IMPACT OF PRE-TREATMENTS AND PROCESSING ON THE SHELF LIFE QUALITY OF PAPAYA PRODUCTS

by

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THESIS
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1994

DECLARATION

I hereby declare that this thesis entitled Impact of pretreatments and processing on the shelf-life quality of papaya products is a bonafide record of research work done by me during the course of research and that the thesis has not previously formed the basis for the award of any degree diploma associateship fellowship or other similar title of any other University or Society

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Certified that this thesis entitled **Impact of pretreatments and processing on the shelf-life quality of papaya products** is a record of research work done independently by Miss SEEJA N under my guidance and supervision and that it has not previously formed the basis for the award of any degree fellowship or associateship to her

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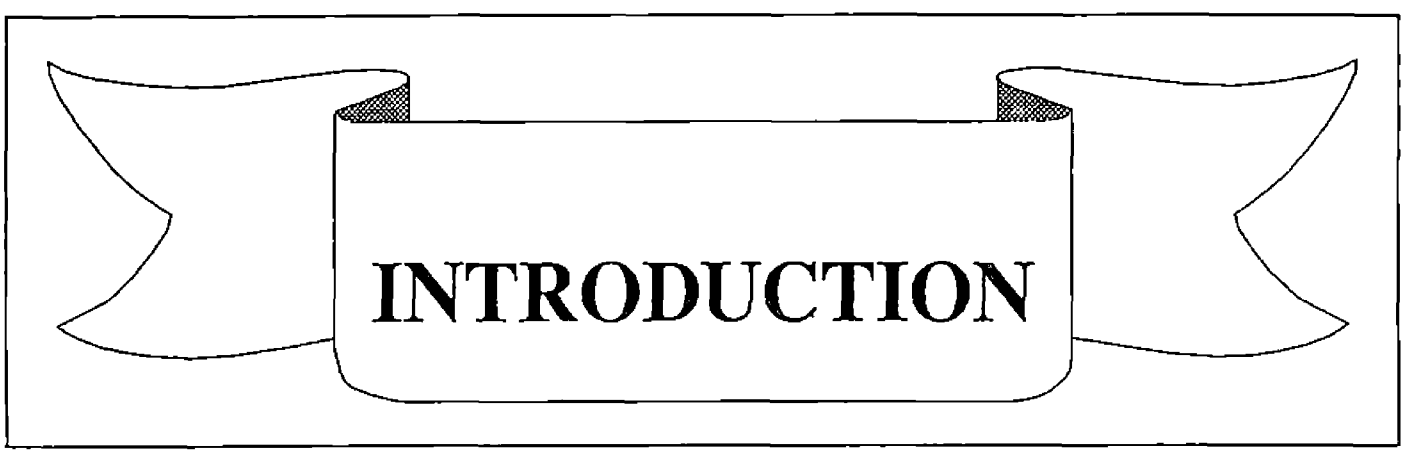

INTRODUCTION

INTRODUCTION

Ever since man gave up his arboreal habits and settled down to a pastoral life his efforts have been directed towards gathering and storing foods when they are in plenty to meet his needs during the days of scarcity This became more and more imperative as he extended his steps towards a high social life and as civilization and industrialisation progressed

Processing of food can be defined as adding value to conventional and innovative basic food items through various permutations and combinations providing protection preservation packaging convenience carriage and disposability (Rao 1989)

In India for a vast majority of people processed foods were synonymous and associated with the Saheb s foods being expensive and synthetic (Rao 1989) However within decades after Independence revolution has taken place in this field and Governmenc has rightly realised the key role that food processing plays in the overall economic growth of the nation

India as a result of its diverse agro-climatic conditions is reported to be one of the few countries of the world capable of growing various kinds of tropical subtropical and temperate fruits Recent food production statistics indicate that India is the second largest producer of fruits in the world after Brazil with a production touching 27 83 million tonnes which accounts for around eight percent of the world production

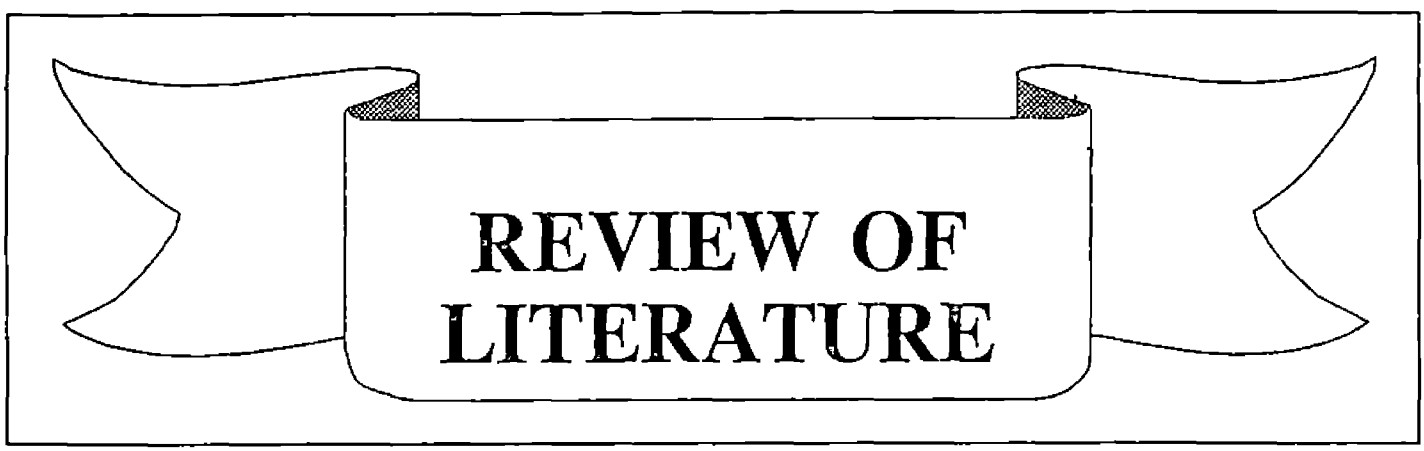
However Sethi (1993) has stated that 20 to 30 percent of the fruits produced in this country are not utilized due to post harvest problems and only about one percent of the total produce are being utilized for processing She has further stated that nine percent of the processed products as fruit juices pulps canned products and pickles are exported from this country

Many of the temperate and tropical fruits which can be new to foreign markets are still under exploited in the country Among these papaya (Carica papaya) is an important fruit grown in tropical and subtropical regions At present papaya is mainly used as an important dessert fruit in the

country The common varieties mainly cultivated in Kerala are Honey Dew Corg Honey Dew Co 1 and Co-2 It is used for the extraction of papain or pectin as well as an alkaloid called carparine (Singh 1990)

Techniques of processing now standardised in the country are mainly related to major fruits Food processing techniques related to fruits like papaya are now lacking Papaya being a quick growing fruit can form the basis for a thriving fruit processing industry Developing such processing technologies and standardising treatments prior to processing may result not only in better utilization of locally available raw materials but also in the production of value added products and gainful employment opportunities for farm families

The present study is an attempt to ascertain the effect of different possible treatments prior to processing and the effect of different processing techniques on the shelf life quality of selected papaya products


REVIEW OF
LITERATURE

REVIEW OF LITERATURE

Papaya (*Carica papaya*) belonging to the family caricaceae is an unusually interesting plant of many uses in tropical and subtropical regions According to Hofmeyr (1938) papaya a native of tropical America was introduced in India in the 16th century However Purseglove (1968) had stated that the fruit indigenous to South Mexico and Costa Rica was taken by Spaniards to Manila in mid sixteenth century and from there introduced it to India

A report published by Food and agricultural Organisation (FAO 1987) indicates that annual world production of papaya is 2914 47 metric tonnes and of this India produces about 350 metric tonnes According to Iyer (1987) in Kerala about 61 1 metric tonnes of the fruit is produced per annum But in a recent report of Kerala Horticultural Development Corporation (1992) it has been revealed that Kerala s annual contribution in this context is only 50 46 metric tonnes

2 1 Nutritional Composition of papaya

Papaya is a wholesome fruit and is consumed primarily as table fruit or salad vegetable (Hayes 1933) Papaya is a rich source of carotene and fair source of Vitamin C niacin riboflavin thiamine and minerals like calcium phosphorus and iron The value of papaya as a medicinal fruit has been reviewed by Quisumbig (1951) and Chopra (1958) As stated by them papaya is said to possess antihelminthic abortifacient and emmennagogue properties They also said that the alkaloid carpaine found in papaya was reported to act as a heart depressant amoebicide and diuretic

2 2 Fruit based products

Processing fruit based products is a method of reducing post harvest losses of perishable foods like fruits Bourne (1986) has classified the causes of post harvest losses of perishable crops in developing countries as primary losses due to insects microbes and mechanical damages and secondary losses due to poor storage and inadequate transport facilities Menezes (1980) studied the suitability of major tropical fruits for processing The fruits selected were pineapple cashew banana avocado guava papaya mango and passion fruit

As reported by Sidappa et al (1986) the modern methods of fruit preservation may be broadly classified into physical and chemical methods The physical methods include preservation using low temperature by heat application dehydration and irradiation The chemical methods include addition of acids salting or brining by addition of sugar by addition of chemical preservatives and fermentation Among all these methods preservation by addition of sugar and application of heat is a highly important method in the case of fruits

Tripathi et al (1988) developed a recipe for amla juice which was found organoleptically acceptable even after 6 months According to the Okoli and Ezenweke (1990) papaya juice at pH 3 9 was highly acceptable Krawger et al (1992) determined major and minor constituents like total soluble solids (11 2 16 2 g/100 nos) acidity (0 46 - 1 2 g citric acid/100 ml) fructose (1 72 4 75 g) glucose (1 21 4 52 g) and sucrose (2 47 9 73 g) in pineapple juice

Kalra et al (1991) reported that beverage made from mango papaya pulp preserved for one year was organoleptically acceptable also Papaya Ready To Serve

beverage (RTS) standardised by Thirumaran et al (1993) consisted of 25 per cent pulp 9 5 per cent sugar (15 Brix) and 65 per cent water The RTS was also found to be highly acceptable organoleptically with a shelf life of more than six months Thirumaran et al (1992) has standardised the formula for the preparation of fermented carrot based RTS which was acceptable even after six months Manan et al (1992) developed an RTS with acceptable sensory attributes from 9 months stored apricot pulp

Sidappa et al (1986) defined fruit juice concentrate as a fruit juice which has been concentrated by the removal of water either by heat or by freezing Pruthi (1959) standardised the method for concentrates from lemon Hodgson (1990) developed partially clarified guava juice concentrate with a pH of 3 16 total acid 4 67 per cent ash 1 15 per cent and moisture 72 4 per cent Thirumaran et al (1990) standardised a recipe for tomato concentrates with a good shelf life period Similarly Sethi (1994) developed a method for whole tomato concentrate using chemical preservations with a shelf life of eight months

Siddappa et al (1986) has defined fruit juice powder as highly hygroscopic powder made from fruit juices to which natural fruit flavours in powder form is incorporated to compensate for any loss of flavour Different fruit powders with avocado banana mango and gauva were standardised by Pruthi and Lal (1959) Passion fruit juice powder has been standardised by Pruthi (1960)

Jam is prepared by boiling the whole fruit pulp with sugar to a moderately thick consistency without retaining the shape of the fruit (Cruess 1966) Donchenko and his colleagues (1983) observed that the pectin/sugar solution prepared in the ratio of 1 5 with water at 30 volume per weight of pectin and pH in range of 2 5 to 6 0 was observed to result in increased jam strength The study further revealed that pH value in range 2 8 to 3 2 are considered optimum for maximum strength of jam made of pineapple Thirumaran et al (1986) had standardised the formula for papaya jam with a shelf life of eight months and with an average overall acceptability score of 3 75 According to Aina and Adesina (1991) high solid jams from low usage tropical fruits are composed of fruits (43-45%) Soluble solids (68 6 68 9 per cent) reducing sugar (35 6

40 6 per cent) and pH 2 8 - 3 4 In this experiment jams showed good storage stability at ambient conditions Bhatnagar (1991) conducted studies on the preparation of jam from water melon rind The jam though low in acid and pectin was highly acceptable and had a shelf life for six months

Maini et al (1982) reported that more fruits are preserved by drying than by any other methods as these methods have major advantages of greater concentration in dry form production with minimal labour less expensive and economic equipment for processing and storage The preparation of dried papaya and jack fruit wre established by Jayaraman and Gupta (1991) Dried papaya and jack fruit are reported to be rated higher in appearance flavour and texture Singaravelu and Arumugam (1993) prepared dried sapota flakes which showed a shelf life of 120 days with pretreatments and 30-40 days without pretreatments

Candied fruits are prepared by gradually concentrating fruit in syrup by repeated boiling until the fruit is heavily impregnated with sugar this process being followed by drying to over come stickiness (Cruess 1958)

Thirumaran et al (1985) standardised a simple processing technique for papaya candy making use of fully matured but unripe papaya It was found that soaking treatment of papaya pieces in water containing two per cent salt and one per cent calcium chloride solution resulted in a product with acceptable colour appearance texture and with a mean score of 3 43 for organoleptic evaluation Mohammed et al (1993) developed a recipe for candy using pineapple which was organoleptically acceptable also

2 3 Shelf life qualities of fruit based products

The quality parameters generally selected to ascertain its suitability for public use and to study the effect of processing method are chemical tests like acidity pH reducing sugar TSS and total sugar Physical qualities like moisture bulk density specific gravity pulp content microbial tests and sensory evaluation are also ascertained

Analysis of citrus juice stored over a period of eight months at room temperature showed an increase of 37 25 per cent in total acidity (Metha and Bajaj 1983) Similar findings were reported in the mango squash by Palaniswami and

Muthukrishnan (1974) and in the stored litchi juice by Sethi (1985) A slight increase in acidity was noticed after 150 days storage of canned papaya products like juice and nectar by Kulwal et al (1985) Studies conducted in amla juice by Tripathi et al (1988) exhibited an increase of 0 86 per cent in acidity during storage Studies conducted by Thirumaran et al had noticed similar increase in acidity in tomato juice concentrate (1990) and in fermented carrot based RTS (1992) Guava pulp stored over a period of 45 days showed an increase in acidity during storage (Kalra and Revath 1981) Studies by Tripathi et al (1988) in amla jam had noticed an increase of 0 03 per cent in acidity during 135 days of storage Changes in chemical characteristics of mango bars during 90 days of storage indicated an increase in acidity (Mir and Nath 1993) Analysis of dried pomegranates had also shown a higher acidity content (Kahtani 1990) Shelf life studies on whole tomato concentrate stored for eight months showed an increase of 2 08 per cent in tirable acidity (Sethi 1994)

On the other hand analysis of preserved grape juice proved that processing and pretreatments had negligible effect on acidity (Sandhu et al 1988) Kalra et al (1991) had also reported that acidity did not change significantly

during the 12 month storage of mango papaya blended beverage The kinnow RTS stored at ambient condition when evaluated showed negligible changes in acidity (Renote et al 1992) Analysis of kinnow juice over a period of storage of six months indicated negligible to slight changes in acidity (Renote et al 1993)

But Bawa and Saini (1987) had reported a decrease in acidity during storage period of bottled carrot juice Perlette (1992) reported that acidity showed a decreasing trend with storage in grape juice Storage studies in amla candy and dehydrates had noticed a decrease of 0 02 per cent in acidity during storage

Since the deteriorative changes were temperature dependent the increase in acidity were minimum at low temperature in mango bars (Mir and Nath 1993) But the study in bottled carrot juice by Bawa and Saini (1987) indicated that the changes in acidity was not obvious at lower temperature Singh et al (1983) explained it on the lower rate of change in acidity at lower tempera ure as due to the inhibitory effect of low temperature on enzyme activities responsible for the production of acidity

pH is important as a measure of active acidity which influence the flavour or palatability of a product and affects the processing requirement (Renganna 1978)

Chemical analysis by Thirumaran et al (1990) showed a decreasing trend in pH in tomato juice concentrate (4 1 - 4 01) during storage period and in fermented carrot based RTS (1992) A similar decrease in pH was noticed in tomato concentrate by Sethi (1994)

Analysis of canned papaya products by Kulwal et al (1985) had indicated no change in pH during storage Chemical changes during storage in amla juice produced little change in pH (Tripathi et al 1988) The kinnow RTS stored showed negligible changes in pH when evaluated for quality (Renote et al 1992) The analysis of pH on grape juice by Perlette (1992) failed to reflect any change in pH during 24 week storage Negligible to slight changes in pH was reported by Renote et al (1993) in kinnow juice during storage

Studies on the chemical characteristics of citrus ju ce by Bawa and Saini (1987) indicated an increase in pH from 4 2 to 4 5 at higher temperature Mehta and Bajaj

(1983) had reported that the citrus juice during storage of eight months showed a slight increase in pH

Chemical changes related to storage were studied by Tripathi et al (1988) in amla jam and dehydrated products The study indicated no change in pH Canned peach and apricot pulp stored well over 24 weeks produced negligible changes in pH (Shah and Bains 1992)

Variation in reducing sugar during storage may be mainly due to the acid hydrolysis of sucrose (Labuza et al 1970) and the inversion is temperature dependent the inversion rate being higher at higher temperature

Singh and Mathur (1953) had observed an increase in reducing sugar in cashew kept under different storage temperatures the increase being greater at higher temperature

Palaniswami and Muthukrishnan (1974) had reported an increase of 0 09 per cent in reducing suga in lemon juice Guava pulp stored at different temperature showed an increase in reducing sugar with 45 days of storage (Kalra and

Revath 1981) A gradual increase in reducing sugar was observed by Mehta and Bajaj (1983) in citrus juice during the storage period of eight months and the increase being 50 88 per cent Analysis on canned papaya products like juice and nectar by Kulwal et al (1985) noticed an increase in reducing sugar during 150 days of storage

Analysis on the shelf life quality of amla juice by Tripathi et al (1988) had indicated an increase of 0 19 per cent in reducing sugar during storage Storage studies conducted by Thirumaran et al had observed an increase in reducing sugar in tomato juice concentrate (1990) and in fermented carrot based RTS (1992) Analysis on kinnow juice stored over a period of six months showed an improvement in invert sugar with the passage of time under ambient condition (Renote et al 1993)

Particularly no changes in reducing sugar was observed by Sandhu et al (1988) during 24 weeks storage of grape juice They concluded that storage period had no effect on the concentration of reducing sugar The chemical analysis of stored kinnow RTS showed only negligible changes in reducing sugar (Renote et al 1992) while in a study

conducted by Perlette (1992) only a slight change in reducing sugars was obtained during the 24 week storage in grape juice It was evident from the study that storage temperature and sulphur dioxide had little effect on the reducing sugar values

The chemical analysis of litchi pulp during storage showed an increase in reducing sugar (Sethi 1985) At higher temperature the inversion was higher than low temperature In the shelf life studies in amla jam by Tripathi et al (1985) an increase of 9 89 per cent in reducing sugar was observed Changes in chemical characteristics of mango bars during 90 days storage were studied at different temperature by Mir and Nath (1993) They had observed that reducing sugar increased significantly at higher temperature

In shelf life studies in amla candy and dehydrated products Tripathi et al (1988) had observed 5 56 per cent increase in reducing sugar

Shelf life studied in amla juice by Tripathi et al (1988) produced a one per cent increase in total sugar during 135 days

In storage studies of Kulwal et al (1985) in canned papaya products namely pieces juice and nectar changes in total sugar was negligible During storage of carrot juice the total sugar was found to decline by 0 14 per cent at room temperature compared to decline of 0 04 per cent at low temperature by Bawa and Saini (1987) Chemical analysis of fermented carrot based RTS indicated a decline in total sugar (Thirumaran et al (1992) A similar decline was also reported by Renote et al (1993) in kinnow juice

Singh and Mathur (1953) observed an increase in TSS content in cashew apples at different temperature and the increase was greater at higher temperature Monthly analysis of citrus juice stored over a period of eight months showed a slight increase of 1 03 in TSS (Mehta and Bajaj 1983) Similarly litchi juice at room temperature and low temperature showed a rise in TSS content irrespective of the storage temperature (Sethi 1985) Storage evaluation of amla juice had revealed that TSS content increased by one per cent with storage period (Tripathi et al 1988) Guava pulp stored at different temperature showed an increase in TSS content within 45 days of storage (Kalra and Revath 1981)

Whole tomato concentrate stored for a period of eight months indicated an increase of 4 847 in TSS (Sethi 1994)

Shelf life evaluation in grape juice with different treatments such as pasteurisation preserved with potassium metabisulphite and sodium benzoate by Sandhu et al (1988) had indicated little changes in TSS content They also concluded that processing and pretreatment had negligible effect on the TSS content Mango papaya blended beverage stored over a period of one year at ambient condition had shown that TSS content did not change significantly during storage (Kalra et al 1991) Similarly kinnow RTS stored at ambient condition over 24 weeks (Shah and Bains 1992) and and kinnow juice over a period of six months (Renote et al 1993) had indicated negligible changes in TSS

In the storage studies by Thirumaran et al (1990 and 1992) they had observed a decline in TSS on storage in tomato juice concentrate and in fermented carrot based RTS

Storage evaluation in dried amla products had revealed that TSS in candy decreased after 45 days while dehydrated amla remained unchanged

According to Herrington (1991) sensory evaluation technology is a method using skilled management and trained panelists to provide confirmation on the acceptability of the product in terms of product profile consumer acceptability and consistency

Storage studies conducted by Mehta and Bajaj (1983) had revealed that colour retention was better in samples preserved with potassium meta bisulphate when compared to pasteurized and sodium benzoate preserved samples Crowell and Ough (1987) had concluded that pretreatment with sulphur dioxide in grape juice was not only effective in preserving good colour and quality but also helped to control the oxidation of juice Organoleptic evaluation of bottled carrot juice had shown that the product was acceptable for six months and twelve months at room temperature and low temperature respectively (Bawa and Saini 1987) The evaluation of colour flavour and taste in stored grape juice had shown particularly no change in colour during storage (Sandhu et al 1988) The grape juice stored for 24 weeks had shown that sulphur dioxide improved the colour during storage (Perlette 1992) The formula for fermented carrot based RTS was acceptable for all the quality

attributes like colour appearance flavour and taste for more than six months (Thirumaran et al 1992)

Organoleptic evaluation of stored amla jam indicated that the acceptability increased with storage (Tripathi et al 1988) Acceptability tests were conducted in mango pulp pretreated with 1000 ppm sulphur dioxide alone and 500 ppm sulphur dioxide and 500 ppm sodium benzoate by Sethi and Malini (1991) The evaluation after one year revealed that addition of sulphur dioxide alone and storage at low temperature helped in the retention of carotenoid pigment flovours and colour

Changes in sensory characteristics of mango bars during 90 days storage at different temperature were studied by Mir and Nath (1993) The study indicated that storage decreased overall acceptability and colour darkened But such changes were lower in sulphited samples

Organoleptic evaluation of amla candy and dehydrated amla showed that the acceptability decreased with storage (Tripathi et al 1985) The evaluation of dried and dehydrated pumpkin indicated that sulphitation retards

browning and retains colour during storage The blanched and sulphited samples were found more organoleptically acceptable (Pawar et al 1985)

