was observed in between the mango bars and 1:1 mango papaya bar has bagged maximum score for texture.

To conclude organoleptic qualities such as appearance, colour and texture was in favour of 1:1 blended fruit bar, whereas for flavour and taste plain mango bar excelled others. However the overall score obtained for mango bars indicated that 1:1 mango papaya bars has got maximum score (3.60) followed by 2:1 and 3:1 mango papaya bar.

### 4.4.3.1 Changes in organoleptic qualities of mango bars during storage

The mango bars developed were kept for storage studies, and the changes in organoleptic qualities were assessed under a panel of 10 judges throughout the storage period of 6 months.

Table 20 (Fig. 2) depicts the mean score obtained for appearance in mango bars during the storage periods.

Consumers preference to the appearance is one of the major factor leading to the increasing demand of the product, it is essential to keep the appearnce of the product quite attractive as reported by Christensen (1985).

CFTRI (1992) reported that shrivelling and colour change are the two main factors that affects the appearance of the processed products.

The mean score obtained for the appearance of mango bars prepared with different proportion of mango and papaya pulp ranged from 2.9 to 4.0 during first month, and the score percentage ranged between 72.5 - centum. The 1:1 mango papaya bar stands good for appearance and has scored maximum.

Statistically no significant difference was observed in appearance during storage. The mean score for appearance found to decrease during storage, and the maximum per cent

decrease was observed in 1:1 mango-papaya bar (17.5 per cent). Bindu and Mary (1995) reported a decrease in appearance scores in dried jack fruit products during storage of 5 months.

Table 20 Mean score obtained for appearance attribute in mango bars during storage

| Products | Storage period in months | | | | | | Percentage decrease |
|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | |
| 1:1 (B1) | 4.0 | 4.0 | 4.0 | 3.5 | 3.4 | 3.3 | 17.5 |
| | (100) | (100) | (100) | (87.5) | (85.0) | (82.50) | |
| 2:1 (B2) | 3.3 | 3.8 | 3.3 | 3.1 | 3.0 | 2.9 | |
| | (82.5) | (82.5) | (82.5) | (71.5) | (75.0) | (72.50) | 12.1 |
| 3:1 (B3) | 3.1 | 3.1 | 3.1 | 2.9 | 2.7 | 2.60 | |
| | (77.5) | (77.5) | (77.5) | (72.5) | (67.5) | 65 | 16.1 |
| C (B4) | 2.9 | 2.9 | 2.9 | 2.7 | 2.6 | 2.50 | |
| | (72.5) | (72.5) | (72.5) | (67.5) | (65) | (62.50) | 13.7 |

F - 0.289 NS

SE - 0.028

(Figures in parentheses give percentage score)

Clydesdale (1979) stated that colour affect the sensory characteristics, such as sweetness, salt and flavour . The joint FAO/WHO expert committee on food additives recognised that colour has an effect on food choices (Anonymous 1991).