The microbial growth or microbial damage of a product is dependent upon certain factors both chemical and physical which are favourable for their growth Among this pH is one of the important factor that determines the survival and growth of microorganisms during processing and storage Microorganism are affected by the level of free hydrogen ion and concentration of undissociated weak acid Vas and Ingram (1949) also suggested the greater preservation of food could be obtained by lowering the pH by addition of acids like sulphur dioxide According to Joslyn and Braverman (1954) Sulphurdioxide is also thought to be an enzyme poison inhibiting the growth of microorganisms and essential enzymes In a report published by the International Commission on Microbiological Specification for Food (1980) it has been further stated that sulphur dioxide possess both the biosidal and biostatic properties The preservation action of sulphur dioxide is mainly by lowering the pH below 4 and main organisms killed or inhibited are yeast mold and gram positive bacteria

Fruit juice containing 66 per cent or more sugar do not ordinarily ferment Scott and his collegues (1940) have found that sugar syrup containing 66 per cent sugar have little moisture available for microorganisms to grow or thrive

Shoenfield and Margalith (1962) isolated Bacillus group especially B lichaniformis which caused gaseous spoilage in cans of banana puree Gupta et al (1971) observed spore forming bacilli associated with the fermentation of commercially prepared vegetable sauce from pumpkin Fields et al (1977) also isolated the same bacteria from house canned tomatoes and Allen et al (1986) found that this group of Bacillus is most prevalent one among the Bacillus species identified in fruit products Analysis on decayed dried pomegranate by Kahtani (1990) showed that the organisms responsible were Aspergillus and Pencillium Evaluation on swelling due to gas formation in commercially canned mango pulp showed that it was caused by B Lichiniforms (Ranganna 1993) Analysis of the spoiled samples of tomato concentrate showed spoilage was either by yeast or Aspergillus (Sethi 1994)

2 4 Effect of different pretreatments prior to processing on the shelf life quality of papaya products

Before processing the fruits are generally treated with blanching in boiling water exposure to sulphur or citric acid to enhance shelf life of the products These treatments are considered as pretreatments

Siddappa et al (1986) defines blanching as a treatment of fruits and vegetables with boiling water and steam for short period followed by cooling before processing Kalra (1990) defines blanching as a partial pre-cooking method in which fruits and vegetable are usually heated in water or on live steam According to Bengtsson (1969) main purpose of blanching before processing is to inactivate enzyme remove raw or bitter flavour stabilize the colour and texture reduce bacterial load add desirable additive and prevent many undesirable changes during processing Kalra (1990) has further reported that blanching may extend shelf-life quality and the organoleptic quality of

the product He also reported that due to blanching decrease in volume nutritive value loss of natural colour and flavour are also observed

Sharma and co-workers (1993) have reported that blanched apricots while drying showed low discolouration compared to untreated fruits However Pawar et al (1985) has felt that blanching is one of the suitable pretreatments for drying and dehydration of fruits since it accelerates the actual drying process and helps in maintaining the quality of the product during processing and storage Experiments conducted by Shah and Bains (1992) on peach and apricot pulps blanching prior to pulping at a temperature of 92 5 ±21 5 C for 3 5 minutes has resulted in better shelf-life qualities A comparative study was carried out by Scow et al (1991) on the effect of low and high temperature blanching on the firmness of canned and frozen fruits The study revealed that low temperature blanched canned guava and papaya were significantly firmer than high temperature blanched products On the basis of these observations a temperature of 50°C for blanching was suggested

Blanching is reported to conserve nutrients as revealed in studies conducted by Sian and Ishak (1991) In this study carotenoids of papaya and pineapple were found to be retained better after blanching It was further observed that carotenoids decreased progressively as the blanching temperature (100 C) and time (14 minutes) increased and carotenoids were found to be retained better with higher moisture and sugar

According to Renganna and Padival (1981) sulphiting is the treatment of fruits and vegetables with soluble sulphites to prevent browning They further explained that small concentration of sulphur dioxide may help in protecting the flavour in products Sulphiting is also reported to be a suitable pretreatment for dehydrated products since it prevents the major problem observed in dehydrated products that is discoloration Similar observations were reported by Sethi (1985) in fruit pulps during storage Litchi pulp samples stored for a year treated either with 500 ppm sulphur dioxide or 500 ppm sulphur dioxide with one per cent citric acid Sulphur dioxide alone was reported to show less browning during storage The studies conducted in mango bars by Mir and Nath (1993) have indicated a decrease in non-

enzymatic browning in sulphited samples The colour of mango bars darkened during storage in unsulphited samples but such changes were negligible in sulphited samples Singaravelu and Arumugam (1993) have stated that sulphitation increased the shelf life of dried sapota flakes three fold than that of control (30-40 days)

An advantage of sulphitation is reported to be retention of nutrients present in fresh fruits A study conducted by Sethi (1991) on mango pulp with different pretreatments such as 1000 ppm sulphur dioxide alone and 500 ppm sulphur dioxide and 500 ppm sodium benzoate has revealed that samples treated with sulphur dioxide alone were found to help in the retention of carotenoids According to Sethi and Malini (1991) juices prepared from sulphited mango pulp had better flavour than controls Studies on solar dried figs by Pawar et al (1992) indicated that samples pretreated with sulphitation retained more sugar than blanched and control A study by Perlette (1992) in grape juice have shown that sulphitation improved the colour of the product Similar results were reported by Mir and Nath (1993) in their studies on mango bars The colour of Mango bars darkened during storage but changes were negligible in sulphited samples A

study conducted by Mohammed et al (1993) have proved that treatment with sulphur dioxide prior to processing pineapple candy had increased the retention of ascorbic acid and also the organoleptic qualities

Organoleptic qualities of the products pretreated with sulphur dioxide were found to be superior in comparison with untreated samples The study on effect of pretreatment with sulphur dioxide in grape juice by Crowell and Ough (1987) showed that the product treated with sulphur dioxide had better acceptability They had further reported that pretreatment with sulphur dioxide helped to preserve good colour since it controlled the oxidation of the juice According to Pawar et al (1985) sulphur dioxide treatment not only helps in accelerating drying process but also helps in maintaining the quality of the product during processing and storage since it retards browning and retain colour Manan et al (1992) conducted storage studies in apricot pulp preserved with 547 ppm sulphur dioxide The study indicated that the pulp was acceptable upto nine months at room temperature They had further stated that squash made from this pulp had good shelf life for six months and was highly acceptable

Sulphur dioxide sulphate bisulphate salts and metabisulphite salts are reported to act similarly Renganna and Padival (1981) have reported that the preservative action is due to the free sulphur dioxide present and not due to combined or total sulphur dioxide Weeny et al (1969) has stated that browning index is inversely proportional to the residual sulphur dioxide in the stored product Hence retention of natural colour

According to Renganna and Padival (1981) sulphuring is a process in which fruits are exposed to fumes of burning sulphur Sulphuring prior to processing not only protect certain nutrients and controls discoloration but also controls microbial and insect activity very effectively

Sharma et al (1993) conducted studies to find out the effect of pretreatments such as heat application chemical dipping and sulphur fumigation prior to drying apircots to prevent discolouration The study revealed that maximum and minimum browning were observed in untreated samples and sulphur fumigated samples respectively According to this experiment among different pretreatments sulphur fumigation was found to be the best

Pederson (1949) found that acid dips or addition of acids during crushing prevent browning of juices and improved the flavour and aroma Teotia et al (1983) have found that of all the pretreatments the okra pieces before canning blanched in 0 1 per cent citric acid solution followed by dipping in one per cent calcium chloride solution was found to be the most superior in colour texture acceptability taste flavour and least microbial attack Eynen et al (1991) studied the effect of citric acid on vegetables The experimental group showed less microbial attack Obviously pretreatment with citric acid for 30 minutes was much more effective than five minutes In the pretreated model colour was natural and the product appeared fresh during storage

2 5 Effect of storage containers on the shelf-life quality of the product

A report published by The International Commission on Microbiological Specification for Foods (1980) package protections can be classified as chemical which prevents the passage of water vapour oxygen or other gases physical which protect against light dirt dust and weight loss and biological which prevents entry of microorganisms or

insects Briston (1971 and 1976) classified containers into two as rigid like cardboard paper glass and plastic or flexible like plastic and foil

Containers such as glass bottles PVC bottles HDPE pouches and metal cans are found suitable for storing fruit products A report of Kerala State Horticultural Development Corporation (1992) had revealed that there is a gradual shift from soft drinks to fruit based soft beverages available in tetra pack and tetrabulic packages

Sethi and Malini (1991) noticed that mango pulp preserved with sulphur dioxide and kept for storage studies had good shelf life in glass bottles when compared to PVC bottles and HDPE pouches Renote et al (1992) had observed that glass containers are better than metallic pouches for storing kinnow RTS since the former was superior in sensory quality Purushotham et al (1992) have also reported that corrosive products like banana and tomato products could be safely packed in glass bottles Thirumaran et al (1990) conducted an experiment on the effect of storage containers on tomato concentrate Among the containers like glass bottles plastic bottles and polythene covers the best

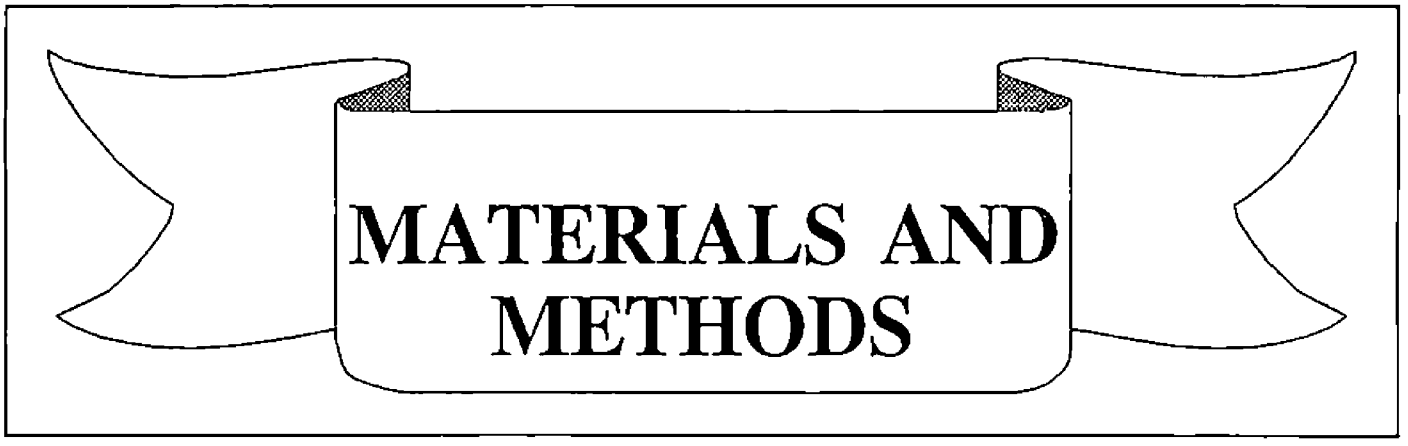
packaging material was found to be glass bottle with a shelf life of four months Kalra et al (1991) found that mango-papaya blended beverage showed a shelf-life of one year in glass bottles Suitability of indigenously available glass containers was studied for packaging processed products by Purushottam et al (1992) Reduction in carotene was found to be less in amber coloured bottles

Pruthi (1950) from his studies concluded that better retention of colour ascorbic acid and keeping quality in canned products Another study by Pruthi (1954) revealed that canned juices and squash could be stored for a period of 12 15 months without any serious loss of quality Bailey (1990) developed a flexible laminate for packaging hygroscopic food especially dried fruits The laminate consists of an inner layer of polystyrene foam with antistick properties The outer layer consists of paper or polyethylene film or plastic film Cristofaro et al (1990) conducted a comparative study of packaging material of fruit juices with glass bottles and cartons The study revealed little effect of packtype on the quality of the product

by Manan et al (1982) on apricot pulp preserved with 547 ppm sulphur dioxide has shown that the quality was satisfactory upto 9 months at room temperature They also found that squashes prepared from this pulp were acceptable upto 8 months Kalra et al (1991) had concluded that the mango papaya blended beverage showed a shelf life of 1 year under ambient condition Sethi (1985) had reported that pulp from litchi fruit was found acceptable for 6 months at room temperature and upto 12 months at low temperature

Kulwal et al (1985) had revealed from his studies that certain undesirable chemical changes like increase in acidity and inversion of sugar were very rapid at higher temperature A similar result was obtained by Sethi (1985) in litchi juice Studies conducted by Bawa and Saini (1985) in litchi juice in the effect of storage temperature inbottled carrot juice revealed that refrigerator temperature was quite acceptable They also observed that the changes in reducing sugar pH acidity and total sugar were not significant at low temperature Changes in the chemical textural and sensory characteristic of mango bars during 90 days of storage at 18 C 27+3 C and 38+1 C were studied by Mir and Nath (1993) Acidity and reducing sugar increased

significantly during storage at higher temperature The deteriorative changes were minimum at 18 C Studies conducted in papaya nectar by Brekke et al (1978) concluded that nectar should be stored at 23 9 C or below for optimum quality retention


MATERIALS AND
METHODS

MATERIALS AND METHODS

The study entitled Impact of pretreatments and processing on the shelf-life quality of papaya products is a comprehensive study on the standardisation of papaya based products and evaluation on shelf life qualities

3 1 Selection of fruit

Papaya needed for the study was collected from the Instructional Farm of the College of Agriculture Vellayani and from adjacent private farms The variety Co I was used They were washed thoroughly and dried

3 2 Pretreatments selected

The pre treatments selected for the study were

3 2 1 Blanching

3 2 2 Sulphiting

3 2 3 Exposure to Sulphur fumes

3 2 4 Immersion in citric acid solution

3 2 5 One sample as control without any of the above pre-treatments

The pretreatments to the fruits were given separately after peeling the outer skin and cutting the fruits into cubical pieces of 3cm size

3 2 1 Blanching

Treatments of fruits and vegetables with boiling water or steam for a short period followed by cooling prior to processing is known as blanching (Siddappa et al 1986) Blanching helps to inactivate enzymes remove raw or bitter flavour and softens the tissue eliminating micro organisms The method of Scow et al (1991) in using the minimum temperature and time for a better effect was administered in the present study

The fruit pieces (about 3cm cubes) were tied in a cotton cloth and submerged in boiling water for a period ranging from 1 3 minutes Different periods of blanching were used for different processing techniques selected

3 2 2 Sulphiting

Sulphiting is immersing the fruit pieces (3cm cubes) in a sulphite or bisulphite solution The pieces were immersed in one percent potassium metabisulphite solution for 30 minutes at room temperature and later the pieces were drained and spread on aluminum trays for 30 minutes before further processsing

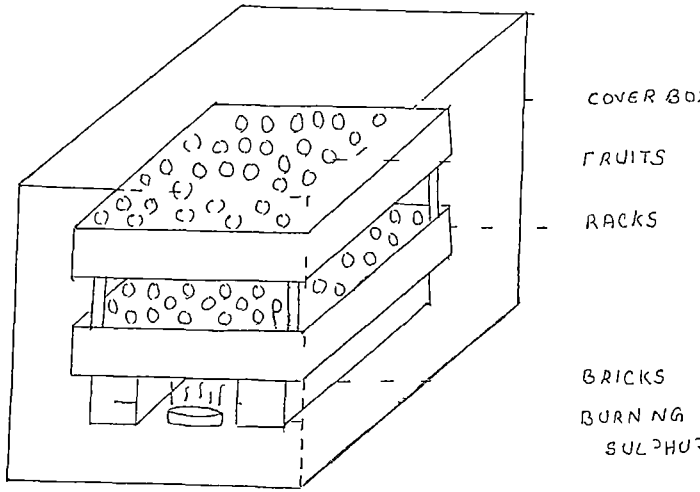
3 2 3 Exposure to sulphur fumes

The fruit pieces were subjected to sulphur fumes Cut pieces of fruits were arranged in perforated metal racks arranged inside a chamber Sulphur powder kept at the bottom rack was burnt inside the chamber for 30 minutes Sulphuring was done at the rate of 3g per Kg of fruits The fruits were processed immediately after this exposure Fig (1) depicts the cross section of a fumigation chamber

3 2 4 Immersion in citric Acid solution

The fruit pieces of size 3cm cube were immersed in five percent citric acid solution for 20-30 minutes drained

Fig 1 CROSS SECTION OF A SULPHUR FUMIGATION CHAMBER



and spread on aluminium trays for 30 minutes before further processing

3 2 5 Control

Fresh fruits without any pretreatment were need as control for comparison with the pretreated samples

3 3 Processing techniques selected

Three different processing techniques to yield the final products squash jam and candy were attempted with papaya

3 3 1 Squash

In each treatment the juice extracted from 4 kg of fully ripe fruits was mixed with double the quantity of sugar A total of 20 kg of fruit was processed to prepare 240 bottles of squash The method is depicted in Fig 2 and the samples processed presented in Fig 3

The squash prepared were bottled in 200 ml bottles and sealed using metal caps

Fig 2 Flow chart showing the steps in preparation of papaya squash

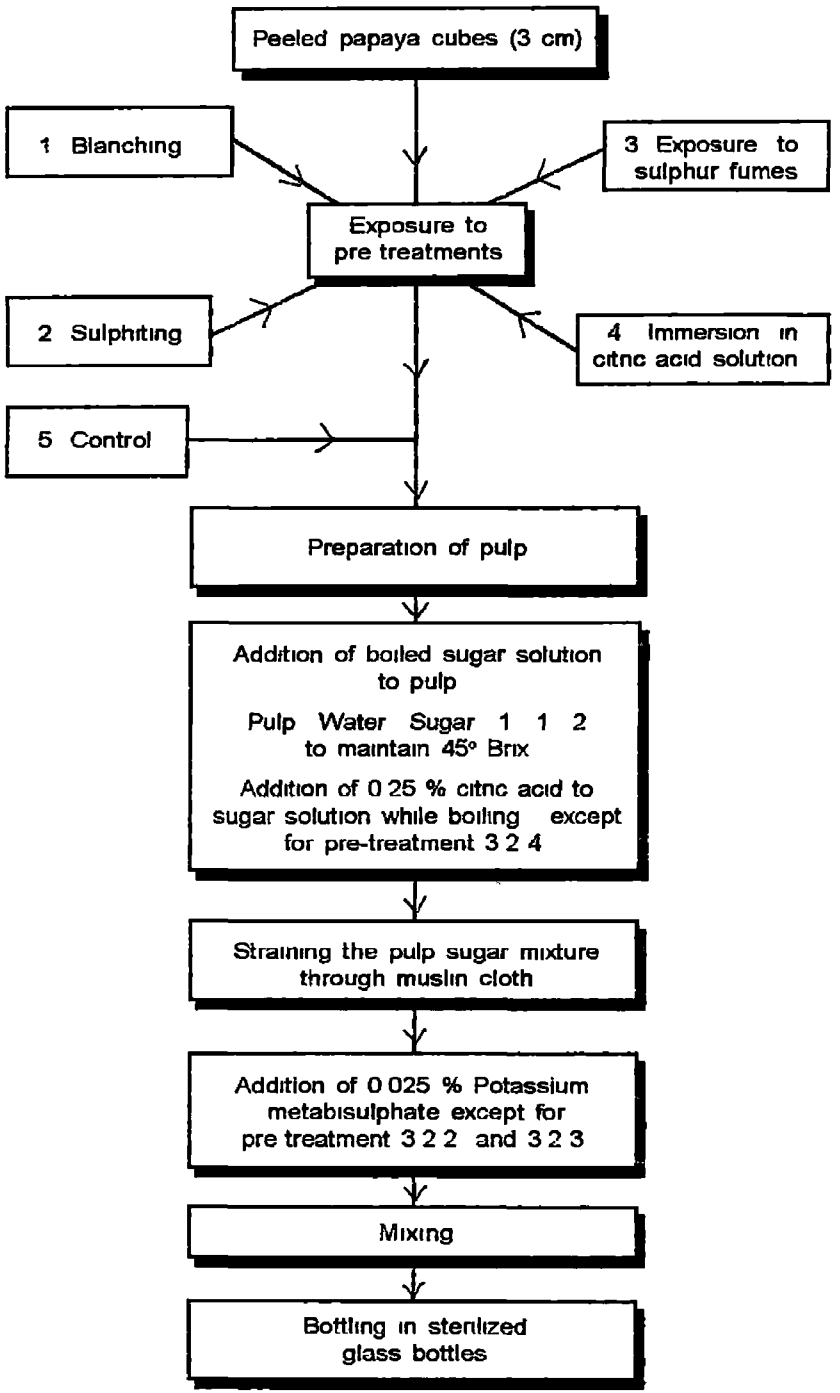


Fig 3 : Papaya squash

3 3 2 Jam

For each treatment 11 5 kg pulp from firm and ripe papaya fruits were used The fruit pulp and sugar ratio standardized was 1 1 The Fig 4 shows the steps involved in the preparation Total of 58 kg of fruit pieces were processed to prepare 240 bottles of Jam The samples processed is presented in Fig 5

The jam prepared were stored in glass bottles of 200 ml capacity The bottles were sealed sing aluminum foil and plastic lids

3 3 3 Candy

Fully matured unripe fruits were selected for the processing Eight kg of peeled fruits were required for each treatment and the equal proportion of sugar used The ratio was 1 1 A total quantity of 40 kg of fruit were processed to prepare 240 packets of Candy The method is depicted in Fig 6 and the samples processed is presented in Fig 7