Fig. 2 Changes in Appearence score of Mango Bars during storage

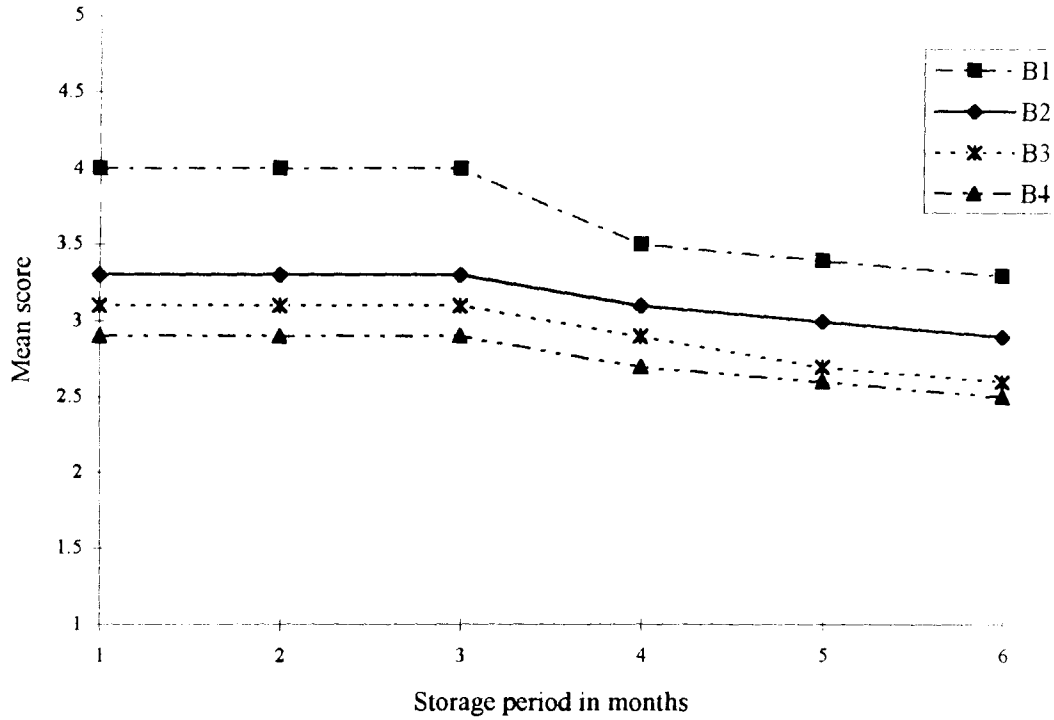



Fig. 3 Changes in colour score of Mango Bars during storage

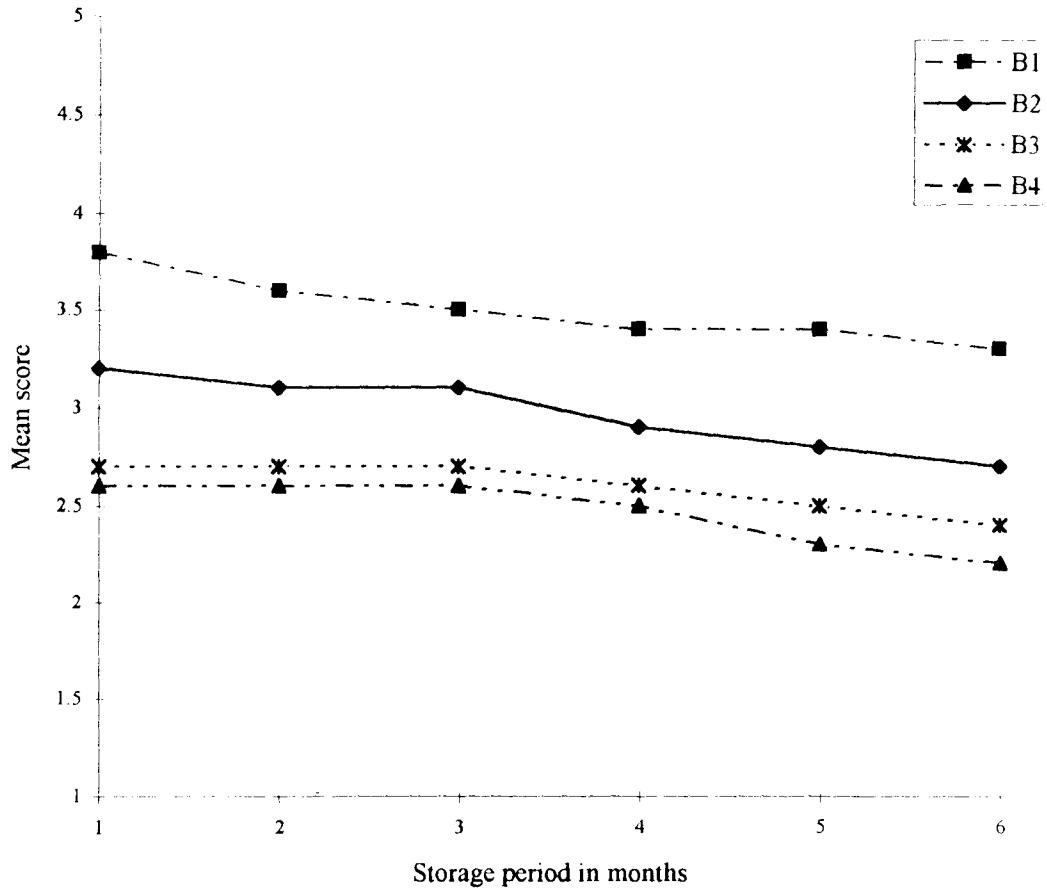


Table 21 Means core obtained for colour attribute in mango bars during storage

| Products | Storage period in months | | | | | | Percentage decrease |
|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | |
| 1:1 (B1) | 3.8 | 3.6 | 3.5 | 3.4 | 3.4 | 3.13 | 13.1 |
| | (95) | (90) | (87.5) | (85.0) | (85.0) | (82.50) | |
| 2:1 (B2) | 3.2 | 3.1 | 3.1 | 2.9 | 2.8 | 2.7 | |
| | (80.0) | (77.5) | (77.5) | (72.5) | (70.0) | (67.50) | 15.6 |
| 3:1 (B3) | 2.7 | 2.7 | 2.7 | 2.6 | 2.5 | 2.40 | |
| | (67.50) | (67.50) | (67.5) | (65.0) | (62.50) | (60.00) | 11.1 |
| C (B4) | 2.6 | 2.6 | 2.6 | 2.5 | 2.3 | 2.2 | |
| | (65) | (65) | (65) | (62.5) | (57.5) | (55.0) | 15.3 |

F - 0.157 NS

SE - 0.023

(Figures in parentheses give percentage score)

As per Table 21 (Fig. 3), the mean score obtained for colour attribute ranged between 2.6 - 3.8 with a percentage score of 65-95 in colour, 1:1 mango papaya bar (B1) was found to be superior. This may be due to the addition of papaya pulp, which improved the colour of the bar.

No significant difference was observed in colour attribute during storage. However table showed a lineor decrease in colour. The maximum decrease in colour was found to be 2:1 mango papaya bar (15.6 per cent).

Table (22) shows the changes in flavour attribute during storage.

Table 22 Mean score obtained for flavour attribute in mango bars during storage

| Products | Storage period in months | | | | | | Percentage decrease |
|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | |
| 1:1 (B1) | 3.0 | 2.9 | 2.8 | 2.6 | 2.5 | 2.4 | |
| | (75) | (72.5) | (70.0) | (65) | (62.5) | (60.0) | 20.00 |
| 2:1 (B2) | 3.3 | 3.1 | 3.1 | 3.0 | 2.8 | 2.7 | |
| | (82.5) | (77.5) | (77.5) | (75) | (70) | (67.5) | 18.18 |
| 3:1 (B3) | 3.4 | 3.4 | 3.4 | 3.1 | 3.0 | 2.9 | |
| | (85) | (85) | (85) | (77.5) | (75.0) | (72.5) | 14.70 |
| C (B4) | 4.0 | 3.9 | 3.9 | 3.6 | 3.4 | 3.2 | |
| | (100) | (97.5) | (97.5) | (90.0) | (85) | (80.0) | 20.00 |

F - 0.139 NS

SE - 0.016

(Figures in parentheses give percentage score)

Acording to Rolls *et al*. (1981) flavour is the quality attribute which stand next to taste. Renganna (1984) stated that flavour is an important factor which enriches the consumers preference to a particular product.

Fig. 4 Changes in Flavour score of Mango Bars during storage

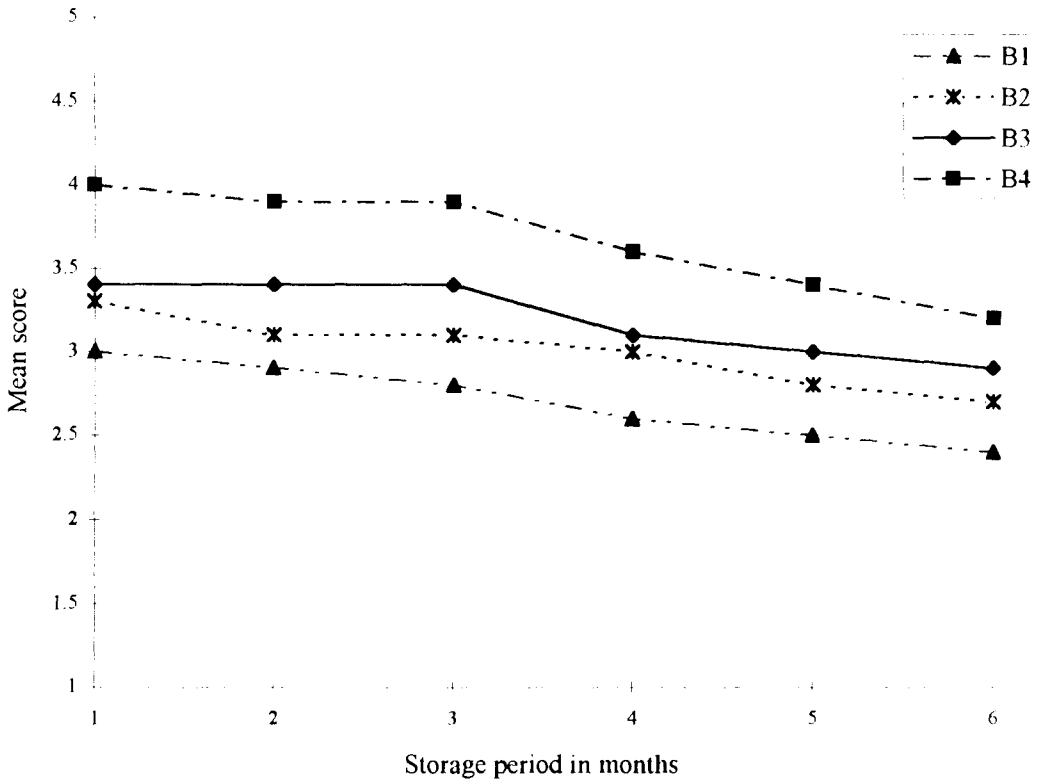
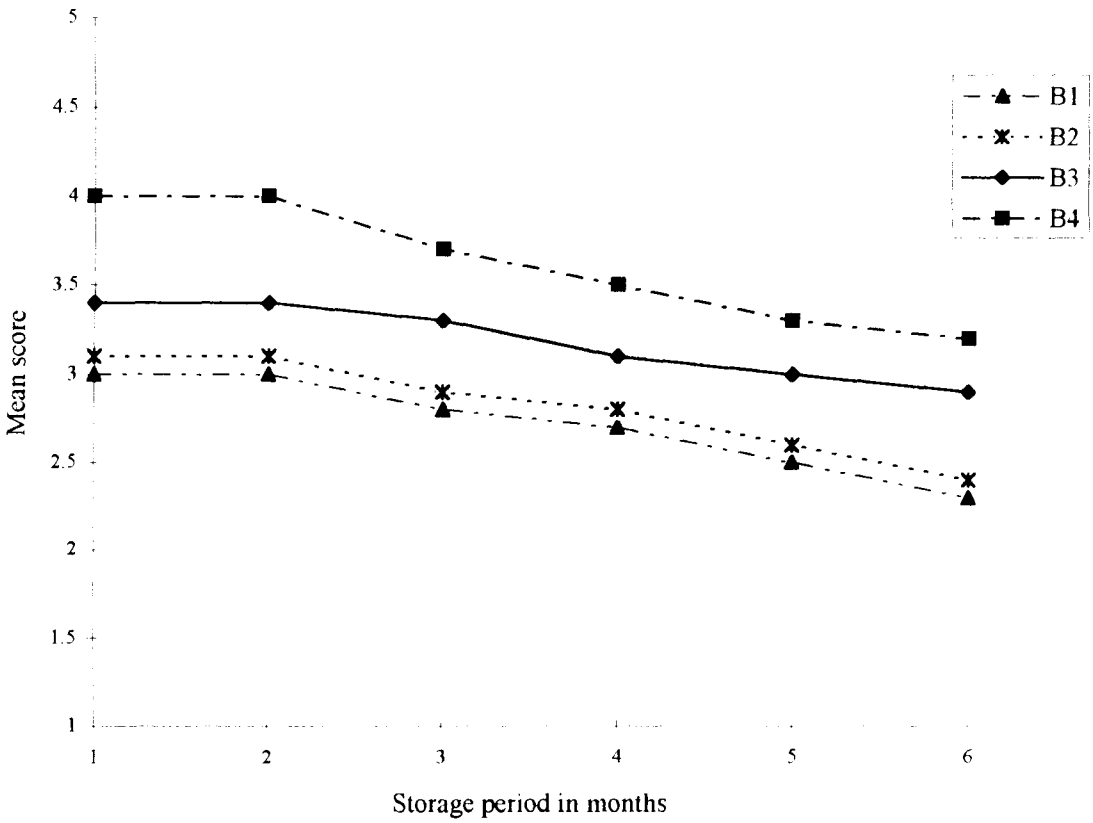