Fig 4. Flow chart showing the steps in preparation of papaya jam

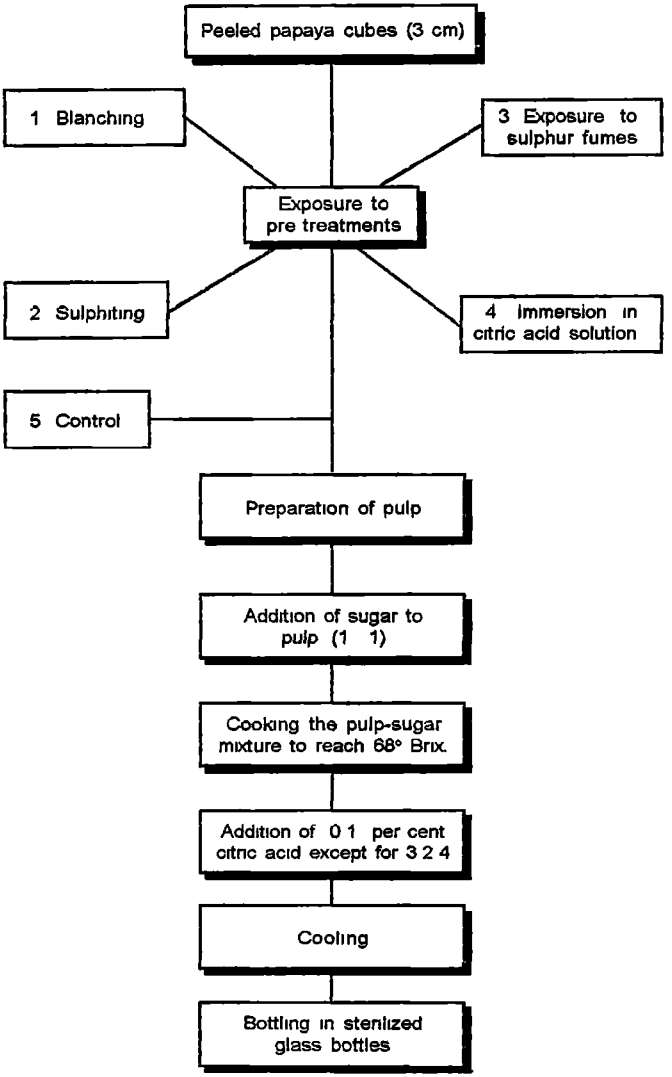


Fig 5 : Papaya jam

Fig 6 Flow chart showing the steps in preparation of papaya candy

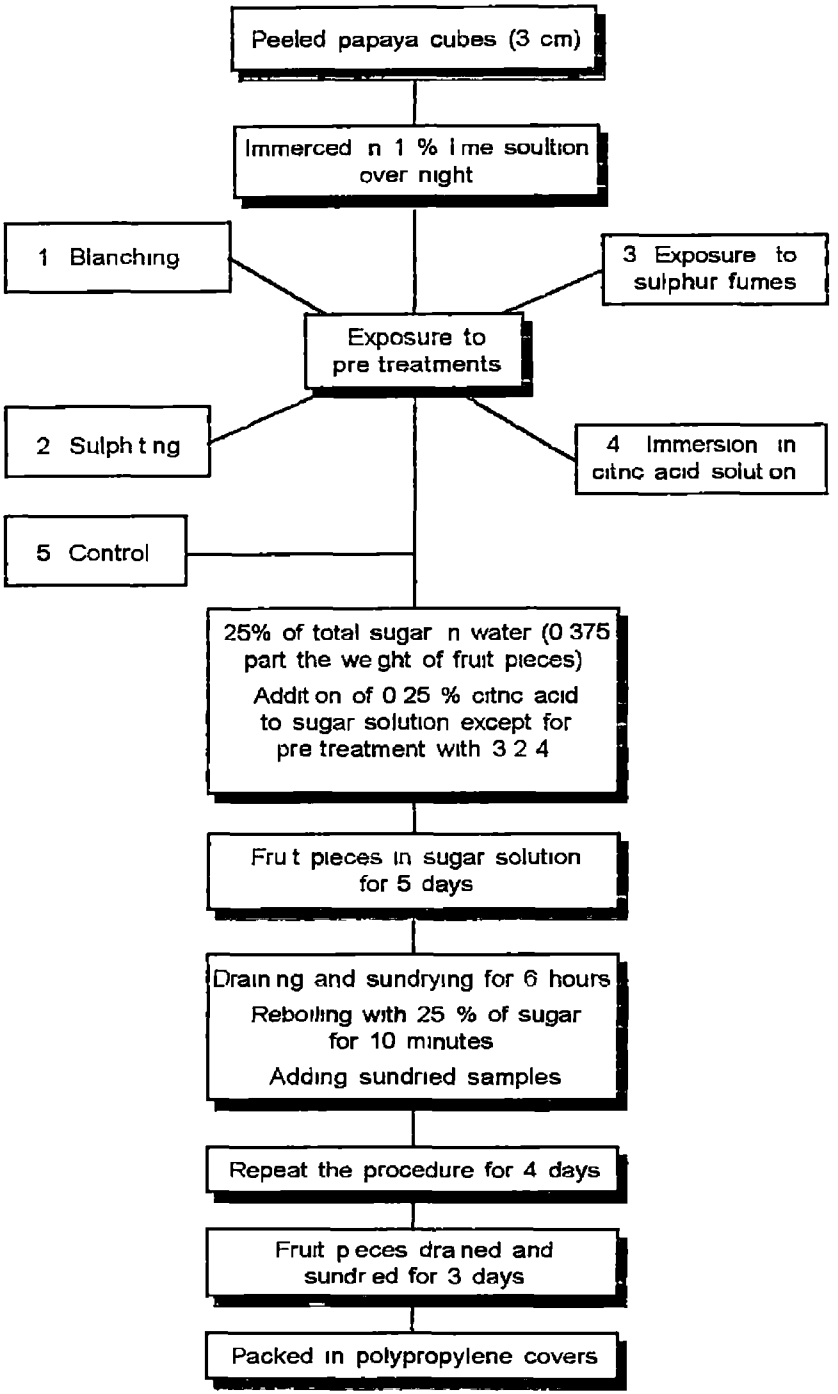


Fig 7 : Papaya candy

am nd was packed in air t ght

e

3 3 1 T st ɔr du d on the fresh products

fr s y prepared papaya squash jam and cand

fo mo sture total ash acidity reducing s gar

ota sugar crude fat crude fibre and non sugar carbol drates

All the samples were drawn randomlv in requ red quantit es for analysis in duplicate The sampling procedure s given below

Liquid sample

From liqu d sample l ke squash 10ml ot the sample was withdrawn for each analysis

Solid sample

From sol d sample ike jam a id candy 10 g ot le sample was weighed and taken for analysis

The organoleptic characteristic of the papaya based products processed by the three different methods were estimated For the conduct of the acceptability trials panel members were selected from a group of 25 healthy women in the age group of 20 25 using the triangle method Further studies have indicated that a small highly sensitive panel would usually give more reliable results than a large less sensitive group Because of this from the twenty five women ten very sensitive women were selected by the triangle test

The acceptability trials on fresh products namely squash jam and card were conducted using ten panel members Major quality attributes scored by the panel members in a five point scale were colour flavour taste and texture The tests were conducted as per the standardized procedure prescribed by Swaminathan 1974

3 4 Storage conditions selected

Storage situations selected for the study were ambient and refrigerated conditions Samples were kept for storage studies Fig 8 for one year as detailed below

Fig 8; Papaya products stored in the refrigerator

Details of samples kept for storage studies

Nature of Samples	Storage Capacity	Refrigerated Condition 4 10^{o}c	Ambient conditions 24 30^{o}c
Squash	200ml capacity	24 bottles (1 repli cation)	24 bottles (1 replication
Jam	200ml capacity	24 bottles (1 repli cation)	24 bottles (1 replicat on
Candy	100g Packets	24 packets (1 repli cation)	24 packets 1 replicat on

Shelf life qualities of the three products were ascertained through periodical tests

3 4 1 Tests conducted to ascertain shelf life qualities of papaya squash

As per Fruit Product Organisation FP specifications routine tests recommended to ascertain she f life qual ties of any squash are net olume we ght of u ce content total s luble solids acid ty pH reduc ng sugar total sugar pulp conteit specif c grav ty organo cpti quality fermentation test mold content and acid so ub e

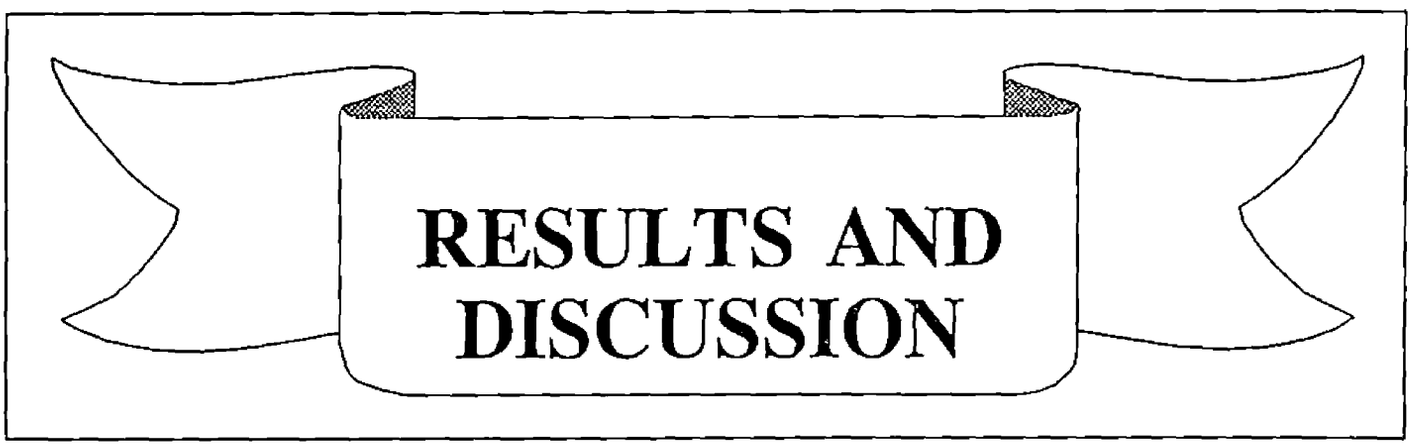
ash These tests were carried out by methods detailed in Table 1

3 4 3 Tests conducted to ascertain shelf life qualities of papaya jam and candy

As per FPO specifications routine tests recommended to ascertain shelf life qualities of jam and candy are acidity pH reducing sugar organoleptic qualities mold count and bulk density These tests were also conducted on the papaya jam and candy by method detailed in Table 1 The score card evolved for the conduct of organoleptic study is presented in Appendix 1

Table-1 Methods adopted for the analysis of the compostion and quality factors of the papaya products

No	Procedure adopted for estimations	References
1	Moisture	Renganna (1978)
2	Total Ash	Renganna (1978)
3	Acidity	A O A C (1960)
4	Reducing sugar	A O A C (1960)
5	Crude Fat	Renganna (1978)
6	Crude Fibre	Renganna (1978)
7	Carbohydrates	A O A C (1960)
8	Net volume/wt of juice content	Renganna (1977)
9	pH	Renganna (1928)
10	Total soluble solids	Renganna (1977)
11	Total Sugar	A O A C (1960)
12	Pulp Content	Renganna (1977)
13	Specific gravity	Renganna (1977)
14	Organoleptic quality	Swaminathan (1974)
15	Acid soluble Ash	Renganna (1977)
16	Bulk density	Renganna (1977)
17	Fermentation test	
18	Mold count	
19	Bacterial count	


RESULTS AND
DISCUSSION

RESULTS AND DISCUSSION

Salient findings obtained in the study entitled Impact of pretreatments and processing on the shelf-life quality of papaya products are presented below under the following headings

4 1 Influence of pretreatments on the shelf-life qualities of papaya products

4 2 Influence of processing technique on the shelf-life qualities of papaya products

Fresh as well as pretreated papaya fruits were processed as squash jam and candy Different pretreatments attempted were blanching sulphiting exposure to sulphur fumes and immersion in citric acid solution

Different storage conditions attempted for one year were mainly based on temperature one set at ambient conditions (24 to 30^{o}C) and another set under refrigerated conditions (4 to 10^{o}C)

4 1 Influence of pretreatments on the shelf-life qualities of papaya products

Shelf life qualities comprise proximate composition organoleptic qualities and selected other parameters like acidity pH reducing sugar total sugar total soluble solids pulp content specific gravity overall acceptability mold content fermentation and acid soluble ash for squash and acidity pH reducing sugar overall acceptability bulk density and mold count for jam and candy The details are presented below under following headings

4 1 1 Processing papaya products

4 1 2 Influence of pretreatments on the proximate composition of the fresh papaya products

4 1 3 Influence of pretreatments on the organoleptic qualities of fresh papaya products

4 1 4 Influence of pretreatments on the shelf life qualities of papaya products

4 1 1 Processing of papaya products

About one hundred and twenty kg of papaya fruits were processed to prepare the three products after pretreatments as indicated in Table 2

Papaya based products processed for the study were squash (240 bottles) jam (240 bottles) and candy (240 packets) The product had the flavour of original fruit and were free from burnt or objectionable flavour The candy prepared was translucent and not hard or granular Fifty per cent of the products were kept in the refrigerator and the remaining at the ambient condition

Percentage of fruit and sugar in the final product on the basis of weight by weight was also varying since percentage of sugar in squash was 66 7 per cent while in jam it was 50 per cent In candy 70 to 71 4 per cent of sugar was observed to be absorbed

In squash the fruit juice included was an unconcentrated liquid extracted from the ripe fruit and contained portions of pulp and other cellular matter FPO

Table 2 Details of papaya based products processed for the study

Pretreatments	Details of products		
	Squash* (200 ml	Jam** (200 ml	Candy** (100 ml
	number of bottles/packets		
1 Control	48	48	48
2 Blanching	48	48	48
3 sulphiting	48	48	48
4 Exposure to sulphur fumes	48	48	48
5 Immersion in citric and solution	48	48	48
	240	240	240

Fruit sugar * 1 2

** 1 1

has specified the minimum percentage of total soluble solids in the final product as a special characteristic of squash In FPO specification for jam besides minimum percentage of soluble solids in the final product minimum percentage of fruit in the final product on the fresh fruit basis (w/w) was indicated Similarly by FPO special characters indicated for candied fruits are percentage of total sugar and percentage of reducing sugar to total sugar (w/w) Details pertaining to the three products in this respect were tested and were found to satisfy the FPO requirements (Table - 3)

4 2 2 Influence of pretreatments on the proximate composition of the fresh papaya products

Proximate composition of the fresh fruit products with reference to moisture total ash acidity reducing sugar total sugar crude fat crude fibre and carbohydrates other than sugars were estimated Along with the determination of proximate composition the tests to ascertain their acceptability by consumers were administered Influence of pretreatments on the above characters were also evaluated The results are presented in Table 4 5 and 6

Table 3 Contrast between specification of papaya products prepared and FPO standards [Siddappa et al ICAR 1986]

Pretreatments		Squash		Jam		Candy	
		1	2	3	4	5	6
		TSS%	Fruit juice(%)	% of fruit in the final	% of soluble solids	% of T S	% of R S to T S
1	FPO standards	40 0	25 0	45 0	68 0	> 70	≥ 25
2	Control	56 6	31 3	53 1	68 2	71 4	29 1
3	Blanching	58 0	30 9	50 0	68 7	83 3	28 6
4	Sulphiting	58 0	31 7	52 1	68 9	83 3	27 3
5	Exposure to sulphur fumes	57 6	30 5	52 1	68 6	71 4	31 8
6	Immersed in citric acid solution	56 8	31 5	51 0	68 4	71 4	30 4

Proximate composition of papaya squash

Various pretreatments administered were found to influence the constituents of the products differently This is well illustrated by the data presented in Table 4 Probably the extraction of constituents from the fruit was stimulated by pretreatments while prolonged application of heat Blanching had negatively affected the retention of constituents like moisture total ash reducing sugar TSS and total sugar Similar trend was observed in control sample also but for higher pH value Chan and Kwok (1975) had reported that the hydrolysis of non reducing sugar to reducing sugar is rapid in papaya after the tissue is macerated Moisture total ash reducing sugar TSS and total sugar were high in samples pretreated with sulphur fumes Statistical analysis of the data revealed that pretreatments had no significant effect on acidity specific gravity acid soluble ash and overall acceptability

Proximate composition of papaya jam

In papaya jam various pretreatments administered were found to influence the constituents of the product

Table 4 Effect of pretreatments on the proximate composition of fresh papaya squash

Pretreatments	Moisture %	Total ash	Acid soluble ash (%)	Acidity % citric acid	Reducing sugar %	Total sugar (%)	Carbohydrate (%)	TSS %	pH	Pulp content (ml)	specific gravity	Organoceptic quality (mean)
1 Control	71 40	1 20	1 00	1 60	5 00	70 67	42 65	56 80	2 80	35 90	1 28	4 45
2 Blanching	72 40	1 40	1 10	1 60	5 00	71 40	42 90	56 00	2 68	36 90	2 30	4 60
3 Sulphiting	73 00	2 00	1 15	1 80	6.250	70 70	51 10	58 00	2 41	36 60	1 29	4 50
4 Exposure to sulphur fumes	75 10	2 00	1 15	1 86	6.250	71 40	45 00	58 00	2 41	35 80	1 29	4 50
6 Immersed in citric acid solution	74 60	1 90	1 16	1 70	5 50	71 40	48 90	57 60	2 5	37 50	1 30	4 55
CD (0 05)	1 06**	0 54*	0 26	0 33	0034**	1 67	0 36**	0 73*	0 23*	0 35**	0 12	0 46

* 5 per cent significant

** 1 per cent significant

differently The data are presented in Table 5 Fruits immersed in sulphur dioxide solution exposed to sulphur fumes and immersed in citric acid solution showed a higher concentration in acidity Moisture level reducing sugar total sugar and carbohydrates were higher in fruits exposed to sulphur fumes while jam processed from blanched fruit recorded the highest score for overall acceptability Lower values obtained for control for acidity reducing sugar total sugar and carbohydrates indirectly indicated the influence of different pretreatments on these constituents Except bulk density and ash all other factors were significantly influenced by the pretreatments

Proximate composition of papaya candy

In the case of papaya candy statistical analysis of the data collected on various constituents of different pretreated samples indicated that moisture total ash total sugar and crude fibre were not influenced by the pretreatments applied as presented in Table 6 while acidity reducing sugar crude fat carbohydrate pH bulk density and overall acceptability were significantly influenced by the pretreatments Products processed with fruits immersed

Table 5 Effect of pretretments on the proximate composition of fresh papaya jam

Pretreatments	Moisture	Total ash %	Acidity % citric acid/g	Reducing sugar	Total sugar %	Crude fat g/ 100g	Crude fibre g/ 100g	Carbo hydrte %	pH	Bulk density lb/wt	Organo-leptic quality (mean score)
1 Control	25 70	2 00	0 50	26 30	38 50	0 09	0 72	23 67	3 90	119 00	4 10
2 Blanching	25 30	1 96	0 50	27 80	41 70	0 10	0 85	25 02	3 80	117 00	4 40
3 Sulphiting	25 00	2 10	0 70	29 40	41 60	0 10	0 80	26 46	3 10	118 10	4 20
4 Exposure to sulphur fumes	26 10	2 20	0 70	31 30	41 70	0 09	0 80	28 17	3 00	117 50	4 30
6 Immersed in citric acid solution	25 30	1 98	0 70	29 40	41 60	0 11	0 80	26 46	3 20	117 00	4 10
CD (0 05)	0 54	0 42	0 04	0 26	0 28	0 04	0 05	0 07	0 03	85 08	0 36

* 5 per cent significant

** 1 per cent significant

Table 6 Effect of pretretments on the proximate composition of fresh papaya candy

Pretreatments	Moisture %	Total %	Acidity % citric acid/g	Reducing sugar % G/g	Total sugar %	Crude fat g/100g	Crude fibre g/100g	Carbo hydrte %/gm	pH	Bulk density lb/wt	Organo-leptic quality (mean score)
1 Control	30 60	0 98	0 50	21 70	71 40	0 23	0 85	19 53	3 56	39 50	3 30
2 Blanching	30 20	0 90	0 50	20 80	71 40	0 21	0 80	18 72	3 50	40 00	3 90
3 Sulphiting	30 10	1 02	0 76	23 80	77 35	0 24	1 05	21 42	3 10	41 10	3 80
4 Exposure to sulphur fumes	30 40	0 86	0 70	22 70	77 35	0 25	1 00	20 43	3 00	41 20	4 60
6 Immersed in citric acid solution	30 30	0 95	0 76	22 70	71 40	0 92	1 00	20 50	3 18	41 60	3 70
CD (0 05)	0 46	0 50	0 12	0 26	13 68	0 12	0 28	0 16	0 52	0 93	0 36

* 5 per cent significant

** 1 per cent significant

in citric acid solution were high in acidity reducing sugar and carbohydrates while those processed with blanched fruits were low in these constituents and also in crude fat Fruits exposed to sulphur fumes obtained the highest score of 4 8 for overall acceptability while control samples obtained the lowest score of 3 3 for overall acceptability

4 1 3 Influence of pretreatments on the organoleptic qualities of fresh papaya products

For any product acceptability among the public is the most important quality In the pretreatments the fresh fruit was exposed to boiling water sulphur and citric acid An attempt was made to ascertain the influence of these treatments on the acceptability of the product Major quality attributes such as appearance colour taste flavour and texture were rated in the products and their overall acceptability was worked out by adding the scores obtained for all the four quality attributes tested Maximum score that would be obtained for a product was 20 and the minimum score was 4

Influence of pretreatments on the organoleptic qualities of three products are presented in Table 7 8 and 9

In the case of squash as detailed in Table 7 scores obtained for overall acceptability was highest for blanching (18 3) followed by fruits immersed in citric acid solution (18 2) fruits exposed to sulphur fumes (18 0) fruits sulphited (17 9) and control (17 8) Exposure to sulphur fumes and immersion in citric acid solution were found to influence the taste and colour of the product This treatment might have temporarily bleached the colour

Further analysis of each quality attribute for papaya squash revealed that taster and colour were not much affected by the pretreatments Statistical analysis of the data revealed that pretreatments had no significant effect on these qualitres Pederson (1947) had found that acid dips before processing improve the flavour and aroma of squash Pretreated samples were found to give higher scores than control Crowell and Ough (1987) had found that the pretreatment with sulphur dioxide help to preserve colour in fruit juices

Table 7 Effect of pretreatments on the organoleptic qualities of fresh papaya squash
(Mean scores)

Treatments	Organoleptic qualities				Total score
	Taste	Colour	Flavour	Appearance	
Control	4 4	4 5	4 6	4 3	17 8
Blanching	4 7	4 6	4 6	4 4	18 3
Immersed in sulphur dioxide solution	4 3	4 5	4 5	4 6	17 9
Exposed to sulphur fumes	4 4	4 6	4 6	4 4	18 0
Immersed in citric acid solution	4 7	4 6	4 6	4 3	18 2
CD (0 05) F-test					0 46

Results pertaining to organoleptic qualities papaya jam are presented in Table 8 The scores obtained for overall acceptability of papaya jam was highest for blanching (17 7) followed by fruits exposed to sulphur fumes (17 2) fruits sulphited (16 8) control (16 4) and fruits immersed in citric acid solution (16 2) Exposure to sulphur fumes and sulphiting might have influenced the taste of the product This treatment might have temporarily bleached the colour and toughened the outer layer of the fruit

In the case of papaya jam comparative scores obtained for all the samples including control were low However the fruits immersed in citric acid solution gave the least acceptable product mainly because of the lower score obtained for texture Statistical analysis of the data revealed that pretreatments had significant effect on the organoleptic qualities Jam processed from blanched fruits and fruits exposed to sulphur fumes had recorded the highest scores Organoleptic evaluation in papaya jam conducted by Thirumaran et al (1986) revealed that the product was acceptable with a mean score of 3 75

Table 8 Effect of pretreatments on the organoleptic qualities of fresh papaya jam

(Mean scores)

Treatments	Organoleptic qualities				Total score
	Taste	Colour	Flavour	Appearance	
Control	4 3	3 8	4 3	4 0	16 4
Blanching	4 5	4 2	4 2	4 8	17 7
Immersed in sulphur dioxide solution	4 0	4 5	4 1	4 2	16 8
Exposed to sulphur fumes	4 2	4 2	4 2	4 6	17 2
Immersed in citric acid solution	4 2	4 2	3 5	4 3	16 2
CD (0 05)					
F test					0 36**

** 1 per cent significant

Table 9 details the data pertaining to papaya candy In the case of papaya candy scores obtained for overall acceptability was higher for fruits exposed to sulphur fumes (18 4) followed by fruits blanched (15 5) fruits sulphited (15 3) fruits immersed in citric acid solution (14 9) and control (13 1) Exposure to sulphur fumes was found to improve the colour and overall acceptability of the product This treatment might have temporarily bleached the colour and toughened the outer layer of the fruit