Fig.5 Changes in Taste score of Mango Bars during storage



As per the Table 22 (Fig. 4) the meanscore for flavour ranged between 3.0 to 4.0 during the first month. The control product (B4) scored maximum as far as flavour in concerned, which is attributed to the retention of natural mango flavour. No significant difference was observed in flavour during storage, however a progressive decrease was observed in flavour scores. The maximum per cent decrease was observed in 1:1 mango papaya bar (B1) and control sample.

According to Rolls *et al*. (1981) in the various quality attributes tests, the first preference goes to taste. The mean score for taste attributes ranged between 3.0 - 4.0 and the score percentage betwen 75 to centum, during first month. The control sample has got maximum score for taste attribute also.

No significant difference was observed in taste during storage (Table 23, Fig. 5), though the score slightly decreased. Mango papaya bar prepared with 1:1 proportion has the maximum percentage decrease in taste score during storage (23.3 per cent).

Texture is a predisposing factor that determines the quality of the processed products. According to Maga and Schutz, (1973) the texture of the processed products depends upon the nature of the fruits used and also on different types of pretreatments applied.

Table 23 Mean score obtained for taste attribute in mango bars during storage

| Products | Storage period in months | | | | | | Percentage decrease |
|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | |
| 1:1 (B1) | 3.0 | 3.0 | 2.8 | 2.7 | 2.5 | 2.3 | 23.3 |
| | (75) | (75) | (70) | (67.5) | (62.5) | (57.5) | |
| 2:1 (B2) | 3.1 | 3.1 | 2.9 | 2.8 | 2.6 | 2.4 | |
| | (77.5) | (77.5) | (72.5) | (70) | (65) | (60.0) | 22.5 |
| 3:1 (B3) | 3.4 | 3.4 | 3.3 | 3.1 | 3.0 | 2.9 | |
| | (85) | (85) | (82.5) | (77.5) | (75) | (72.5) | 14.7 |
| C (B4) | 4.0 | 4.0 | 3.7 | 3.5 | 3.3 | 3.2 | |
| | (100) | (100) | (92.5) | (87.5) | (82.50) | (80) | 20.0 |

F - 0.114 NS

SE - 0.012

Figures in parentheses give percentage score

As indicated in Table 24 (Fig. 6) the texture of the product ragned between 2.4 -2.9 with the score percentage of 60-72.5 per cent. A significant difference was observed in textural qualities during storage. The highest mean score for texture was obtained by 1:1 mango papaya bar followed by 2:1, 3:1 and the control (plain mango bar).

Results revealed that papaya blended fruit bars excel the control sample with regard to texture. This may be due to the soft texture of papaya, pulp with less amount of fibre content compared with mango. The least score for texture was obtained by the control sample Texture of the plain mango bar was found to decrease maximum during storage.

Table 24 Meanscore obtained for texture attribute in mango bars during storage for texture

| Products | Storage period in months | | | | | | Percentage decrease |
|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | |
| 1:1 (B1) | 2.9 | 2.9 | 2.8 | 2.5 | 2.3 | 2.2 | 24.1 |
| | (72.5) | (72.5) | (70) | (62.5) | (57.5) | (55.0) | |
| 2:1 (B2) | 2.7 | 2.7 | 2.6 | 2.3 | 2.2 | 2.0 | |
| | (67.5) | (67.5) | (65.0) | (57.5) | (55.0) | (50.0) | 25.9 |
| 3:1 (B3) | 2.6 | 2.6 | 2.5 | 2.2 | 2.1 | 1.9 | |
| | (65) | (65) | (62.5) | (55.0) | (52.5) | (47.5) | 26.9 |
| C (B4) | 2.4 | 2.4 | 2.2 | 2.1 | 2.0 | 1.7 | |
| | (60) | (60) | (55.0) | (52.5) | (50.0) | (42.5) | 29.1 |

F - 7.537**

SE - 0.023

CD - 0.046

Figures in parentheses give percentage score)

The overall acceptability of score of the products ranged from 3.0 to 3.3 with the score percentage between 75 to 82.5 per cent during first month Table 25 (Fig. 7).

The overall acceptability of the products decrease during storage and the maximum percentage decrease was in plain mango bar and the bar prepared with 2:1 proportion.

Fig. 6 Changes in texture score of Mango Bars during storage

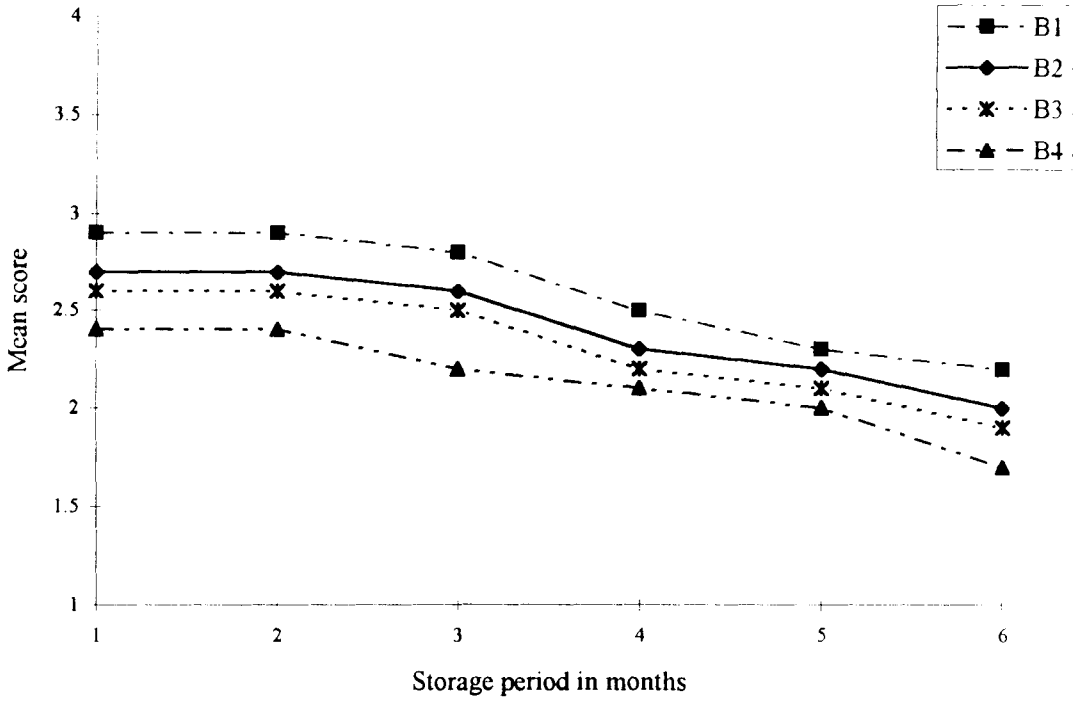



Fig. 7 Changes in overall acceptability score of Mango Bars during storage

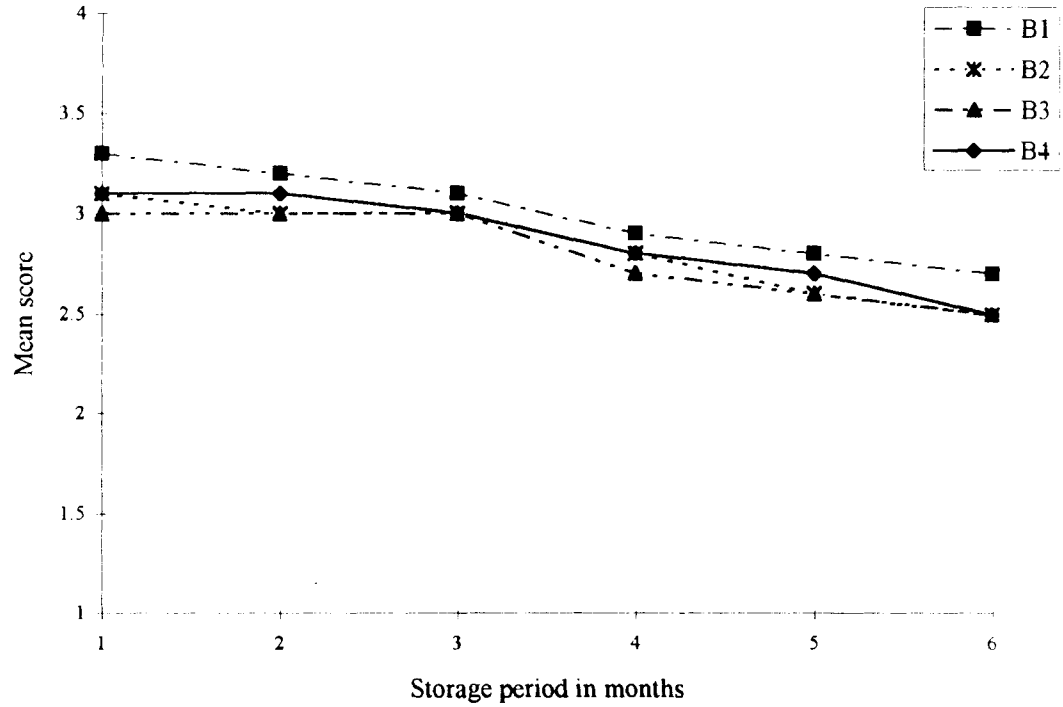


Table 25 Overall acceptability scores of mango bars during storage

| Products | Storage period in months | | | | | | Percentage decrease |
|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | |
| 1:1 (B1) | 3.3 | 3.2 | 3.1 | 2.9 | 2.8 | 2.7 | 18.1 |
| | (82.5) | (80) | (77.5) | (72.5) | (70) | (67.5) | |
| 2:1 (B2) | 3.1 | 3.0 | 3.0 | 2.8 | 2.6 | 2.5 | |
| | (77.5) | (75) | (75) | (70) | (65) | (62.5) | 19.3 |
| 3:1 (B3) | 3.0 | 3.0 | 3.0 | 2.7 | 2.6 | 2.5 | |
| | (75) | (75) | (75) | (67.5) | (65) | (62.5) | 16.6 |
| C (B4) | 3.1 | 3.1 | 3.0 | 2.8 | 2.7 | 2.5 | |
| | (77.5) | (77.5) | (75) | (70) | (67.5) | (62.5) | 19.3 |