Compared to squash and jam papaya candy received lesser scores Candy processed with papaya pretreated with sulphur fumes unlike the other two products gave the maximum values for colour score Mehta et al (1983) reported high acceptability to dehydrated papaya slices blanched in 50° Brix sugar Studies conducted by Crowell and Ough (1987) Pawar et al (1985) and Sharma et al (1993) had revealed that fruits exposed to sulphur fumes would give a better colour for the product All the pretreated samples gave higher values than control sample Among the quality parameters texture taste and colour were responsible for the lower scores of candy Statistical treatment of the data

Table 9 Effect of pretreatments on the organoleptic qualities of fresh papaya candy

(Mean scores)

Treatments	Organoleptic qualities				Total score
	Taste	Colour	Flavour	Appearance	
Control	3 1	3 0	3 3	3 7	13 1
Blanching	3 9	3 8	4 0	3 8	15 5
Immersed in sulphur dioxide solution	4 0	3 8	3 7	3 8	15 3
Exposed to sulphur fumes	4 8	4 2	4 4	5 0	18 4
Immersed in citric acid solution	3 9	3 6	3 5	3 9	14 9
CD (0 05)					
F-test					0 36**

** 1 per cent significant

revealed that pretreatments had significant effect on the organoleptic evaluation Candy processed from fruits exposed to sulphur fumes had the highest organoleptic acceptability followed by product processed from blanched fruits However Scow et al (1991) in their study on candy revealed that blanching would increase the firmness of candies Earlier studies conducted by Scow et al (1991) Pawar et al (1985 and 1992) and Sharma et al (1993) had also revealed that there will be individual variation in scores among products for a similar pretreatment

Studies conducted by Bengtsson (1964) Pawar et al (1985) and Kalra (1990) had revealed that heat application may stabilize the colour and texture and also remove raw or bitter taste thus improving the overall acceptability In the present study among the three products squash and jam processed with blanched fruits were most acceptable while in the case of candy processed with fruits exposed to sulphur fumes was the most acceptable When compared to control all the squash prepared from the different pretreated fruits gave higher scores In a similar comparison of jam processed from fruits immersed in citric acid solution gave lower score compared to control Results obtained for candy revealed

that the product prepared from the pre treated fruits gave higher scores when compared to control

4 1 4 Influence of pretreatments on the shelf-life qualities of papaya products

The shelf-life qualities of papaya products were assessed periodically for one year The qualities analysed for the three products were acidity pH reducing sugar overall acceptability and mold content

In papaya squash specific gravity acid soluble ash total sugar pulp content total soluble solids and fermentation tests were also determined while in the case of papaya jam and candy bulk density was also tested

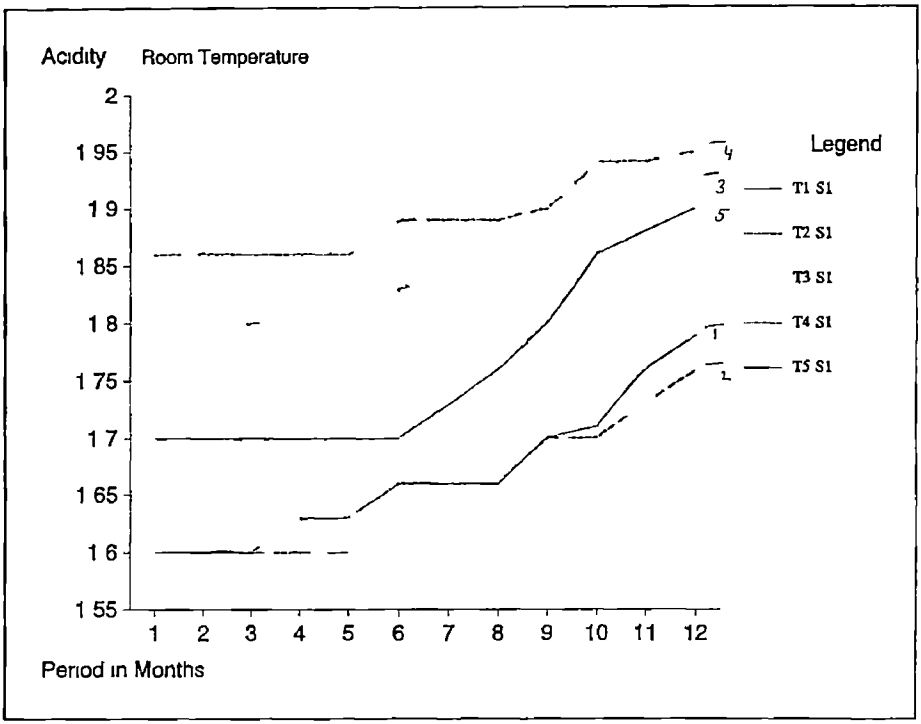
Effect of different pretreatments on the shelf-life qualities of papaya squash

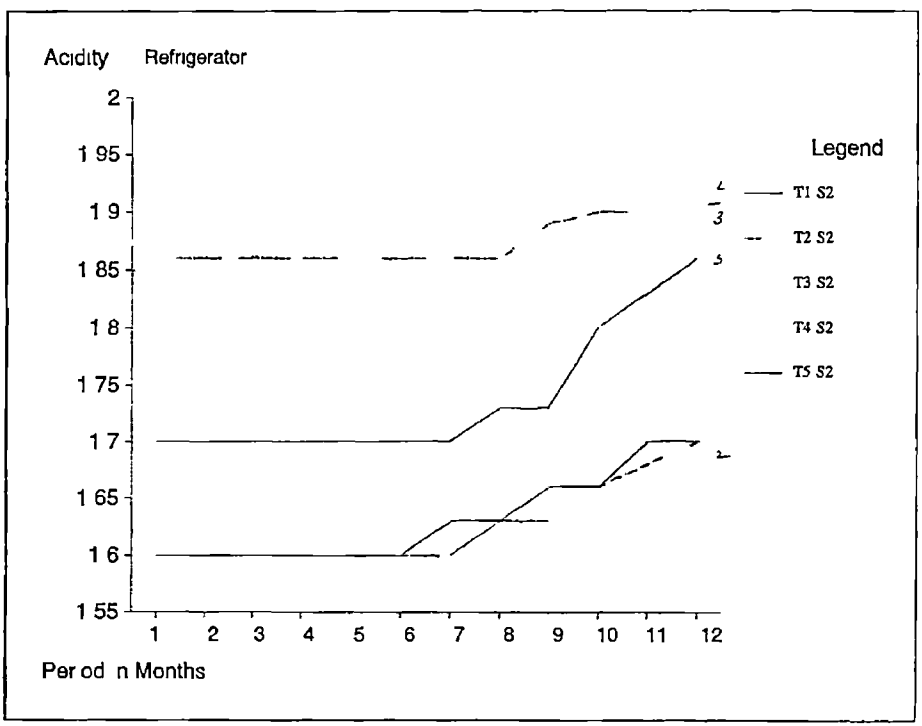
Periodical testing of the stored papaya squash revealed that variation in the specific gravity acid soluble ash and pulp content during the storage period was negligible

Fluctuation in the acidity level of various samples of squash are illustrated in Fig 9 and mean acidity values are presented in Table 10

For all the pretreatments there was no change in acidity upto four months for squash samples stored at ambient conditions while similar variation was observed in the refrigerated samples only by the sixth month of storage Changes in acidity at ambient conditions were found to be a steady increase from 1 60 to 1 95 per cent while in the refrigerated samples it was 1 60 to 1 92 per cent Variation in acidity level in stored juices may be due to changes in concentration of organic acids or due to formation of organic acids by degradation of the sugars

Increase in acidity during storage was reported in papaya juice and nectar by Kulwal et al (1985) in litchi juice by Sethi (1985) in amla juice by Singh et al (1988) In citrus juice by Mehta (1983) and in tomato juice by Thirumaran et al (1990) and in ready to serve beverages prepared from carrots by Thirumaran et al (19°2)


Acidity
Room Temperature
2
1 95
1 9
1 85
1 8
1 75
1 7
1 65
1 6
1 55
1 2 3 4 5 6 7 8 9 10 11 12
Period in Months
Legend
T1 S1
T2 S1
T3 S1
T4 S1
T5 S1


Acidity
Refrigerator
2
1 95
1 9
1 85
1 8
1 75
1 7
1 65
1 6
1 55
1 2 3 4 5 6 7 8 9 10 11 12
Per od n Months
Legend
T1 S2
T2 S2
T3 S2
T4 S2
T5 S2

Fresh products pretreated with sulphur and citric acid had higher acidity value However impact of various pretreatments on acidity during storage was varying in squash when compared with squash processed with fruits devoid of any pretreatment (1 60 1 79 per cent) Acidity level was found to be decreasing in squash processed from blanched fruits (1 60 1 76 per cent) and in products processed from fruits pretreated with sulphur dioxide solution (1 70 1 90 per cent) fruits exposed to sulphur fumes (1 86 to 1 95 per cent) and in fruits immersed in citric acid solution (1 70 to 1 86 per cent) The rate of increase in acidity was less in similar pretreated refrigerated samples Variation in acidity between squash prepared from control and blanched samples were not significant up to the eighth month While for squash prepared from other pretreated samples increase in acidity during storage was not significant at all Thus pretreatment had a significant effect in preventing degradation of sugars to acidic products in the squash

The lower rate of change in acidity at low temperature might be due to the inhibitory effect of low temperature on enzyme activities responsible for the production of acidity (Singh et al 1983)

Table 10 Effect of pretreatments and storage temperature on ac dity of papaya squash storage (Acidity expressed as per cent of citric acid/g)

Pre treat ments	Storage periods (Months) 1		2		3		4		5		6		7		8		9		10		11		12	
	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2
T_1	1 60	1 60	1 60	1 60	1 60	1 60	1 60	1 60	1 63	1 60	1 66	1 60	1 66	1 63	1 66	1 63	1 70	1 66	1 71	1 66	1 76	1 70	1 79	1 70
T_2	1 60	1 60	1 60	1 60	1 60	1 60	1 60	1 60	1 60	1 60	1 66	1 60	1 66	1 60	1 66	1 63	1 70	1 63	1 70	1 66	1 73	1 68	1 76	1 70
T_3	1 80	1 80	1 80	1 80	1 80	1 80	1 80	1 80	1 81	1 80	1 83	1 80	1 84	1 80	1 86	1 83	1 86	1 83	1 89	1 86	1 90	1 86	1 92	1 90
T_4	1 86	1 06	1 86	1 86	1 86	1 86	1 86	1 86	1 86	1 86	1 89	1 86	1 89	1 86	1 89	1 86	1 90	1 89	1 94	1 9	1 94	1 90	1 95	1 92
T_5	1 70	1 70	1 70	1 70	1 70	1 70	1 70	1 70	1 70	1 70	1 71	1 70	1 73	1 70	1 76	1 73	1 80	1 73	1 86	1 8	1 88	1 83	1 90	1 86
CD (0 05)											0 039	0 035	0 065	0 068	0 046	0 063		0 045		0 062				
											ns	ns	ns	ns	ns	ns		ns		ns				

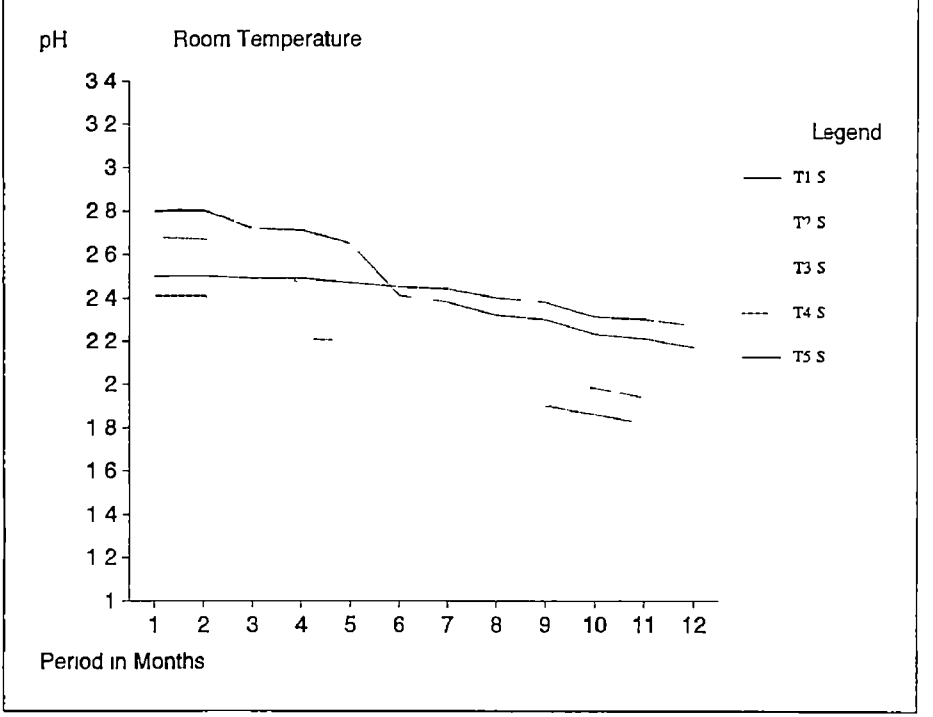
T Pretreatments methodology
S_1 Room temperature
S_2 Refrigerator

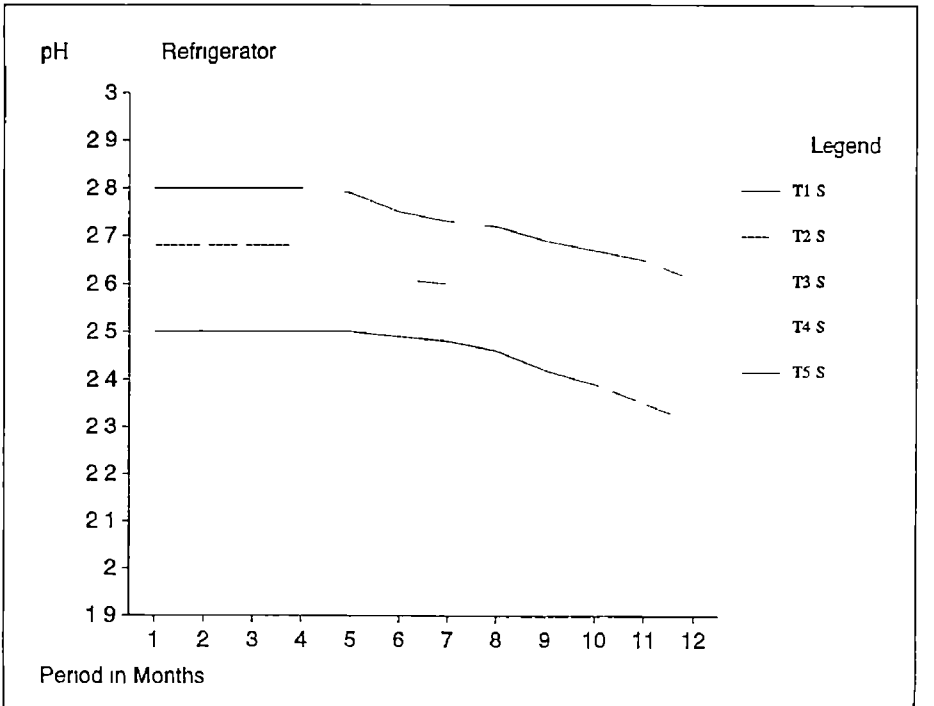
T_1 Control
T_2 Blanched
T_3 Immersed in sulphurdioxide solution
T_4 Exposed to sulphur fumes
T_5 Immersed n citric ac d solution

Studies conducted by Kulwal et al (1985) and Bawa et al (1987) had revealed that the rate of change in acidity in fruit juices were not significant at lower temperature Probably the deteriorative changes were more temperature dependent as suggested by Mir and Nath (1993) Acidity increase is an undesirable quality and in this case samples pretreated with sulphur fumes can be considered to have better shelf life quality

Influence of storage on pH of the squash is illustrated in Fig 10 and the mean values of pH recorded every month for one year at both ambient and refrigerated conditions for papaya squash is presented in Table 11

For all the five samples (Control and pretreatments) there was no change in pH for the two months of storage at ambient conditions except in the blanched samples while change in pH could be observed only after four months in a few refrigerated samples such as control and squash processed from blanched and citric acid dipped fruits The changes in pH in squash at ambient condition were observed to be a steady decrease from 2 80 to 1 79 while in the case of the refrigerated samples it was from 2 80 to


pH
Room Temperature
3 4
3 2
3
2 8
2 6
2 4
2 2
2
1 8
1 6
1 4
1 2
1
1 2 3 4 5 6 7 8 9 10 11 12
Period in Months
Legend
T1 S
T2 S
T3 S
T4 S
T5 S


pH
Refrigerator
3
2 9
2 8
2 7
2 6
2 5
2 4
2 3
2 2
2 1
2
1 9
1 2 3 4 5 6 7 8 9 10 11 12
Period in Months
Legend
T1 S
T2 S
T3 S
T4 S
T5 S

2 08 Among the various pretreatments the rate of decrease in pH of the squash on storage was lower in samples prepared from papaya fruits pretreated by immersion in citric acid solution In samples stored at ambient condition a steady decrease was noticed in control (2 80 to 2 17) and squash processed from blanched fruits (2 68 to 1 91) fruits immersed in sulphur dioxide solution (2 41 to 1 97) fruits immersed in citric acid solution (2 50 to 2 27) and fruits exposed to sulphur fumes (2 41 to 1 79)

In the present study the rate of decrease in pH of the refrigerated samples was less in all the pretreated samples

In line with the present study a decrease in pH values were reported by Sethi (1985) in litchi juice by Thirumaran et al in tomato juice (1990) and in fermented carrot juice by Thirumaran et al (1992)

Bawa et al (1987) have explained that chemical changes were more pronounced at room temperature as compared to those in refrigerated samples Mir and Nath (1993) had also reported that the deteriorative changes are directly

Table 11 Effect of pretreatments and storage temperature on pH of papaya squash during storage

Pre treatments	Storage periods (Months) 1		2		3		4		5		6		7		8		9		10		11		12	
	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2
T_1	2 80	2 80	2 80	2 80	2 72	2 80	2 71	2 80	2 65	2 79	2 41	2 75	2 38	2 73	2 32	2 72	2 30	2 69	2 23	2 67	2 21	2 65	2 17	2 61
T_2	2 68	2 68	2 67	2 68	2 60	2 68	2 46	2 68	2 31	2 64	2 21	2 61	2 10	2 60	2 05	2 57	2 01	2 52	1 98	2 46	1 94	2 41	1 91	2 37
T_3	2 41	2 41	2 41	2 41	2 36	2 40	2 31	2 36	2 24	2 34	2 16	2 29	2 15	2 29	2 12	2 28	2 05	2 25	2 01	2 17	1 98	2 12	1 97	2 08
T_4	2 41	2 42	2 41	2 42	2 30	2 42	2 21	2 39	2 20	2 38	2 12	2 33	2 05	2 31	2 04	2 29	1 90	2 25	1 88	2 22	1 82	2 19	1 79	2 14
T_5	2 50	2 50	2 50	2 50	2 49	2 50	2 49	2 50	2 47	2 50	2 45	2 49	2 44	2 48	2 40	2 46	2 38	2 42	2 31	2 39	2 30	2 35	2 27	2 31
CD (0 05)									0 02**		0 025**		0 056**		0 031**		0 013**		0 031**		0 022**		0 022**	

** significant at 5% level

S_1 Room temperature

S_2 Refrigerator

T_1 Control

T_2 Blanched

T_3 Immersed in sulphurdioxide solution

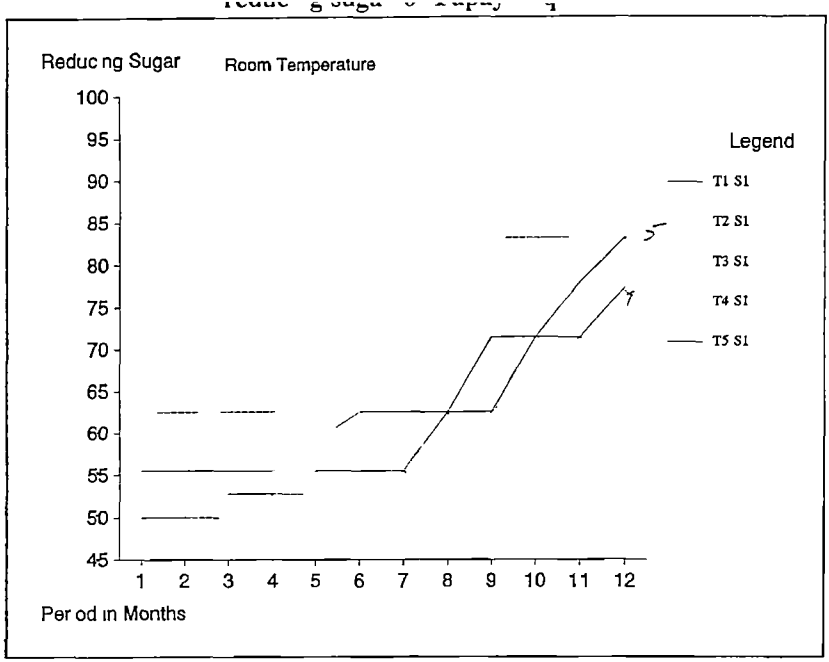
T_4 Exposed to sulphur fumes

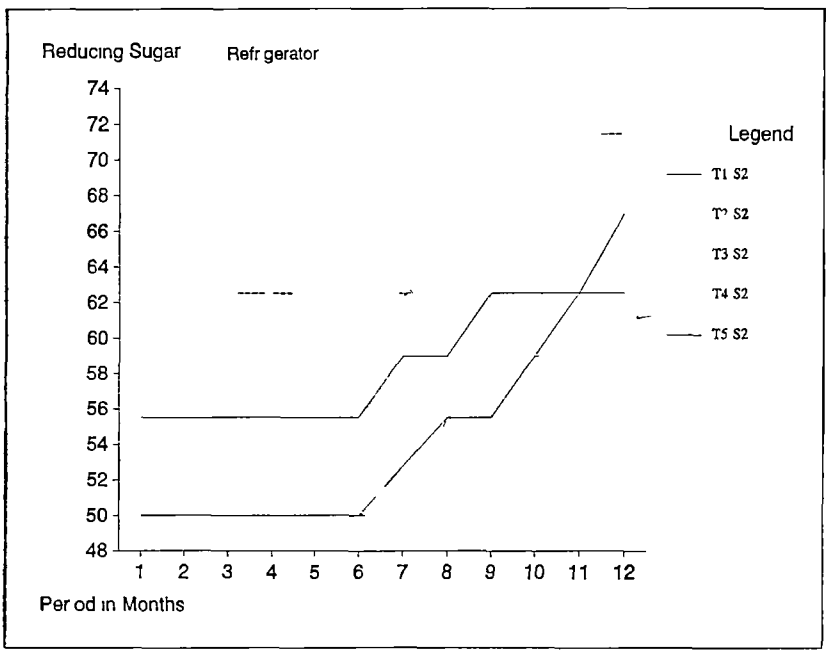
T_5 Immersed in citric acid solution

related to temperature increase Bawa et al (1987) from their studies in carrot juice concluded that at low temperature the change in pH was not significant But Sethi (1985) indicated that a fall in pH was observed irrespective of the storage temperature