Figures in parentheses give percentage score

Taking into account of the changes in organoleptic qualities in the different mango-papaya blended bars developed, it can be concluded that, minimum changes were noted in all the blended bars prepared with respect to quality attributes viz., appearance, colour, flavour, taste, texture and over all acceptability. However textural qualities of the fruit bars were found to decrease significantly with storage. All the products were acceptable even after 6 months of storage as indicated by the scores obtained for quality attributes.

## 4.5. Assessment of consumer preference of the products

The consumer preference of the mango bars prepared out of different blends was assessed by conducting acceptability test among 25 randomly selected consumers. The results of which are presented in Table (26).

Table 26 Assessment of consumer preference of the products

| Products | Apperance | Colour | Flavour | Taste | Texture | Overall score |
|---|---|---|---|---|---|---|
| B1 | 3.72 | 3.60 | 2.68 | 3.16 | 3.16 | 16.32 |
| | (93.00) | (90.00) | (67.00) | (79.00) | (79.00) | |
| B2 | 3.16 | 3.08 | 2.92 | 2.88 | 2.76 | 14.8 |
| | (79.99) | (77.00) | (73.00) | (72.00) | (69.00) | |
| B3 | 3.24 | 2.64 | 2.40 | 2.60 | 2.56 | 13.44 |
| | (81) | (66) | (60) | (65) | (64) | |
| B4 | 2.16 | 2.52 | 3.24 | 3.72 | 2.20 | 13.84 |
| | (54) | (63) | (81) | (93) | (60) | |
| F | 50.69** | 24.16** | 8.53** | 14.06** | 10.11** | |
| SE | 0.092 | 0.099 | 0.122 | 0.127 | 0.125 | |
| CD | 0.259 | 0.280 | 0.344 | 0.359 | 0.354 | |

Figures in parentheses give percentage score

In the case of appearance, the score ranged from 2.16 to 3.72 and the score percentage between 54 to 93. A significant difference was observed in between the products with regard to appearance. Mango papaya bar, prepared with 1:1 proportion was found to be significantly higher in appearance attribute than the others.

The mean score of the mango bars for colour ranged from 2.52 to 3.60 with a percentage score between 63-90. In this attribute also 1:1 mango papaya bar (B1) was significantly superior than B2, B3 and B4. Considering the flavour and taste attribute, the mean scores ranged between 2.40 to 3.24 and 2.60 to 3.72 respectively. Significant difference was observed in flavour and taste in between the products. The control sample scored highest for both flavour and taste attribute.

In texture the mean score ranged between 2.20 to 3.16 and the score percentage ranged between 60-79. A significant difference was observed between the products with regard to texture attribute and 1:1 mango-papaya bar (B1) was significantly superior to other products.

Consumer preference of the products indicated that, the highest overall score was obtained by 1:1 mango papaya bar (B1) followed by 2:1 (B2) control (B4) and 3:1 (B3) blended products.

On considering consumer preference of the products developed, it was found that the fruit bar prepared out with mango and papaya in the ratio 1:1 (B1) was the most acceptable among the judges and consumers which can be recomended for product development.

## 4.6 Assessment of microbial contamination of the products

The shelf life quality of the processed product is of much importance because the need for improving different processing technique is influenced by the shelf life quality (Tandon, 1987). The microbial damage in a product is brought about by the changes in chemical and physical factors (Bindu, 1995). Among the chemical components pH is an important factor which helps to determine the growth of microorganisms during the storage period.

There was no microbial contamination up to 10 months in differently treated mango bars during storage period.

On examining the sample under the microscope after 10 months, the product showed colonies of *Aspergillus* and *Penicillium* which confirmed microbial decay. Kahtani (1990) have reported that *Aspergillus* and *Penicillium* are responsible for the decay of dried pomegranate.

Bindu and Mary (1995) and Riji and Mary (1995) have also reported the microorganisms responsible for the decay of dried jack fruit and pineapple as *Aspergillus* and *Penicillium* after 5 months of storage.

## 4.7 Cost benefit analysis of mango bars

The cost benefit analysis was carried out based on the cost of various materials needed for the preparation of

mango bars such as cost of mangoes, papaya, sugar and polypropylene cover etc. Labour cost was also taken into account while calculating the cost of products.

The Table (27) given below depicts the cost benefit analysis of the products developed.

Table 27 Cost benefit analysis of mango bars

| Sl.No. | Products | Cost/kg Rs.Ps. |
|---|---|---|
| 1. | 1:1 mango-papaya bar (B1) | 58.00 |
| 2. | 2:1 mango-papaya bar (B2) | 62.00 |
| 3. | 3:1 mango-papaya bar (B3) | 66.00 |
| 4. | Plain mango bar (B4) | 68.00 |

The cost of mango bars ranged from Rs.58 to Rs.68 per kilogram. The cost incurred for dried mango bar prepared from plain mango pulp was found to be comparitively higher Rs. 68/kg followed by B3, B2 and B1.

From the cost benefit analysis we can come to the conclusion that the bars prepared with more quantity of papaya had lower cost compared with the fruit bar prepared with plain mango pulp. This is due to the low cost of papaya.

Bindu and Mary (1995) reported the cost of dehydrated jack fruit products between 16.30 to 18.10 Rs./kg for firm flesh variety and 12.30 to 14.10 Rs./kg for soft flesh variety.

Deena and Mary (1994) reported the cost of dehydrated banana products ranged between Rs.62 to Rs.70 per kg.

It can be concluded that the preparation of dried products are comparitively easy and cheap and can be adopted by the rural women as an income generating activity.

# SUMMARY AND CONCLUSION

## SUMMARY AND CONCLUSION

The study entitled "Developing blended fruit product utilising stored mango pulp" was undertaken to develop shelf stable and organoleptically acceptable blended mango-papaya fruit bar using stored mango pulp.

On viewing the physical and organoleptic characteristics, the selected mango cultivar Kottukonam was observed to have an oblong shape with dark orange coloured flesh. The average fruit weight of the variety was 204.5 g with a pulp yield of 74.3 per cent per kg fruit. The fruit is slightly fibrous, mildely flavoured and moderately sweet.

Considering the chemical components of the mango it was observed that, the reducing sugar content of mango was 4.5 per cent as against 4.8 per cent in mango pulp. The titrable acidity and pH of mango as well as the pulp was observed to be 0.256 per cent and 5.4 respectively. Total soluble solids present in mango was 19°Brix and that of mango pulp was 27°Brix. The vitamin C content of fresh mango was 28.13 mg/100g pulp while that of mango pulp was reduced to 12.45 mg/100g pulp.

Assessment with regard to the changes in chemical components of stored pulp indicated that the reducing sugar

content of the treatment ($T_1$) ranged between 4.77 to 5.47 per cent. In ($T_2$) it ranged from 4.23 and 5.26 per cent and in $T_3$ it was 5.05 to 5.50 per cent. The total sugar content of $T_1$, $T_2$ and $T_3$ ranged between 13.05 to 13.93, 11.79 to 13.14 and 13.96 to 14.56 per cent respectively. The titrable acidity of $T_1$ ranged between 0.43 to 0.47 per cent, $T_2$ ranged between 0.40 to 0.46 and $T_3$ ranged between 0.49 to 0.53 per cent during storage. Negligible changes were noted in TSS content of the pulp with storage. The pH of $T_1$, $T_2$ and $T_3$ ranged between 3.96 to 3.90, 3.95 to 3.90 and 2.88 to 2.80 respectively. The vitamin C content of $T_1$ ranged between 13.83 to 9.68, $T_2$ ranged between 12.45 to 9.10 and $T_3$ ranged between 12.45 to 8.30 mg/100g pulp during storage.

Considering the storage stability of mango pulp in different containers, treatment $T_1$ (0.1 per cent potassium metabisulphite) was found to be shelf stable up to 36 days in both glass and PVC containers. $T_2$ (0.05 per cent potassium metabisulphite and 0.05 per cent sodium benzoate) was observed to have a storage stability of 49 days in glass container and 41 days in PVC container. The treatment $T_3$ (0.1 per cent potassium metabisulphite and 1.0 per cent citric acid) had a shelf life of 96 days in both glass and PVC containers are more suitable for storing mango pulp than PVC containers. Among the different pretreatments applied KMS along with citric acid was found to be the most effective preservative treatment.

Detailed investigations on drying characteristics, chemical analysis, and organoleptic qualities of blended fruit bars were carried out. The moisture content of fruit bars prepared out of different proportion ranged between 8.8 to 9.3 per cent, while the drying time ranged between 40 to 53 hours.

Considering the chemical analysis of dried fruit bars, the reducing sugar content of B1, B2, B3 and B4 ranged between 26.79 - 28.86, 30.72 - 32.02, 26.79 - 31.25 and 27.83 - 33.0 per cent respectively during storage. The total sugar and titrable acidity of B1, B2, B3 and B4 ranged from 36.64 - 37.54, 34.92 - 41.66, 37.54 - 45.45, 40.59 - 42.82 per cent and 1.19 - 1.49, 1.49 - 1.60, 1.49 - 1.53 and 1.49 - 1.60 per cent respectively during storage of 6 months. Not much variation was observed in TSS content of the stored mango bars. The pH of B1, B2, B3 and B4 was observed to be 4.60, 4.0, 4.0 and 4.03 during storage. The vitamin C content of B1, B2, B3 and B4 decreased from 37.35 to 33.97, 36.73 to 33.0, 37.35 to 34.73 and 36.50 to 33.00 mg/100g pulp respectively during storage.

From the results obtained it can be concluded that the reducing sugar, total sugar and acidity content of the mango bars increased during storage of 6 months, while the pH decreased. A slight decrease in vitamin C was also observed in mango bars, after 4th month onwards.