Variation in reducing sugar in a stored fruit product is reported to be an index of acid hydrolysis of sucrose by Labuza et al (1970) Fig 11 depicts the fluctuation in reducing sugar of the products at ambient and refrigerated conditions is presented in Table 12

Reducing sugar content was unaffected for two months in all the five pretreatments at ambient conditions while similar results were observed in refrigerated samples for nearly six months The hydrolysis of nonreducing sugars is thus much slower under refrigerated conditions In the samples kept at ambient conditions the increase in reducing sugar concentration was from 5 610 per cent in the first month to 8 424 per cent in the 12th month In the case of refrigerated samples it was 5 610 per cent in the first month to 6 695 per cent in the twelveth month The increase in reducing sugar was found to be varying among the different


Reduc ng Sugar
Room Temperature
100
95
90
85
80
75
70
65
60
55
50
45
1 2 3 4 5 6 7 8 9 10 11 12
Per od in Months
Legend
T1 S1
T2 S1
T3 S1
T4 S1
T5 S1


Reducing Sugar
Refr gerator
74
72
70
68
66
64
62
60
58
56
54
52
50
48
1 2 3 4 5 6 7 8 9 10 11 12
Per od in Months
Legend
T1 S2
T? S2
T3 S2
T4 S2
T5 S2

pretreated samples in the control group (5 00 to 7 74 per cent) in squash from blanched samples (5 00 to 7 74 per cent) in squash from fruits immersed in sulphurdioxide solution (6 25 to 9 16 per cent) squash from fruits exposed to sulphur fumes (6 25 to 9.16 per cent) and squash prepared from fruits immersed in citric acid solution (5 55 to 8 33 per cent)

An increase in reducing sugar was reported by in cashew apples Singh and Mathur (1953) in lemon juice by Palaniswami and Muthukrishnan (1974) Kulwal et al (1985) in papaya juice and nectar by Sethi (1985) in litchi juices by Bawa et al (1987) in carrot juice in amla juice by Tripathi et al (1988) in fermented carrot RTS by Thirumaran et al (1992) and in kinnow juice by Renote et al (1993) in citrus juice by Mehta et al (1983)

Kulwal et al (1985) and Sethi (1985) had reported that the inversion of sugar in fruit products was rapid at higher temperature thar at low temperature In the present study also the rate of increase was higher at ambient condition compared to refrigerated conditions Similar results were reported by Bawa et al (1987) also During his

Table 12 Effect of pretreatments and storage temperature on reducing sugar of papaya squash during storage (reducing sugar expressed as percent glucose/g)

Pre treatments	Storage period (Months) 1		2		3		4		5		6		7		8		9		0		1		2	
	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2
T_1	5 00	5 00	5 00	5 00	5 28	5 00	5 28	5 00	5 55	5 00	5 55	5 00	5 55	5 28	6 25	5 55	6 25	5 55	7 14	5 90	7 14	6 25	7 74	6 25
T_2	5 00	5 00	5 00	5 00	5 00	5 00	5 28	5 00	5 28	5 00	5 55	5 00	5 55	5 00	6 25	5 55	6 25	5 55	6 67	5 90	7 14	5 90	7 74	6 25
T_3	6 25	6 25	6 25	6 25	6 25	6 25	6 25	6 25	6 25	6 25	7 14	6 25	7 14	6 25	7 14	6 67	8 33	6 67	8 33	6 67	8 33	7 14	9 16	7 14
T_4	6 25	6 25	6 25	6 25	6 25	6 25	6 25	6 25	6 67	6 25	7 14	6 25	7 14	6 25	7 74	6 25	8 33	6 67	8 33	7 14	8 33	7 14	9 16	7 14
T_5	5 55	5 55	5 55	5 55	5 55	5 55	5 55	5 55	5 90	5 55	6 25	5 55	6 25	5 90	6 25	5 90	7 14	6 25	7 14	6 25	7 74	6 25	8 33	6 67
CD(0 05)									0 684 ns		0 0 ns		0 274 ns		0 748 ns		0 627 ns		0 717 ns		0 545 ns		0 86 ns	

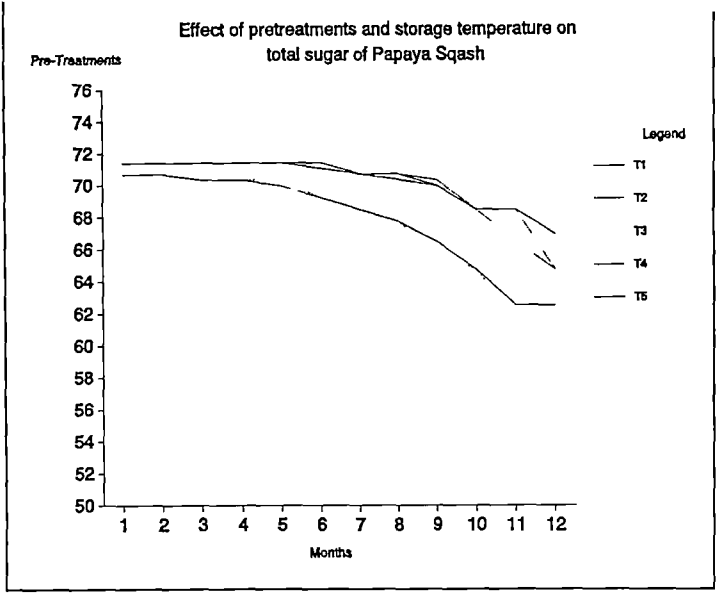
S_1 Room temperature
S_2 Refrigerator

T Control
T_2 Blanched
T_3 Immersed in sulphurdioxide solution
T_4 Exposed to sulphur fumes
T_5 Immersed in citric acid solution

study in carrot juice it was noticed that storage at room temperature resulted in an increase in reducing sugar as compared to refrigerated samples Evaluation studies on bottled carrot juice stored over a period of six months at room temperature was also conducted by Bawa and Saini (1987) The results of this study also indicated an increase of 1 59 per cent in reducing sugar in samples kept at ambient condition compared to the refrigerated samples

Influence of storage on total sugar of the product is illustrated in Fig 12 and the mean values of total sugar recorded every month for one year at ambient and refrigerated conditions for papaya squash is presented in Table 13

Total sugar was not affected during four months of storage There after the change in total sugar was observed to be a steady decrease from 71 03 per cent to 61 99 per cent in samples at ambient condition while it was 71 03 per cent to 65 17 per cent in refrigerated samples Among the various pretreatments a slight decrease was observed in control group (70 67 to 62 5 per cent) in blanched product (71 4 to 64 73 per cent) in fruits sulphited (70 67 to 59 0 per cent) and in fruits exposed to sulphur fumes (71 4 to 63 7 per


Effect of pretreatments and storage temperature on total sugar of Papaya Sqash
Pre-Treatments
76
74
72
70
68
66
64
62
60
58
56
54
52
50
1 2 3 4 5 6 7 8 9 10 11 12
Months
Legend
T1
T2
T3
T4
T5

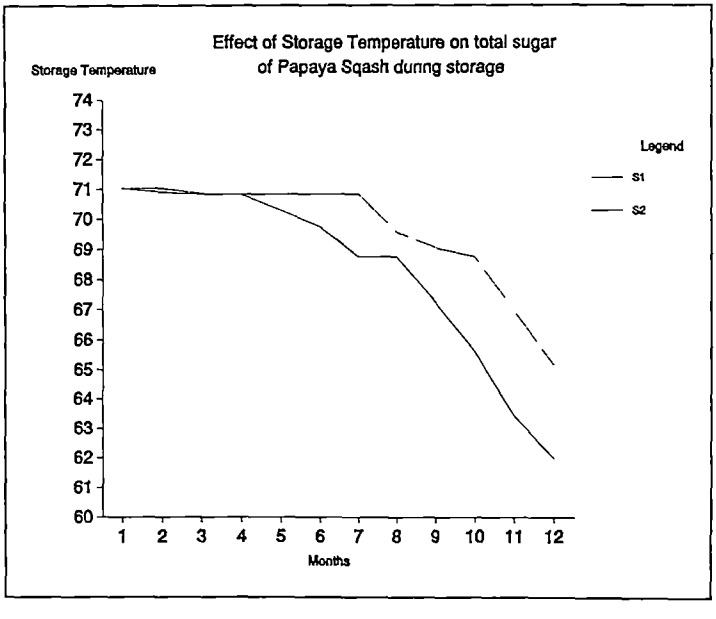

Effect of Storage Temperature on total sugar of Papaya Sqash during storage
Storage Temperature
74
73
72
71
70
69
68
67
66
65
64
63
62
61
60
1 2 3 4 5 6 7 8 9 10 11 12
Months
Legend
S1
S2

Table 13 Effect of pretreatment on total sugar content of papaya squash dur ng storage (Total sugar expressed as per cent)

Pretre atments	Storage per od (Months) 1	2	3	4	5	6	7	8	9	10	11	12	
T_1	70 67	70 67	70 31	70 31	69 95	69 20	68 45	67 70	66 47	64 73	62 50	62 50	
T_2	71 40	71 40	71 40	71 40	71 40	71 04	70 67	70 31	69 95	68 45	66 4	64 73	
T_3	70 67	70 67	70 31	70 31	70 31	69 20	68 45	67 70	65 84	64 73	61 65	59 00	
T_4	71 40	71 40	71 40	71 40	71 40	71 40	70 67	70 67	70 30	68 45	68 45	63 73	
T_5	71 40	71 40	71 40	71 40	71 40	71 40	70 67	70 67	69 95	68 45	68 45	66 95	

$CD_{(0\ 05)}$ 3 88

Effect of storage temperature on total sugar content during storage of papaya squash (Total sugar expressed as per cent)

	1	2	3	4	5	6	7	8	9	10	11	12	
S_1	71 03	70 90	70 82	70 82	70 29	69 74	68 75	68 75	67 24	65 62	63 41	61 99	
S_2	71 03	71 03	70 85	70 82	70 82	70 82	70 82	69 56	69 01	68 75	66 96	65 17	

$CD_{0\ 05}$ 2 75

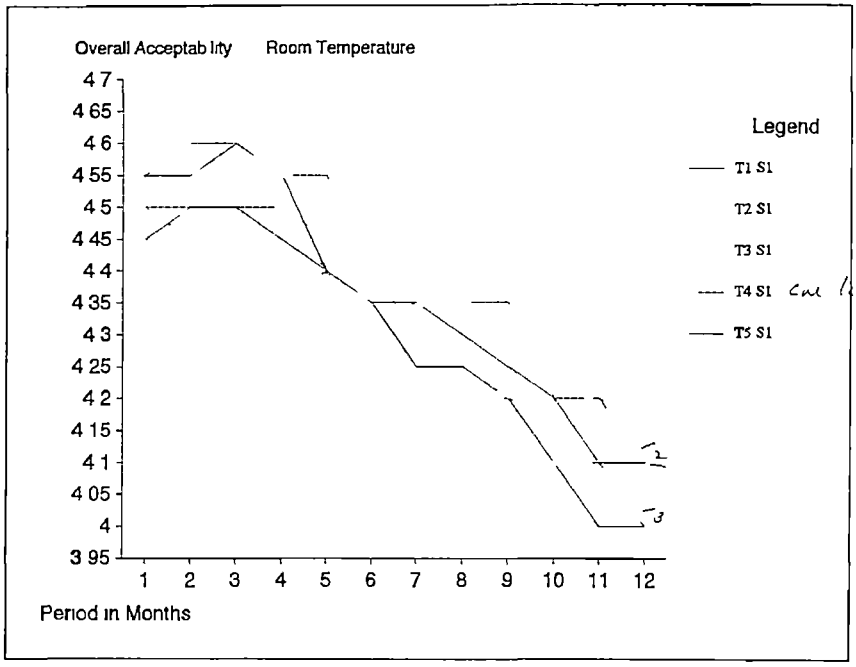
cent) and in fruits immersed in citric acid solution (71 4 to 66 95 per cent) A similar crease in total sugar was reported by Kulkal et al (1985) inpapaya juice

A comparison in total sugar content of samples kept in the refrigerator and at ambient condition revealed that the increase was greater in samples at ambient condition but the difference was not significant Bawa and Saini (1987) had also observed that the change in total sugar was greater at higher temperature

Overall acceptability of the products was ascertained through the scores given for various quality parameters like colour taste flavour and appearance by panel members and it is illustrated in Fig 13 The mean values of overall acceptability obtained during the storage period of one year at ambient and refrigerated conditions for papaya squash is presented in Table 14

For all the samples prepared from pretreated fruits and stored at ambient condition there was no change in overall acceptability upto three months while similar results were observed in the refrigerated samples after a longer

Overall Acceptability of Papaya Squash



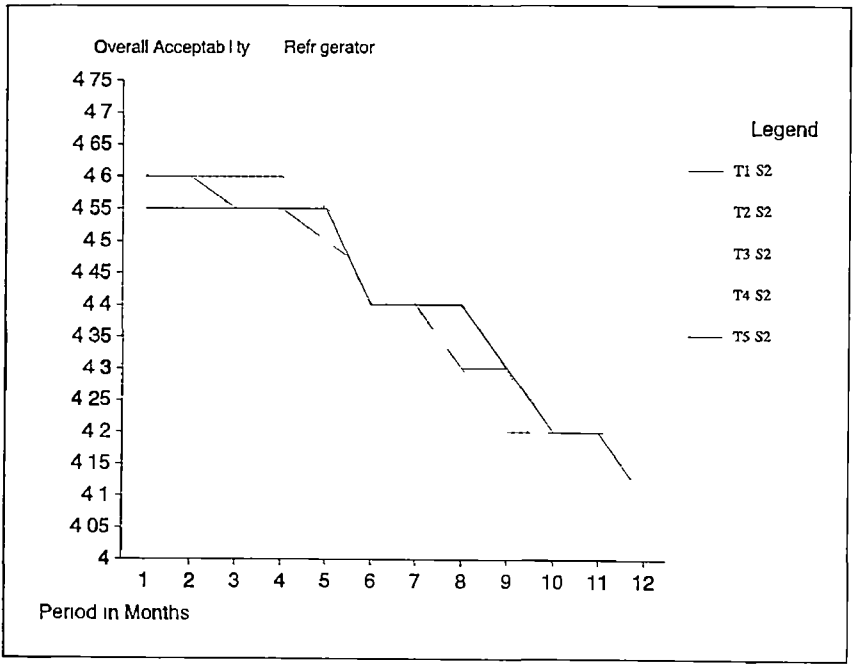


Table 14 Effect of pretreatments and storage temperature on the overall acceptability of papaya squash during storage (Mean score)

Treatments	Storage periods (Months) 1		2		3		4		5		6		7		8		9		10		11		12	
	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2
T_1	4 45	4 55	4 50	4 55	4 50	4 55	4 45	4 55	4 40	4 50	4 35	4 45	4 35	4 40	4 30	4 40	4 25	4 30	4 20	4 20	4 10	4 20	4 10	4 10
T_2	4 55	4 60	4 60	4 60	4 60	4 60	4 55	4 60	4 55	4 55	4 40	4 50	4 40	4 45	4 35	4 45	4 35	4 40	4 20	4 25	4 20	4 30	4 10	4 20
T_3	4 50	4 50	4 45	4 45	4 50	4 45	4 50	4 45	4 40	4 45	4 30	4 40	4 00	4 35	4 20	4 35	4 20	4 30	4 10	4 15	4 10	4 10	4 00	4 10
T_4	4 50	4 45	4 50	4 50	4 50	4 50	4 45	4 55	4 45	4 50	4 40	4 45	4 30	4 30	4 25	4 30	4 20	4 20	4 10	4 20	4 10	4 20	4 00	4 20
T_5	4 55	4 60	4 55	4 60	4 60	4 55	4 55	4 55	4 40	4 55	4 35	4 40	4 25	4 40	4 25	4 30	4 20	4 30	4 10	4 20	4 09	4 20	4 00	4 10
CD(0 05)									0 12 ns	0 13 ns	0 12 ns	0 12 ns	0 11 ns	0 16 ns	0 15 ns	0 13 ns								

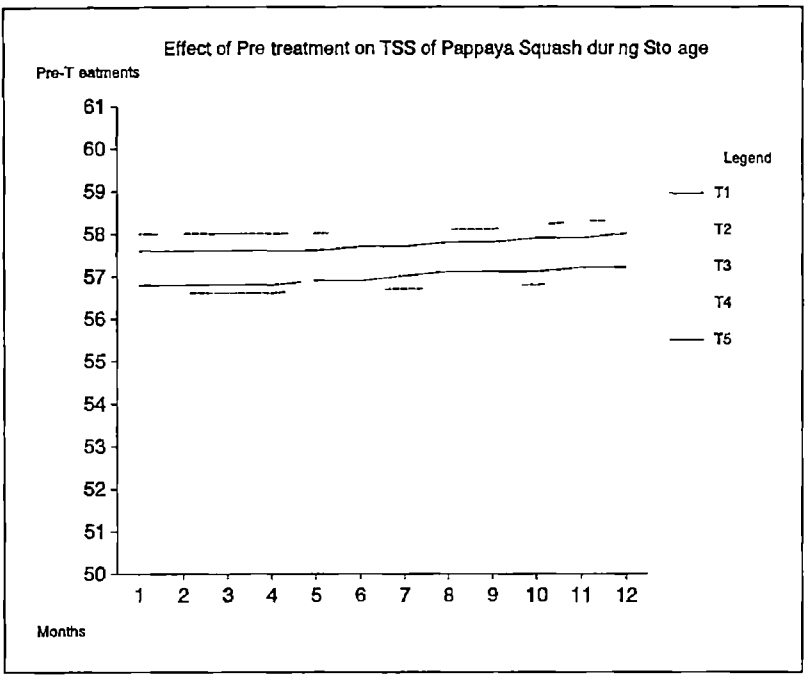
S_1 Room temperature
S_2 Refrigerator

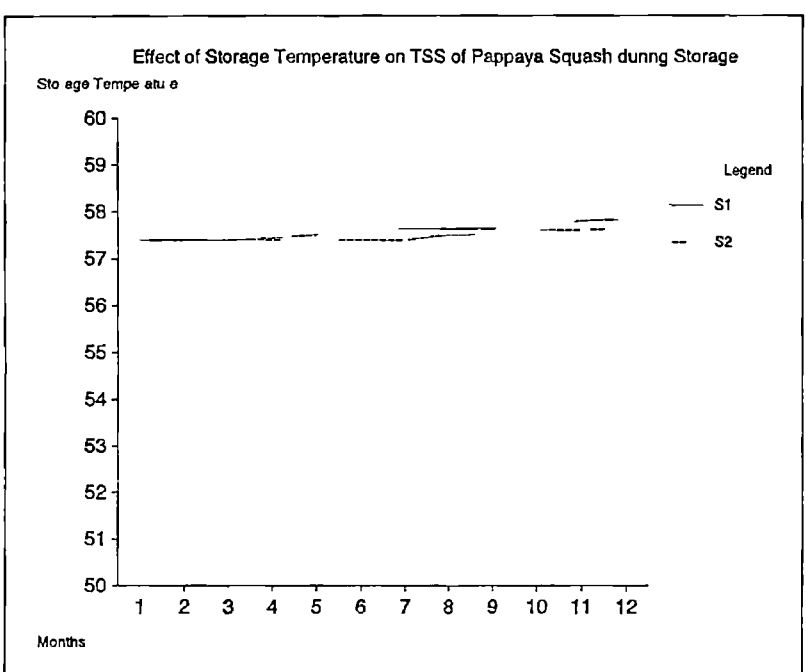
T_1 Control
T_2 Blanched
T_3 Immersed in sulphurdioxide solution
T_4 Exposed to sulphur fumes
T_5 Immersed in c tric acid solution

period (five months) The changes in overall acceptability in papaya squash at ambient condition were observed to be a gradual decrease from 4 51 to 4 04 while in the case of refrigerated samples it was from 4 53 to 4 14 Among various pretreatments a steady decrease was observed in control group (4 45 to 4 10) followed by pretreated fruits namely blanched fruits (4 55 to 4 10) fruits immersed in sulphur dioxide solution (4 5 to 4 0) fruits exposed to sulphur fumes (4 5 to 4 0) and fruits treated with citric acid solution (4 55 to 4 0) Mehta et al (1983) revealed that colour retention during storage was better in samples preserved with potassium meta bisulphite Crowell and Ough (1987) found that pretreatment with sulphur dioxide helped to preserve good colour and quality and it seems to control the oxidation of juice The rate of decrease was more or less the same in similar pretreated refrigerated samples Similar results were reported by Bawa et al (1987) Sandhu et al (1988) and Tripathi et al (1988)

Fig 14 depicts the fluctuation in TSS of papaya squash stored at ambient and refrig rated conditions Mean values of TSS obtained is presented in Table 15

Fig 14 Effect of pre treatment and storage period on TSS of Papaya Squash





For all the five pretreatments there was no change in TSS upto three months The change in TSS content was observed to be a steady increase from 57 4 to 57 8 per cent while in the case of refrigerated samples it was 57 4 to 57 6 per cent Among the various pretreatments a slight increase in TSS was observed in control group (56 8 to 57 2 per cent) followed by products prepared with blanched fruits (56 6 to 56 9 per cent) fruits immersed in sulphur dioxide solution (58 0 to 58 3 per cent) fruits exposed to sulphur fumes (58 0 to 58 3 per cent) and fruits immersed in citric acid solution (57 6 to 58 0 per cent)

Similar results were reported by Mehta et al (1983) and Sethi (1985 and 1994)

A comparison in TSS content of the samples kept in refrigerator and ambient conditions revealed that increase was greater in samples at ambient condition compared to refrigerated samples Singh and Mathur (1953) have also observed that the increase in TSS was greater at higher temperature

Table 15(i) Effect of pre treatments on the TSS content of papaya squash during storage

Treatments	Storage period (Months) 1	2	3	4	5	6	7	8	9	10	11	12
T_1	56 8	56 8	56 8	56 9	56 9	56 9	57 0	57 1	57 1	57 1	57 2	57 2
T_2	56 6	56 6	56 6	56 6	56 7	56 7	56 7	56 7	56 8	56 8	56 9	56 9
T_3	58 0	58 0	58 0	58 0	58 0	58 0	58 1	58 1	58 1	58 2	58 3	58 3
T_4	58 0	58 0	58 0	58 0	58 0	58 1	58 1	58 1	58 1	58 2	58 3	58 3
T_5	57 6	57 6	57 6	57 6	57 6	57 7	57 7	57 8	57 8	57 9	57 9	58 0

CD - 0 23**

** Significant at 1% level

Table 15(ii) Effect of storage temperature on TSS content

	1	2	3	4	5	6	7	8	9	10	11	12
S_1	57 4	57 4	57 4	57 4	57 5	57 6	57 6	57 6	57 6	57 7	57 8	57 8
S_2	57 4	57 4	57 4	57 4	57 4	57 4	57 4	57 5	57 5	57 6	57 6	57 6