Taking into account of the organoleptic assessment, the organoleptic qualities such as appearance, colour and texture was in favour of 1:1 (B1) blended fruit bar, whereas for flavour and taste plain mango bar (B4) excelled others. However the overall score obtained for mango-bars indicated that 1:1 mango-papaya bars has got maximum score (3.60) followed by 2:1 (B2) and 3:1 (B3). Taking into account of the changes in organoleptic qualities in the different mango-papaya blended bars developed, it can be concluded that, minimum changes were noted in all the blended fruit bars prepared with respect quality attributes viz. appearance, colour flavour taste texture and overall acceptability. However textural qualities of the fruit bars were found to decrease significantly with storage. All the products were acceptable even after 6th months of storage, as indicated by the scores obtained for quality attributes.

Considering the consumer preference of the products developed, it was found that the fruit bar prepared with mango and papaya pulp in the ratio (1:1) (B1) was most acceptable among the judges and consumers which can be recommended for product development.

Evaluation of microflora in the stored products revealed that no microbial infestation till 10 months of storage, after which colonies of *Penicillium* and *Aspergillus* were seen on the surface of the fruit bar.

Cost benefit analysis of the products revealed that the cost of 1 kg fruit bar ranged between Rs.58 to 68.

Thus it can be concluded that, locally cultivated Kottukonam mango cultivar can be utilised effectively by storing its pulp in glass containers and further utilising it product development in the form of fruit bars at a relatively low cost and labour.

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* Originals not seen

# APPENDIX

## APPENDIX - I

## SCORE CARD

| Criteria | Score | $B_1$ | $B_2$ | $B_3$ | $B_4$ |
|---|---|---|---|---|---|
| **Appearance** | | | | | |
| Very good | 4 | | | | |
| Good | 3 | | | | |
| Fair | 2 | | | | |
| Poor | 1 | | | | |
| **Colour** | | | | | |
| Most acceptable | 4 | | | | |
| Acceptable | 3 | | | | |
| Less acceptable | 2 | | | | |
| Not acceptable | 1 | | | | |
| **Flavour** | | | | | |
| Very pleasant | 4 | | | | |
| Pleasant | 3 | | | | |
| Moderately pleasant | 2 | | | | |
| Unpleasant | 1 | | | | |
| **Taste** | | | | | |
| Very good | 4 | | | | |
| Good | 3 | | | | |
| Fair | 2 | | | | |
| Poor | 1 | | | | |
| **Texture** | | | | | |
| Very soft | 4 | | | | |
| Soft | 3 | | | | |
| Moderately soft | 2 | | | | |
| Hard | 1 | | | | |

# ABSTRACT

# DEVELOPING BLENDED FRUIT PRODUCT UTILISING STORED MANGO PULP

BY

JYOTHI. H.

ABSTRACT OF THE THESIS

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## ABSTRACT

The study entitled "Developing blended fruit product utilising stored mango pulp" was undertaken to develop shelf stable dried mango-papaya bar using stored mango pulp.

On viewing the physical and organoleptic characteristics, the selected mango cultivar Kottukonam was observed to have an oblong shape with dark orange coloured flesh. The average fruit weight of the variety was 204.5 g with a pulp yield of 74.3 per cent per kg fruit. The fruit is slightly fibrous, midely flavoured and moderately sweet.

The chemical analysis of fresh mango, mango pulp and that of treated pulp were assessed with regard to its reducing sugar, total sugar, acidity, pH, TSS and vitamin C. From the study it can be concluded that the reducing sugar, total sugar and acidity of all the treatments increased with storage while pH and vitamin C decreased in stored pulp. Results indicated that glass containers proved to be the best for storing B mango-pulp than PVC containers, and 0.1 per cent potassium metabisulphite along with 1.0 per cent citric acid was adjudged to be the best preservative treatment.

Drying characteristics of the blended fruit bar prepared indicated that 1:1 mango papaya bar (B1) had least moisture content (8.8 per cent) and required maximum drying time (53 hrs) than others.

The chemical constituents of the dried fruit bar showed increase in reducing sugar, total sugar and acidity during storage. pH showed a slight decline however TSS has not much variation during storage. Vitamin C decreased during storage of fruit bars.

Taking into account of the organoleptic assessment, the organoleptic qualities such as appearance, colour and texture was in favour of 1:1 blended fruit bar (B1), whereas for flavour and taste plain mango-bar (B4) excelled others. However the overall score obtained for mango bars indicated that 1:1 mango papaya bars has got maximum score (3.60) followed by 2:1 (B2), 3:1 (B3). Considering the changes in organoleptic qualities in the different mango papaya blended bars developed, it can be concluded that, minimum changes were noted in all the blended fruit bars prepared with respect to quality attributes. viz. appearance, colour, flavour, taste, texture and overall acceptability. However textural qualities of the fruit bars were found to decrease significantly with storage. All the products were acceptable even after 6 months of storage.

Considering the consumer preference of the products developed, it was found that the fruit bar prepared with mango and papaya pulp in the ratio 1:1 (B1) was most acceptable among the judges and consumers which can be recommended for product development.

Evaluation of microflora in the stored products revealed that no microbial infestation till 10 months of storage, after which colonies of *Pencillium* and *Aspergillus* were seen on the surface of the fruit bar.

Cost benefit analysis of the products revealed that the cost of 1 kg fruit bar ranged between Rs. 58 to 68.

Thus it can be concluded that locally cultivated Kottukonam mango cultivar can be utilised effectively by storing its pulp in glass containers and further utilising it for product development in the form of fruit bars at a relatively low cost and labour.