CD - 0 15
ns

The initial and final values of acidity pH reducing sugar and overall acceptabil ty of papaya squash kept in ambient and refrigerated condition for one year was statistically tested by administering student s t test and the result are presented in Table 16

Changes in acidity was noted to be not significant in all the ambient and refrigerated products A similar increase in acidity was noted in litchi juice by Sethi (1985) in mango squash by Palaniswamy et al (1954) in amla juice by Thripthi et al (1985 in fermented carrot based RTS by Thirumaran et al (1992) in citric juice by Mehta and Bajaji (1983) and in papaya juice and nectar by Kulwal et al (1985)

The decrease in pH was noted to be statistically significant in all the samples stored at both ambient and refrigerated conditions A fall in pH was observed by Sethi (1985) in litchi juice irrespective of the storage temperature A fall in pH was also reported by Thirumaran et al (1992) in fermented carrot based RTS

Table 16 Statistical analysis of the shelf-life qualities of papaya squash base on initial and final values during storage

Shelf life quality tested	Pretreatments		Ambient Condition Initial	Final	t test	Refrigerator Initial	Final	t test
Acidity (%)	1	Control	1 60	1 79	3 90	1 60	1 70	2 50
	2	Blanching	1 60	1 76	3 78	1 60	1 70	2 55
	3	Sulphiting	1 80	1 92	3 60	1 80	1 90	1 79
	4	Exposure to sulphur fumes	1 86	1 95	2 34	1 86	1 92	1 67
	5	Immersed in citric acid solution	1 70	1 90	3 69	1 70	1 86	3 24
pH	1	Control	2 80	2 17	14 39**	2 80	2 61	4 38*
	2	Blanching	2 68	1 91	17 63**	2 68	2 37	6 58*
	3	Sulphiting	2 41	1 97	6 10*	2 41	2 08	7 14*
	4	Exposure to sulphur fumes	2 41	1 79	14 40**	2 41	2 14	5 69*
	5	Immersed in citric acid solution	2 50	2 27	5 50*	2 50	2 31	5 30*
Reducing sugar (%)	1	Control	5 00	7 75	5 15	5 00	6 25	3 34
	2	Blanching	5 00	7 75	5 15	5 00	6 25	3 11
	3	Sulphiting	6 25	9 16	6 59	6 25	7 14	2 00
	4	Exposure to sulphur fumes	6 25	9 16	6 59	6 25	7 14	3 97
	5	Immersed in citric acid solution	5 55	8 33	4 69	5 55	6 59	3 10
Overall Acceptibility	1	Control	4 45	4 10	4 02	4 45	4 10	3 02
	2	Blanching	4 55	4 10	4 03	4 55	4 20	2 50
	3	Sulphiting	4 50	4 00	3 06	4 50	4 10	2 55
	4	Exposure to sulphur fumes	4 50	4 00	2 64	4 50	4 20	3 50
	5	Immersed in citric acid solution	4 55	4 00	3 32	4 55	4 10	4 02

* Significant at 5% level

An increase in reducing sugar was noted to be significant in all the samples stored at ambient condition while the increase was not significant in the case of refrigerated samples Studies conducted in papaya juice and nectar by Kulwal et al (1985) and in bottled carrot juice by Bawa and Saini (1987) have observed that storage at room temperature resulted in a rapid increase in reducing sugar compared to samples kept in the refrigerator A rise in reducing sugar was reported in lemon juice by Palaniswami and Muthukrishnan (1974) in citrus juice by Mehta and Bajaj (1983) in amla juice by Tripathi et al (1988) in litchi juice by Sethi (1985) and in fermented carrot based RTS by Thirumaran et al (1992)

The differences in overall acceptability was not significant in all the sample stored at both storage condition namely ambient and refrigerated Bawa and Saini (1987) have observed from their studies in bottled carrot juice that storage temperature had no effect organoleptic acceptability No marked change in colour scores was observed by Sandhu et al (1988) in stored grape ju ce during storage

Effect of pretreatments on the shelf-quality of papaya jam

Table 17 Influence of pretreatments on the shelf-life period of papaya jam

Pretreatments	Ambient condition Shelf life period	
	No of days	% No of days on the year basis
1 Control	157	43
2 Blanching	184	50
3 Immersed in Sulphur dioxide solution	245	67
4 Exposed to Sulphur fumes	306	84
5 Immersed in citric acid solution	245	67
CD (0 05)	1 63**	

** Significant at 1 % level

The assessment of shelf-life period of jam prepared from different pretreated fruit samples revealed tha they had a good shelf-life period (100 per cent) when stored in the refrigerator In the case of the products kept at ambient

temperature it could be seen that pretreated papaya fruits had longer shelf life than samples prepared from the control Fruits exposed to sulphur fumes were found to give jam having longer shelf life (84 per cent) followed by jam prepared from fruits immersed in citric acid solution and fruits immersed in sulphur dioxide solution (67 per cent) Jam prepared from fruits blanched had the least effect (50 per cent) though they were superior to the control

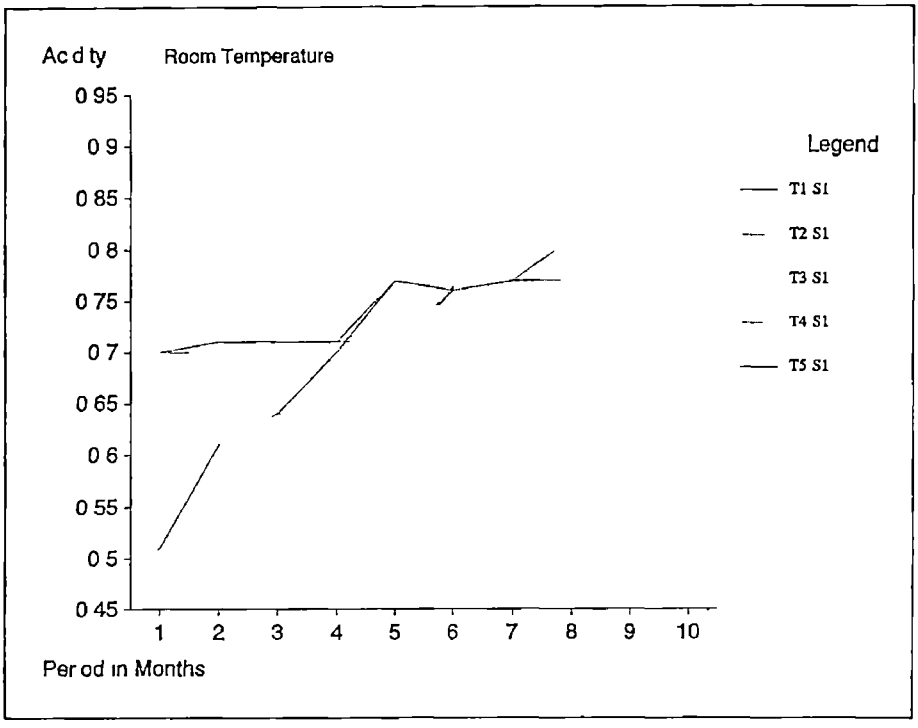
Samples had a shelf-life of 5 to 10 months depending on the pretreatments received by the fruits from which the jam had been prepared Jam prepared without any pretreatment had a shelf life of only five months followed by blanched fruits (6 months) product from fruits pretreated with sulphur dioxide and citric acid solution (8 months) and samples prepared from fruits pretreated with sulphur fumes (10 months)

The shelf life quality of papaya jam was determined by ascertaining acidity pH reducing sugar organoleptic quality bulk density and mold count The periodical testing revealed that variation in bulk density was negligible

Fluctuation in acidity is presented in Fig 15 and mean values are presented in Table 18

Variation in acidity was for all the pretreated samples There was no change in acidity during the first month at ambient condition while similar trend was observed in the refrigerated samples upto four months The changes in acidity in jam at ambient condition were observed to be a steady increase from 0 50 to 0 86 per cent while in the refrigerated samples it was 0 50 to 0 81 per cent Among the various pretreatments a steady increase was observed in the control group (0 51 to 0 77 per cent) in Products prepared from blanched fruits (0 50 to 0 76 per cent) products from fruits pretreated with sulphur dioxide solution (0 70 to 0 81 per cent) jam from fruits exposed to sulphur fumes (0 70 to 0 86 per cent) and from fruits pretreated with citric acid solution (0 70 to 0 81 per cent)

Studies conducted in litchi pulp by Sethi (1985) showed an increase in acidity A similar increase in acidity was noticed in amla jam by Tripathi *et al* (1988) and in mango bars by Mir *et al* (1993) during storage while no significant change was noticed in peach and apricot pulp by


Ac d ty
Room Temperature
0 95
0 9
0 85
0 8
0 75
0 7
0 65
0 6
0 55
0 5
0 45
1 2 3 4 5 6 7 8 9 10
Per od in Months
Legend
T1 S1
T2 S1
T3 S1
T4 S1
T5 S1

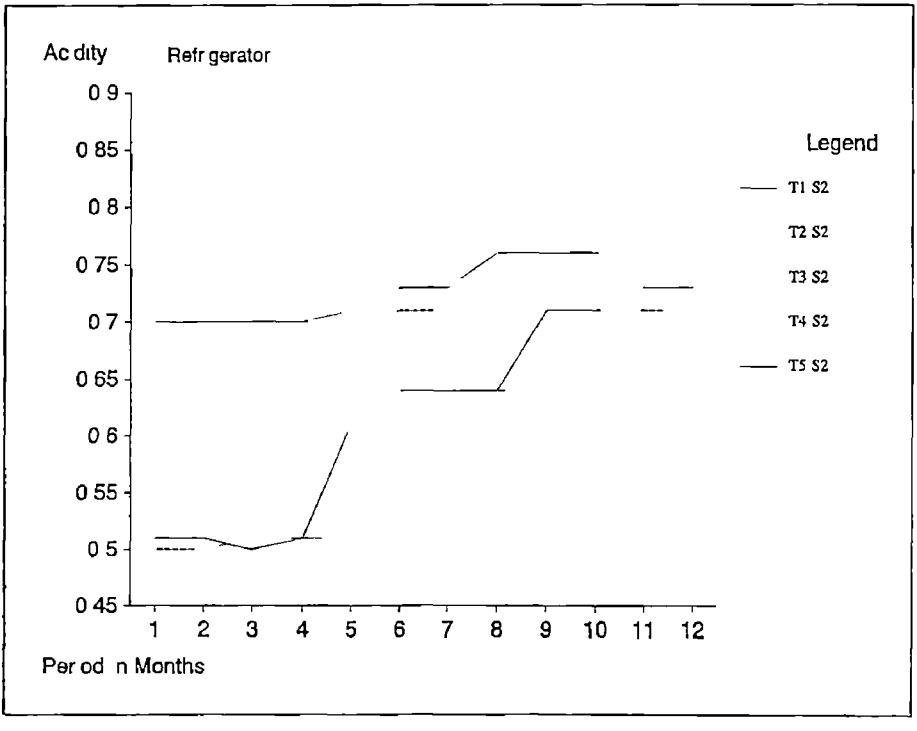

Ac dity
Refr gerator
0 9
0 85
0 8
0 75
0 7
0 65
0 6
0 55
0 5
0 45
1 2 3 4 5 6 7 8 9 10 11 12
Per od n Months
Legend
T1 S2
T2 S2
T3 S2
T4 S2
T5 S2

Table 18 Effect of pretreatments and storage temperature on the acdity of papaya jam during storage (acidity expressed as per cent citric acid/g)

Treat ments	Storage periods (Months) 1		2		3		4		5		6		7		8		9		10		11		12	
	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2
T_1	0 51	0 51	0 60	0 51	0 64	0 50	0 70	0 51	0 77	0 61		0 64		0 64		0 64		0 71		0 71		0 73		0 73
T_2	0 50	0 50	0 51	0 50	0 61	0 51	0 67	0 51	0 70	0 51	0 76	0 61		0 64		0 64		0 64		0 71		0 71		0 71
T_3	0 70	0 70	0 71	0 70	0 71	0 70	0 71	0 71	0 73	0 71	0 76	0 71	0 77	0 73	0 81	0 73		0 76		0 76		0 79		0 79
T_4	0 70	0 70	0 70	0 70	0 71	0 70	0 71	0 70	0 71	0 70	0 76	0 70	0 77	0 71	0 77	0 73	0 81	0 73	0 86	0 76		0 76		0 79
T_5	0 70	0 70	0 71	0 70	0 71	0 70	0 71	0 70	0 77	0 71	0 76	0 73	0 77	0 73	0 81	0 76		0 76		0 76		0 79		0 81

CD (0 05) 0 39**

** Significant at 1% level

S_1 Room temperature
S_2 Refrigerator

T_1 Control
T_2 Blanched
T_3 Immersed in sulphurdioxide solution
T_4 Exposed to sulphur fumes
T_5 Immersed in citric acid solution

Shah et al (1992) Sethi (1985) suggested that the increase in acidity during storage may be due to the formation of organic acid by ascorbic acid degradation

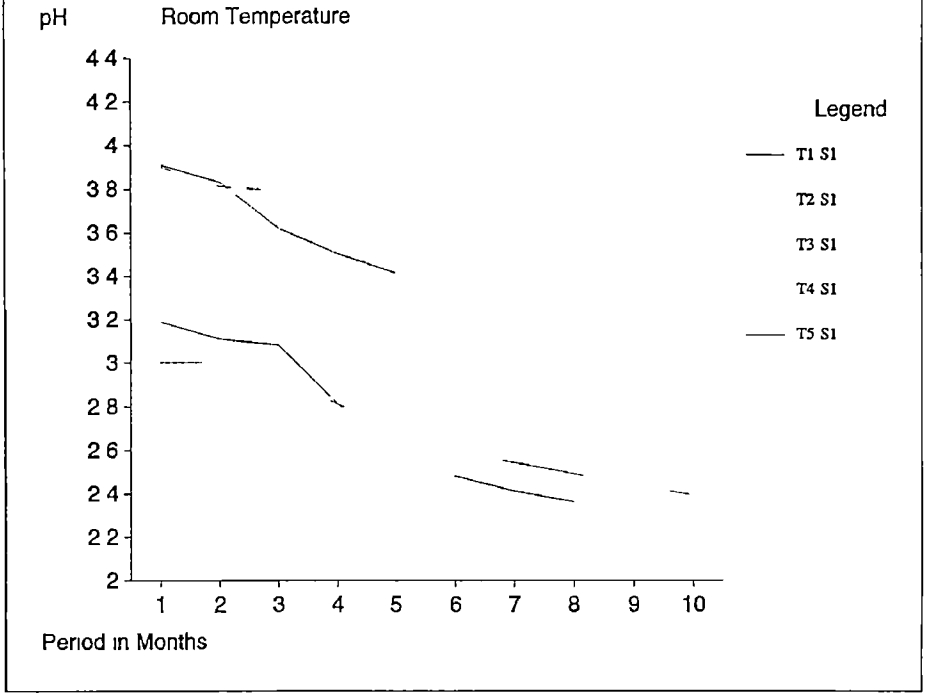
In the present study the rate of increase in acidity was less in the refrigerated samples The lower rate of change in acidity in samples stored at refrigerated condition might be due to the inhibitory effect of low temperature on enzyme activities responsible for the production of acidity (Singh et al 1983) Studies conducted by Kulwal et al (1985) and Bawa et al (1987) have also shown that the rate of change in acidity were not significant at low temperature Mir and Nath (1993) had also explained that the deteriorative changes were at a higher and faster rate at higher temperature

In the present study the rate of increase in acidity was not significant at room temperature while the changes were at a relatively lower rate in the case of samples kept at lower temperature Among the various pre treatments administered pretreatment of the fruits with sulphur fumes was the best

Fluctuation in the pH level is illustrated in Fig 16 Mean values of pH obtained during the storage period of one year at ambient and refrigerated conditions for papaya jam is presented in Table 19

In all the five samples of jam prerpared from different pretreated fruits there was no change during the first month at ambient condition while similar results were observed in refrigerated samples for two months The change in pH in jam at ambient condition was observed to be a steady decrease from 3 42 to 2 74 while in the case of refrigerated samples it was from 3 42 to 2 96 Among the various pretreatments a steady decrease was observed in control (3 91 to 3 41) in jam blanched prepared from fruits (3 90 to 3 22) jam prepared from fruits immersed in sulphur dioxide solution (3 10 to 2 31) jam from fruits exposed to sulphur fumes (3 0 to 2 39) and in jam from fruits immersed in citric acid solution (3 19 to 2 36) The rate oi decrease was less in similar pretreated refrigerated samples

In this study a gradual decrease in pH was observed The temperature had significant effect on the pH content The rate of decrease was lower in refrigerated


pH
Room Temperature
4 4
4 2
4
3 8
3 6
3 4
3 2
3
2 8
2 6
2 4
2 2
2
1 2 3 4 5 6 7 8 9 10
Period in Months
Legend
T1 S1
T2 S1
T3 S1
T4 S1
T5 S1

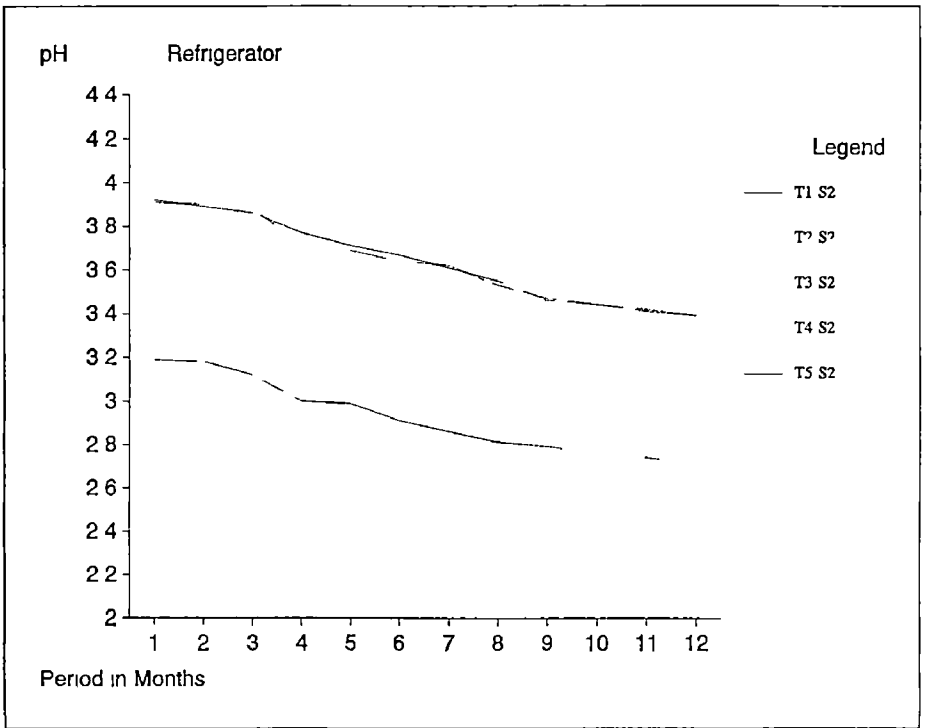

pH
Refrigerator
4 4
4 2
4
3 8
3 6
3 4
3 2
3
2 8
2 6
2 4
2 2
2
1 2 3 4 5 6 7 8 9 10 11 12
Period in Months
Legend
T1 S2
T2 S2
T3 S2
T4 S2
T5 S2

Table 19 Effect of pretreatments and storage temperature on the pH of papaya jam during storage

Treatments	Storage periods (Months) 1		2		3		4		5		6		7		8		9		10		11		12	
	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2
T_1	3 91	3 92	3 83	3 89	3 82	3 86	3 50	3 77	3 41	3 71		3 67		3 81		3 55		3 46		3 44		3 41		3 39
T_2	3 90	3 91	3 81	3 90	3 79	3 88	3 56	3 72	3 35	3 69	3 22	3 64		3 82		3 53		3 47		3 44		3 42		3 39
T_3	3 10	3 10	3 05	3 10	2 91	3 05	2 81	2 92	2 62	2 85	2 40	2 81	2 38	2 81	2 31	2 78		2 76		2 73		2 69		2 68
T_4	3 00	3 00	3 00	3 00	2 91	2 99	2 81	2 91	2 70	2 75	2 59	2 65	2 54	2 57	2 49	2 51	2 44	2 50	2 39	2 48		2 47		2 44
T_5	3 19	3 19	3 11	3 18	3 08	3 12	2 81	3 00	2 61	2 99	2 48	2 91	2 41	2 86	2 36	2 81		2 79		2 76		2 74		2 71

CD (0 05) 0 42**

** Significant at 1% level

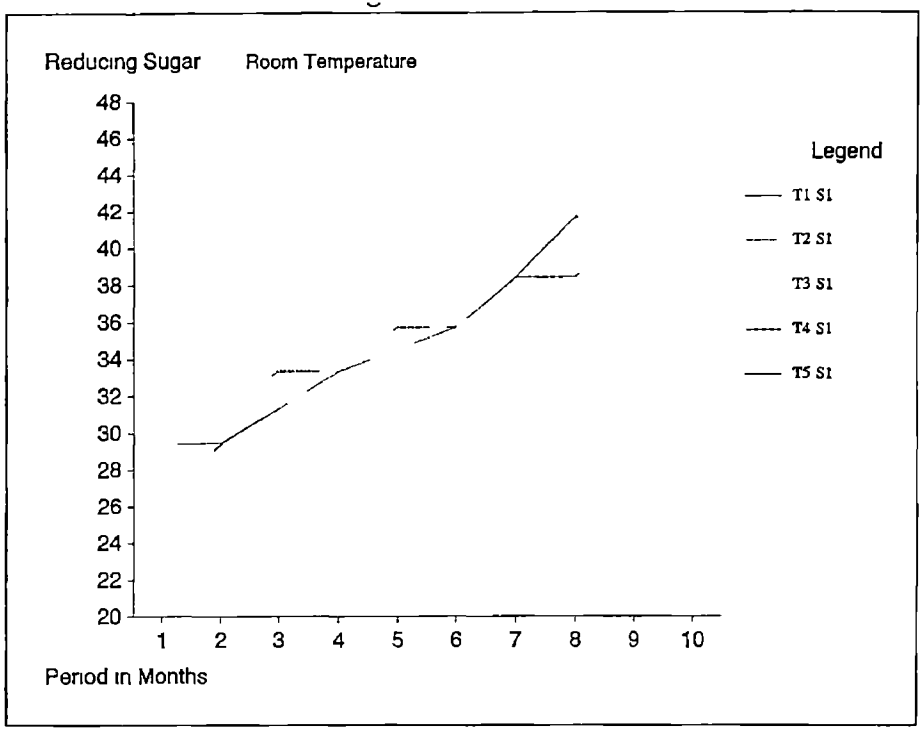
S_1 Room temperature
S_2 Refrigerator

T_1 Control
T_2 Blanched
T_3 Immersed in sulphurdioxide solution
T_4 Exposed to sulphur fumes
T_5 Immersed in citric acid solution

samples Mir and Nath (1993) have also stated that since the deteriorative changes were temperature dependent and the rate of deteriorative changes were more at higher temperature

Variation in reducing sugar in a stored fruit product is reported to be an index of acid hydrolysis of sucrose by Labuza et al (1970) Fig 17 depicts the fluctuations in the reducing sugar content of papaya jam and mean values of reducing sugar of the product at ambinet condition and when kept in the refrigerator is presented in Table 20

Reducing sugar was not affected upto the first month in all the five pretreated products at ambient condition while similar results were observed in refrigerated samples for three months A steady increase from 28 85 to 39 75 per cent was observed at ambient condition while in the case of refrigerated samples it was 28 85 to 37 57 per cent Increase in reducing sugar was varying among different pretreated samples in control group (26 3 to 33 3 per cent) blanched fruits (27 85 to 38 45 per cent) fruits immersed in sulphurdioxide solution (29 4 to 41 7 per cent) fruit exposed to sulphur fumes (31 3 to 43 6 per cent) and fruits pretreated with citric acid solution (29 4 - 41 7 per cent)


Reducing Sugar
Room Temperature
48
46
44
42
40
38
36
34
32
30
28
26
24
22
20
1
2
3
4
5
6
7
8
9
10
Period in Months
Legend
T1 S1
T2 S1
T3 S1
T4 S1
T5 S1

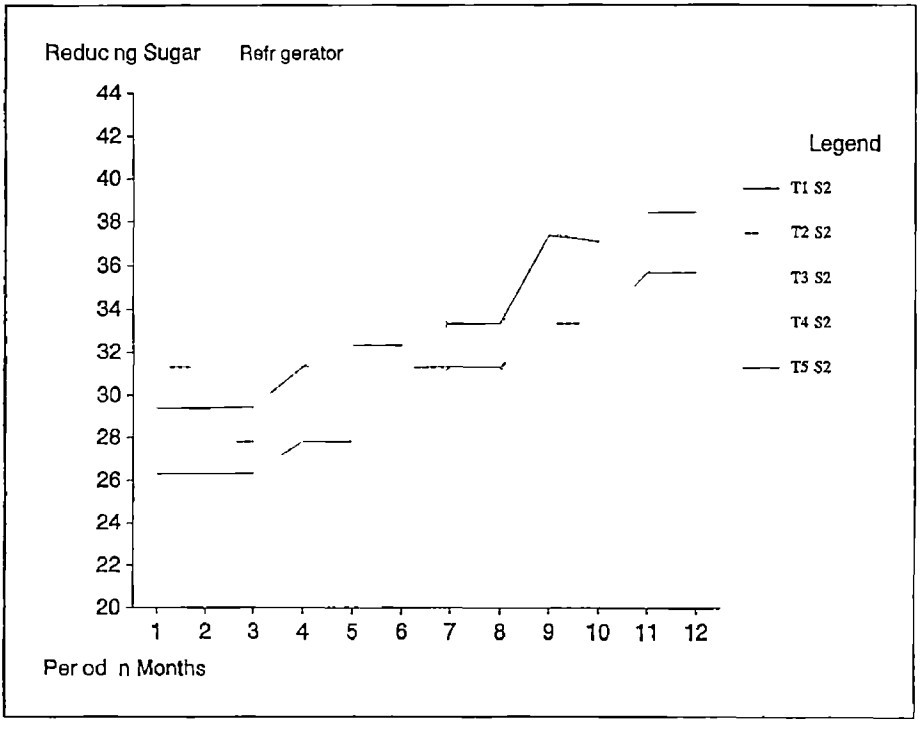

Reduc ng Sugar
Refr gerator
44
42
40
38
36
34
32
30
28
26
24
22
20
1
2
3
4
5
6
7
8
9
10
11
12
Per od n Months
Legend
T1 S2
T2 S2
T3 S2
T4 S2
T5 S2

Table 20 Effect of pretreatments and storage temperature on reducing sugar papaya jam during storage (Reducing sugar expressed as per cent glucose/g)

Treatments	Storage periods (Months)																							
	1		2		3		4		5		6		7		8		9		10		11		12	
	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2
T_1	26 30	26 30	27 80	26 30	29 40	26 30	31 30	27 80	33 30	27 80		29 40		31 30		31 30		32 30		33 30		35 65		35 65
T_2	27 85	27 80	29 40	27 80	31 30	27 80	33 30	29 40	35 70	29 40	38 45	31 28		31 30		31 30		33 30		33 30		35 65		37 01
T_3	29 40	29 40	31 30	29 40	33 40	29 40	33 30	31 30	35 70	31 30	35 70	31 30	38 40	33 30	41 70	33 30		35 85		37 05		38 40		38 40
T_4	31 30	31 30	31 35	31 30	33 30	31 30	33 30	31 30	35 70	33 30	35 70	33 30	38 40	33 30	38 40	35 70	41 50	37 05	43 60	37 05		38 40		38 40
T_5	29 40	29 40	29 40	29 40	31 30	29 45	33 30	31 30	34 50	32 30	35 70	32 30	38 40	33 30	41 70	33 30		37 05		37 05		38 40		38 40

S_1 Room temperature
S_2 Refrigerator

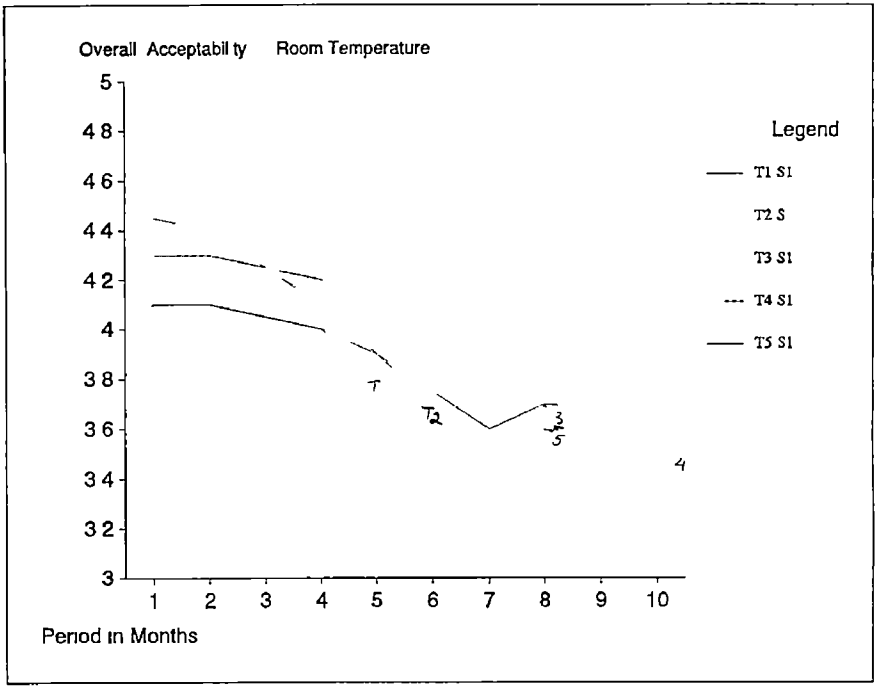
T_1 Control
T_2 Blanched
T_3 Immersed in sulphurd oxide solution
T_4 Exposed to sulphur fumes
T_5 Immersed in citric acid solution

Similar results were obtained by Sethi (1985) in litchi pulp in amla jam by Tripathi et al (1988) and in mango bars by Mir and Nath (1993)

Kulwal et al (1985) and Sethi (1985) had reported that the inversion of sucrose in fruit products were rapid at higher temperature than at lower temperature In the present study also the rate of increase of reducing sugar was higher at ambient condition when compared to refrigerated samples Similar results were reported by Singh and Mathur (1953) in cashew apples

Overall acceptability of the products were ascertained through the scores given for various quality parameters like colour flavour texture and taste by panel members and it is illustrated in Fig 18 Mean values of overall acceptability obtained during the storage period of one year at ambient and refrigerated conditions for papaya jam is presented in Table 21

The change in overall acceptability in papaya jam at ambient condition was observed to be a gradual decrease from 4 2 to 3 7 while in the case of refrigerated samples it


Overall Acceptabil ty
Room Temperature
5
4 8
4 6
4 4
4 2
4
3 8
3 6
3 4
3 2
3
1 2 3 4 5 6 7 8 9 10
Period in Months
Legend
T1 S1
T2 S
T3 S1
T4 S1
T5 S1

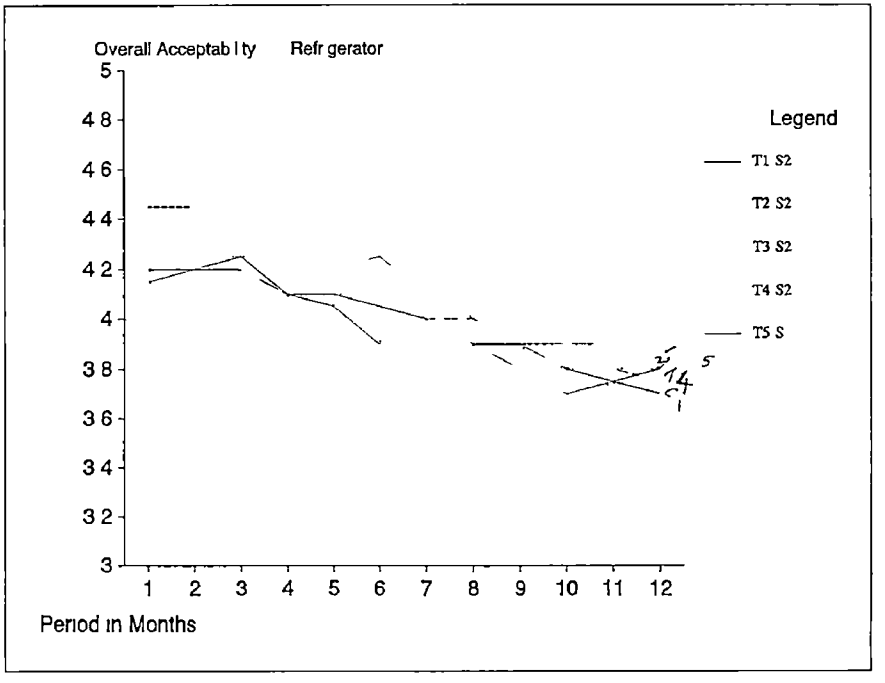

Overall Acceptab l ty
Refr gerator
5
4 8
4 6
4 4
4 2
4
3 8
3 6
3 4
3 2
3
1 2 3 4 5 6 7 8 9 10 11 12
Period in Months
Legend
T1 S2
T2 S2
T3 S2
T4 S2
T5 S

Table 1 Effect of pretreatments and storage temperature on the overall acceptab lity of papaya jam during storage (Mean score)

Treatments	Storage periods (Months) 1		2		3		4		5		6		7		8		9		10		11		12	
	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2
T_1	4 10	4 15	4 10	4 20	4 05	4 20	4 00	4 10	3 80	4 05		3 90		4 00		3 90		3 80		3 70		3 75		3 70
T_2	4 45	4 45	4 40	4 45	4 25	4 35	4 10	4 30	3 90	4 20	3 70	4 25		4 10		4 0		4 00		3 90		3 90		3 80
T_3	4 20	4 20	4 20	4 25	4 10	4 25	4 10	4 25	4 00	4 10	3 90	4 10	3 75	4 00	3 70	4 00		3 85		3 80		3 80		3 80
T_4	4 30	4 25	4 30	4 30	4 25	4 30	4 20	4 25	4 10	4 20	4 00	4 10	3 90	4 00	3 75	4 00	3 60	3 90	3 50	3 90		3 80		3 75
T_5	4 10	4 20	4 10	4 20	4 05	4 25	4 00	4 10	3 90	4 10	3 75	4 05	3 60	4 00	3 70	3 90		3 90		3 80		3 75		3 80

S_1 Room temperature
S_2 Refr gerator

T_1 Control
T_2 Blanched
T_3 Immersed in sulphurdioxide solution
T_4 Exposed to sulphur fumes
T_5 Immersed in citric ac d solution

was from 4 25 to 3 8 Among various pretreatments a decrease was observed in the control group (4 1 to 3 8) in the blanched fruits (4 45 to 3 7) fruits immersed in sulphur dioxide solution (4 2 to 3 7) fruits exposed to sulphur fumes (4 3 to 3 5) and those immersed in citric acid solution (4 1 to 3 7) Mir and Nath (1993) reported that storage decreases overall acceptability of fruit products Sethi and Malini (1991) revealed that flavour and colour retention was better in samples preserved with sulphur dioxide in mango pulp Mir and Nath (1993) further reported that the colour retention of mango bars were better in sulphited samples Similar results were reported by Sethi (1985) Tripathi et al (1988) and Bhatnagar (1991) The rate of decrease was more in samples kept at ambient condition than in refrigerated samples Similar results were reported by Sethi (1985) and Sethi and Malini (1991)

The initial and final values of acidity pH reducing sugar and overall acceptability of papaya jam kept in ambient and refrigerated condition for one year was statistically tested by administering student s t test and the results are presented in Table 22

Table 22 Statistical analysis of the shelf lif
on initial and final values during sto

Shelf-life quality tested	Pretreatment		Ambient Condition Initial	Final	t test			est
Acidity (%)	1	Control	0 50	0 77	2 29	0	0 73	3 02
	2	Blanching	0 50	0 70	2 97	0 50	0 71	2 9
	3	Sulphiting	0 70	0 83	1 66	0 70	0 79	1 43
	4	Exposure to sulphur fumes	0 70	0 86	3 13	0 70	0 79	2 06
	5	Immersed in citric acid solution	0 70	0 83	1 66	0 70	0 86	2 90
pH	1	Control	3 91	3 41	10 70**	3 91	3 39	12 05**
	2	Blanching	3 90	3 22	14 73**	3 90	3 39	11 83**
	3	Sulphiting	3 10	2 31	17 19**	3 10	2 68	8 9*
	4	Exposure to sulphur fumes	3 00	2 39	14 06**	3 00	2 44	8 41*
	5	Immersed in citric acid solution	3 19	2 36	18 08**	3 19	2 71	10 28**
Reducing sugar (%)	1	Control	26 30	33 30	14 79**	26 30	35 65	16 41**
	2	Blanching	27 80	38 40	22 14**	27 80	37 05	16 24**
	3	Sulphiting	29 40	41 60	20 24**	29 40	38 40	18 88**
	4	Exposure to sulphur fumes	31 30	43 60	20 41**	31 30	38 40	15 00**
	5	Immersed in citric acid solution	29 40	41 60	21 26**	29 40	38 40	15 82**
Overall Acceptability	1	Control	4 30	3 70	3 50	4 30	3 70	3 57
	2	Blanching	4 40	3 60	3 57	4 45	3 80	3 83
	3	Sulphiting	4 20	3 80	2 04	4 20	3 80	2 55
	4	Exposure to sulphur fumes	4 30	3 50	3 32	4 30	3 75	3 32
	5	Immersed in citric acid solution	4 10	3 70	2 55	4 10	3 80	2 52

* Significant at 5% level

The increase in acidity was not significant in all the samples stored under both ambient and refrigerated conditions A rise in acidity was observed during storage in guava pulp by Kalra and Revath (1981) in amla jam by Tripathi et al (1988) in mango bars by Mir and Nath (1993) and in whole tomato concentrate by Sethi (1994)

A significant decrease was noted in pH during the Shelf life analysis of jam samples stored at both ambient and refrigerator temperature A similar decrease in pH was observed in whole tomato concentrate by Sethi (1994)

The increase in reducing sugar was noted be significant in all the samples stored under ambient and refrigerator condition A rise in reducing sugar was noticed in guava pulp by Kalra and Revath (1981) in amla jam by Tripathi et al (1988) and in mango bars by Mir and Nath (1993)

The decrease in overall acceptability of papaya jam during storage was not significant in all the samples stored at both storage temperature A similar decrease in organoleptic acceptability was noticed in mango bars by Mir and Nath (1993)

Microbial tests

The periodical testing for the microbial growth in papaya jam revealed that the product processed with untreated fruits started spoilage after 5 months followed by product processed with blanched fruits (6 months) fruits immersed in citric acid solution (8 months) fruits sulphited (8 months) and fruits exposed to sulfur fumes (10 months) The main organisms which were found responsible for the spoilage of the product were bacteria yeast and mold Fungus like aspergillus and penicillium and bacteria like bacillus were identified The data is presented in Table 23 24 and 25

Table 23 Bacteria count (10^6/g) of the papaya jam at different time intervals

	Treatments	Storage period (Months) 6	7	8	9	10	11	12
1	Control	1		-				
2	Blanching		1 0		-			
3	Sulphiting		-		1 5	-		-
4	Exposure to sulphur fumes		-				1 0	
5	Immersion in citric acid solution			-	1 0	-		

Table 24 Yeast count (10^2/g) of the papaya jam at different time intervals

		Storage period (Months)					
	Treatment	6	7	8	9	10	11	12
1	Control	4						
2	Blanching	-	3					
3	Sulphiting				3 0	-		-
4	Exposure to sulphur fumes		-		-	-	3 0	-
5	Immersion in citric acid solution		-	-	3 5			-

Table 25 Mold count (10^4/g) of papaya jam at different time intervals

		Storage period (Months)						
	Treatments	6	7	8	9	10	11	12
1	Control	3 0			-			
2	Blanching		2 5					-
3	Sulphiting		-		2 5		-	
4	Exposure to sulphur fumes						2 0	
5	Immersion in citric acid solution	-	-	-	3 0			

Effect of pretreatments on the shelf-life quality of papaya candy

(Table 26)
The result reveal that candy from fresh untreated fruits had the least storage duration followed by candy processed from blanched fruits immersed in citric acid solution immersed in sulphur dioxide solution and those exposed to sulphur fumes Statistical analysis of the actual shelf-life period on the different samples for pretreated papaya revealed that all the pretreatments were found to be significantly effective in increasing the shelf life when compared to control The pretreated and refrigerated products had longer shelf-life Candy processed from fruits pretreated with sulphur fumes had the longest shelf-life followed by fruits immersed in sulphur dioxide solution Compared to ambient condition refrigerated samples had a longer shelf life

The shelf life quality of papaya candy was determined by ascertaining acidity pH reducing sugar bulk density overall acceptability and mold count The periodical testing revealed that variation in bulk density was negligible

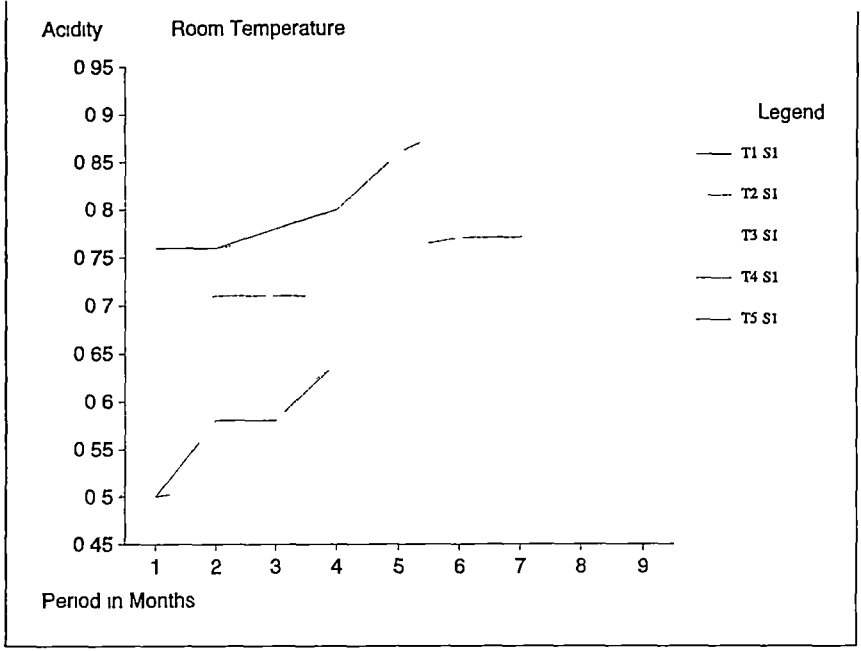
Table 26 Shelf life of papaya candy processed from pretreated papaya fruits stored under different conditions

Pretreatments	Storage condition			
	Ambient		Refrigerator	
	Shelf-life in number of days	% on maximum shelf-life/ year	Shelf-life in No of days	% on maximum shelf-life/ year
1 Control	124	34	334	92
2 Blanching	153	42	365	100
3 Immersed in sulphur-dioxide solution	245	67	365	100
4 Exposed to sulphur fumes	274	75	365	100
5 Immersed in citric acid solution	186	51	365	100
C D (0 05)	8 13*			

* significant at 5% level

Influence of storage on acidity level of candy is illustrated in Fig 19 and mean values of acidity recorded every month for one year in the stored sample at both ambient and refrigerated condition are presented in Table 27

Variation in acidity level in fruit products may be due to changes in the concentration of organic acid In all the pretreated samples there was no change in acidity during first month at ambient condition while a similar trend was observed in the refrigerated samples upto four months The changes in acidity in candy at ambient condition were observed to be an increase from 0 50 to 0 89 per cent In the case of refrigerated samples it was from 0 50 to 0 86 Fresh candy prepared from fruits with sulphur dioxide or citric acid had higher acidity values However impact of various pretreatments on acidity during storage was varying in the order as control (0 50 to 0 64) blanched (0 76 to 0 89) fruits exposed to sulphur fumes (0 70 to 0 86%) and those immersed in citric acid solution (0 76 to 0 89%) The rate of increase in acidity was however less in similar pretreated but refrigerated samples Variation among pretreated and refrigerated samples were significant from third month onwards Probably the deteriorative changes were


Acidity
Room Temperature
0 95
0 9
0 85
0 8
0 75
0 7
0 65
0 6
0 55
0 5
0 45
1 2 3 4 5 6 7 8 9
Period in Months
Legend
T1 S1
T2 S1
T3 S1
T4 S1
T5 S1

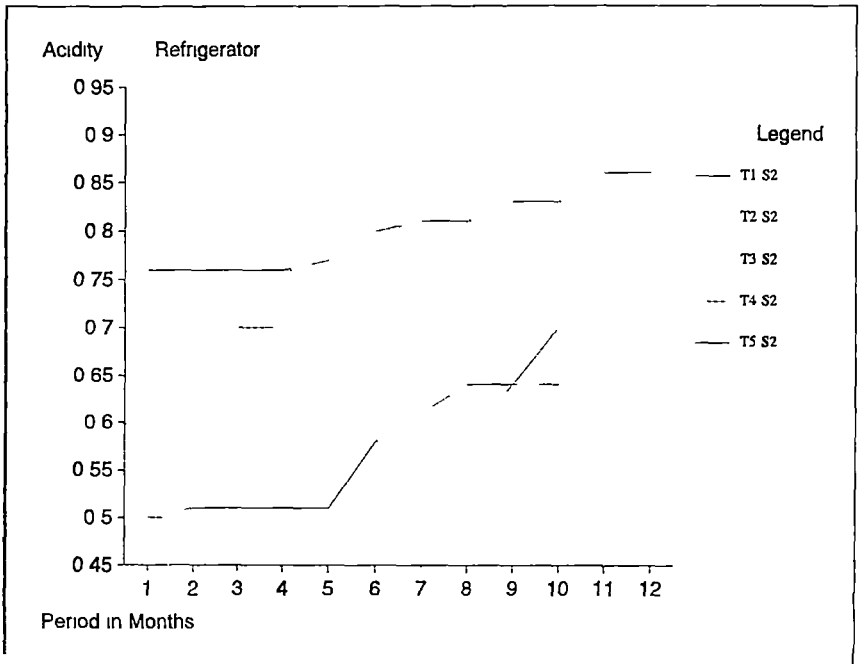

Acidity
Refrigerator
0 95
0 9
0 85
0 8
0 75
0 7
0 65
0 6
0 55
0 5
0 45
1 2 3 4 5 6 7 8 9 10 11 12
Period in Months
Legend
T1 S2
T2 S2
T3 S2
T4 S2
T5 S2

Table 27 Effect of pretreatments and storage temperature on acidity of papaya candy during storage (Acidity expressed per cent citric acid/g)

Treatments	Storage period (Months)																							
	1		2		3		4		5		6		7		8		9		10		11		12	
	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2
T_1	0.50	0.50	0.58	0.51	0.58	0.51	0.64	0.51		0.58		0.58		0.61		0.64		0.64		0.70				
T_2	0.50	0.50	0.51	0.50	0.59	0.51	0.64	0.51	0.67	0.5		0.56		0.58		0.58		0.64		0.64		0.64		0.67
T_3	0.76	0.76	0.76	0.76	0.77	0.76	0.77	0.76	0.8	0.76	0.77	0.71	0.86	0.77	0.89	0.89		0.81		0.83		0.83		0.86
T_4	0.70	0.70	0.71	0.70	0.71	0.70	0.71	0.70	0.76	0.70	0.77	0.71	0.77	0.71	0.8	0.76	0.86	0.77		0.81		0.81		0.83
T_5	0.76	0.76	0.76	0.76	0.78	0.76	0.80	0.76	0.86	0.77	0.89	0.80		0.81		0.81		0.83		0.83		0.86		0.86

S_1 Room temperature

S_2 Refrigerator

T_1 Control

T_2 Blanched

T_3 Immersed in sulphurdioxide solution

T_4 Exposed to sulphur fumes

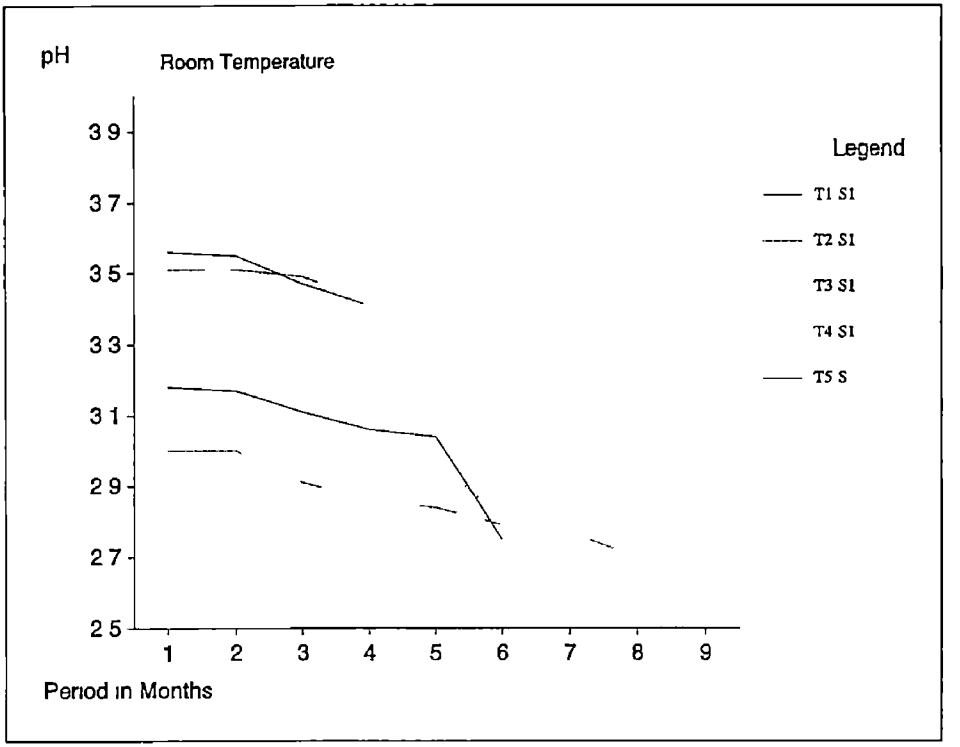
T_5 Immersed in citric acid solution

more temperature dependent as suggested by Mir and Nath (1993)

Influence of storage on pH of product is illustrated in Fig 20 and the mean values of pH recorded every month for one year at ambient and refrigerated condition for papaya candy is presented in Table 28

For all the five samples at ambient condition there was change in pH even during the first month except in product prepared from fruit pretreated with sulphur dioxide solution while no change in pH were observed for nearly two months in refrigerated samples prepared from fruits pretreated with sulphur dioxide solution sulphur fumes and citric acid solution The changes in pH in candy at ambient condition was observed to be a steady decrease from 3 56 to 2 62 While in the case of refrigerated samples it was 3 56 to 2 86 In samples stored at ambient condition a steady decrease was noticed in control from 3 56 to 3 41 in fruits blanched from 3 51 to 3 35 fruits pretreated with sulphur dioxide solution from 3 10 to 2 72 fruits exposed to sulphur fumes from 3 00 to 2 62 and those immersed in citric acid solution from 3 18 to 2 75

e pH of Papaya Candy



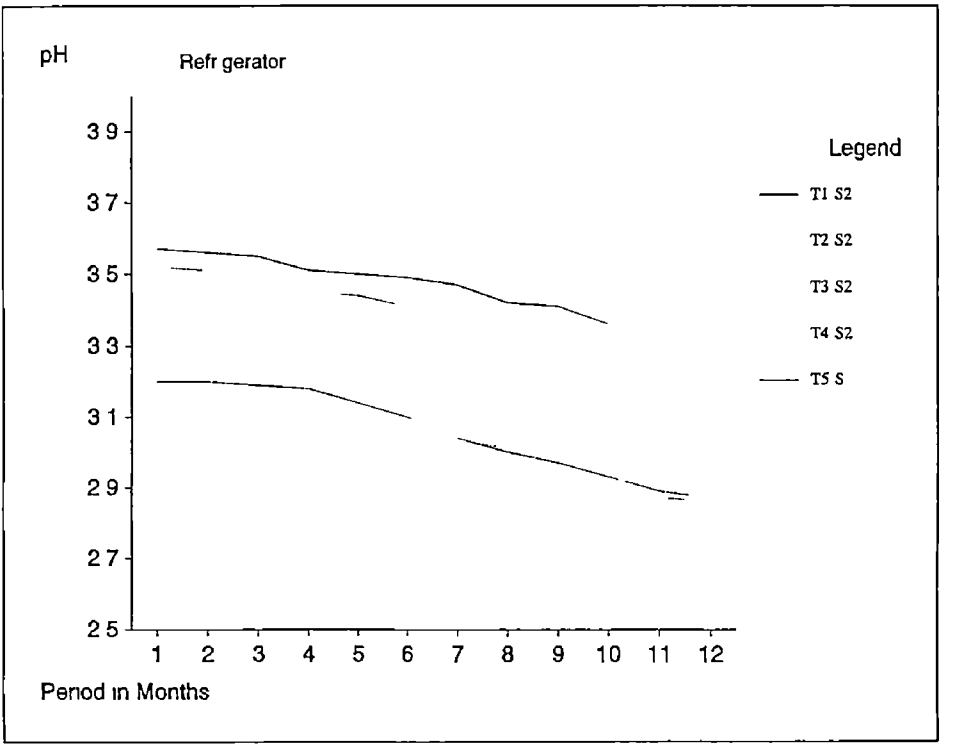


Table 28 Effect of Pretreatments and storage tempe ature on pH of papaya candy products dur ng storage

Treatments	Months																							
	1		2		3		4		5		6		7		8		9		10		11		12	
	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2
T_1	3 56	3 57	3 55	3 56	3 47	3 55	3 41	3 51		3 9		3 49		3 47		3 42		3 41		3 36		3 36		
T_2	3 51	3 52	3 51	3 51	8 49	3 46	3 42	3 45	3 35	3 44		3 41		3 41		3 39		3 38		3 34		3 31		3 30
T_3	3 10	3 10	3 05	3 10	3 0	3 10	3 00	3 09	2 97	3 09	2 81	3 07	2 79	3 03	2 72	3 01		2 99		2 98		2 97		2 94
T_4	3 00	3 01	3 04	3 01	2 9	3 00	2 86	3 00	2 84	3 00	2 79	2 98	2 77	2 95	2 70	2 91	2 62	2 90		2 89		2 87		2 86
T_5	3 18	3 20	3 17	3 20	3 1	3 19	3 06	3 18	3 05	3 14	2 75	3 10		3 04		3 00		2 97		2 93		2 89		2 87

S_1 Room temperature

S_2 Refrigerator

T_1 Control

T_2 Blanched

T_3 Immersed in sulphurd ox de solution

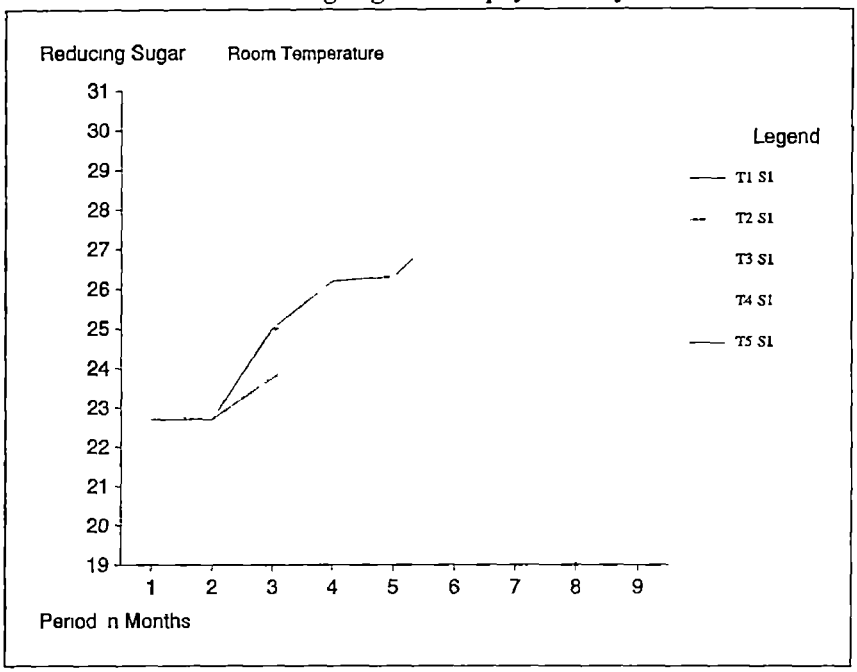
T_4 Exposed to sulphur fumes

T_5 Immersed n citr c ac d solut on

In the present study the rate of decrease in the refrigerated samples was less in all the pretreated samples

Variation in reducing sugar in a stored fruit product is reported to be an index of acid hydrolysis of sucrose (Labuza et al 1970) Fig 21 depicts the fluctuations in the reducing sugar content of papaya candy and mean values of reducing sugar of the products at ambient and refrigerated conditions are presented in Table 29

Reducing sugar was not affected during the first month at ambient condition while similar results were observed in refrigerated samples upto three months An increase from 23 8 per cent to 29 11 per cent was observed at ambient condition while in the case of refrigerated samples it was from 23 8 to 27 3 per cent Increase in reducing sugar was varying among different pretreated samples in control group (21 7 to 25 per cent) in fruits blanched (20 8 to 25 0 per cent) in fruits immersed in sulphur dioxide solution (23 8 to 29 4 pe cent) in fruits exposed to sulphur fumes (22 8 to 29 4 per cent) and in fruits immersed in citric acid solution (22 7 to 27 7 per cent)


Reducing Sugar
Room Temperature
31
30
29
28
27
26
25
24
23
22
21
20
19
1
2
3
4
5
6
7
8
9
Period in Months
Legend
T1 S1
T2 S1
T3 S1
T4 S1
T5 S1

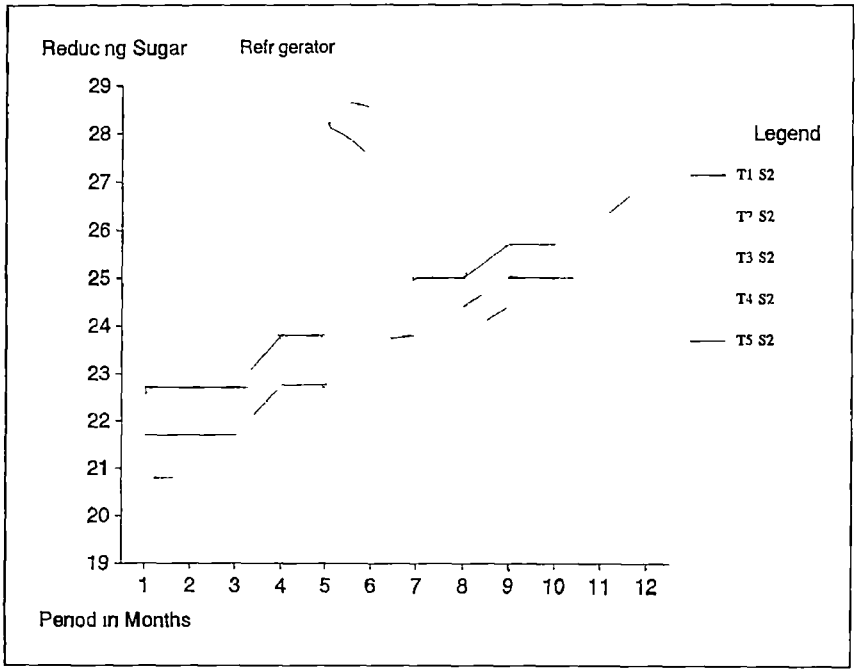

Reduc ng Sugar
Refr gerator
29
28
27
26
25
24
23
22
21
20
19
1
2
3
4
5
6
7
8
9
10
11
12
Period in Months
Legend
T1 S2
T2 S2
T3 S2
T4 S2
T5 S2

Table 29 Effect of pretreatments and storage temperature on reducing sugar of papaya candy products during storage (Reduced sugar expressed as per cent glucose/g)

Treatments	Months																							
	2		3		4		5		6		7		8		9		10		11		12			
	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2
T_1	21 70	21 70	22 70	21 70	23 70	21 70	25 00	22 70		22 70		23 70		23 80		24 40		25 00		25 00				
T_2	20 80	20 80	2 70	20 80	22 70	20 80	23 80	21 70	25 00	2 70		22 70		23 80		23 80		24 40		25 00		25 00		25 30
T_3	23 80	23 80	23 80	23 80	25 00	23 80	25 00	23 80	25 60	24 40	26 30	25 00	27 70	25 00	29 40	25 00		26 30		27 00		27 30		27 30
T_4	22 80	22 72	22 70	22 70	23 80	22 70	23 80	22 70	24 40	22 70	25 00	23 70	26 20	23 80	27 70	24 40	29 45	25 00		25 70		26 20		26 20
T_5	22 70	22 70	22 70	22 70	25 00	22 70	26 20	23 80	26 30	23 80	27 70	24 40		25 00		25 00		25 70		25 70		26 20		27 00

S_1 Room temperature

S_2 Refrigerator

T_1 Control

T_2 Blanched

T_3 Immersed in sulphurdioxide solution

T_4 Exposed to sulphur fumes

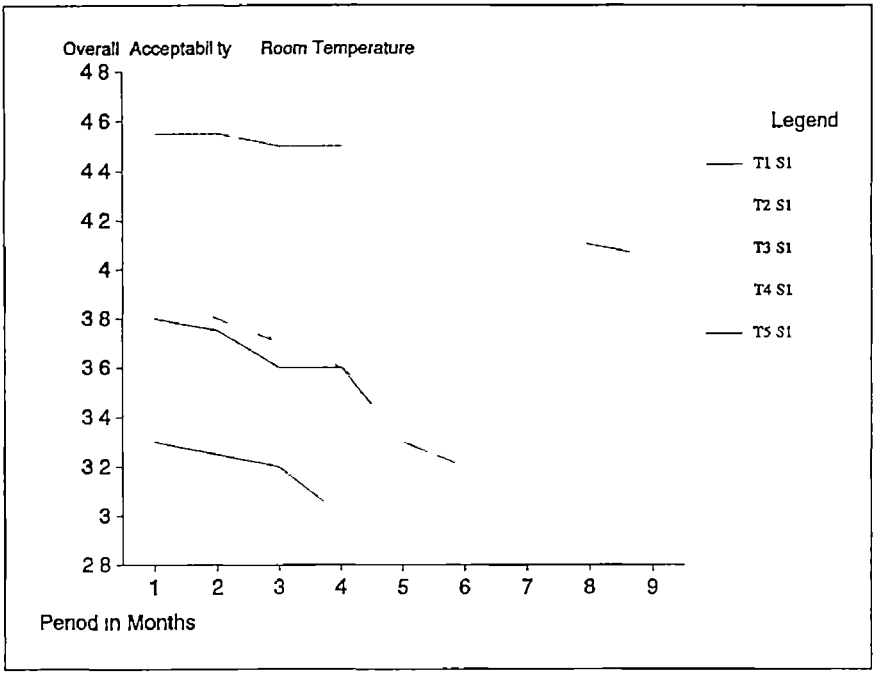
T_5 Immersed in citric acid solution

Similar results were obtained for a study with amla candy by Tripathi et al (1985)

Kulwal et al (1985) and Sethi (1985) had reported that the inversion of sugar in fruit products were rapid at higher temperature In the present study also the rate of increase of reducing sugar was higher at ambient condition when compared to refrigerated samples

Overall acceptability of the products were ascertained through the scores given for various quality parameter like colour flavour texture and taste by panel members and it is illustrated in Fig 22 Mean values of overall acceptability obtained during the storage period of one year at ambient condition and in refrigerator for papaya candy is presented in Table 30

There was change in overall acceptability for the five pretreatments even by the first month at ambient condition While similar results were observed in refrigerated samples by the third month The change in overall acceptability in papaya candy at both ambient and refrigerated condition were observed to be a gradual decrease


Overall Acceptabil ty Room Temperature
48
46
44
42
4
38
36
34
32
3
28
1 2 3 4 5 6 7 8 9
Period in Months
Legend
T1 S1
T2 S1
T3 S1
T4 S1
T5 S1

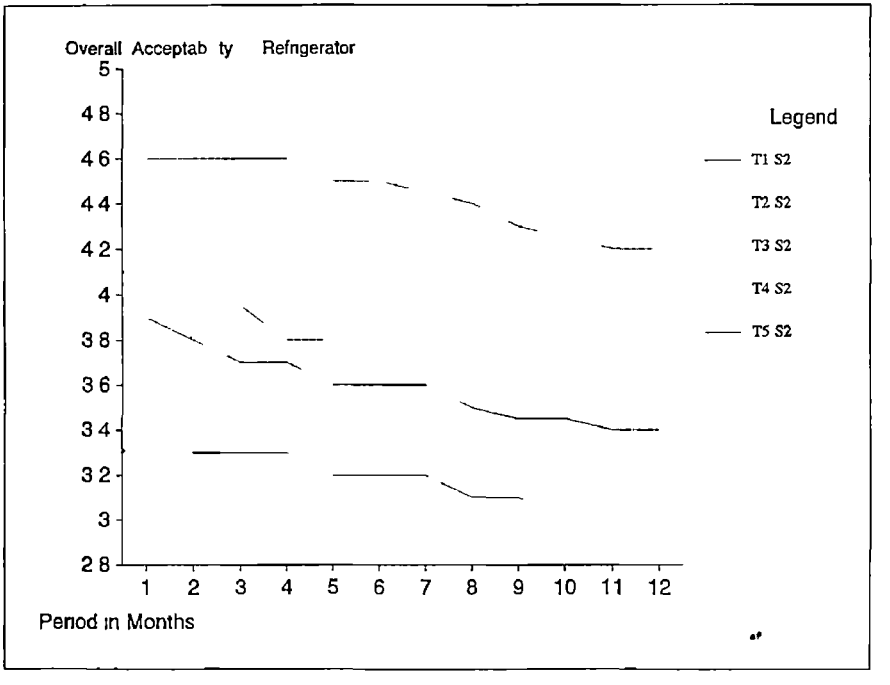

Overall Acceptab ty Refrigerator
5
48
46
44
42
4
38
36
34
32
3
28
1 2 3 4 5 6 7 8 9 10 11 12
Period in Months
Legend
T1 S2
T2 S2
T3 S2
T4 S2
T5 S2

Table 30 Effect of pretreatments and storage temperature on overall acceptability of papaya candy products during storage (Mean score)

Treatments	Months																							
	1		2		3		4		5		6		7		8		9		10		11		12	
	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2
T_1	3 30	3 40	3 25	3 30	3 20	3 30	3 00	3 30		3 20		3 20		3 20		3 10		3 10		3 00				
T_2	3 90	3 90	3 80	4 00	3 70	3 95	3 60	3 80	3 40	3 80		3 75		3 70		3 70		3 60		3 55		3 50		3 50
T_3	3 80	4 00	3 65	3 80	3 70	3 90	3 60	3 80	3 50	3 70	3 45	3 60	3 30	3 70	3 25	3 70		3 60		3 60		3 65		3 50
T_4	4 55	4 60	4 55	4 60	4 50	4 60	4 50	4 60	4 40	4 50	4 25	4 50	4 20	4 45	4 10	4 40	4 05	4 30		4 25		4 20		4 20
T_5	3 85	3 90	3 75	3 80	3 60	3 70	3 60	3 70	3 30	3 60	3 20	3 60		3 60		3 50		3 45		3 45		3 40		3 40

S_1 Room temperature

S_2 Refrigerator

T_1 Control

T_2 Blanched

T_3 Immersed n sulphurdioxide solution

T_4 Exposed to sulphur fumes

T_5 Immersed in citric acid solution

from 4 55 to 3 0 and from 4 55 to 3 2 respectively Among various pretreatments a steady decrease was observed in control group (3 3 to 3 0) in blanched product (3 9 to 3 4) in fruits immersed in sulphur dioxide solution (3 8 to 3 25) in fruits exposed to sulphur fumes (4 55 to 4 05) and in those immersed in citric acid solution (3 8 to 3 2) Tripathi et al (1983) reported that the acceptability of candy and dehydrated products decreased with storage Pawar et al (1985) revealed that sulphitation retards browning and retains colour in dehydrated products They also observed that blanched and +sulphited samples were more organoleptically acceptable in the case of dehydrated pumpkin Scow et al (1991) reported that blanching may give firmness to the candied products Sharma et al (1993) reported that colour retention was best in dried apricots pretreated with sulphur fumes The rate of decrease in overall acceptability was more in samples at ambient condition that in refrigerated samples Similar results were reported by Kulwal et al (1985)

The initial and final values of acidity pH reducing sugar and overall acceptability of papaya candy kept in ambient and refrigerator condition for one year was

statistically tested by administering student s t test and the results are presented in Table 31

Changes in acidity was noted to be not significant in all samples stored at both storage conditions A rise in acidity was observed in dried pomegranate by Kahtani (1990)

The decrease in pH was noted to be statistically significant in all samples stored at both storage conditions

The increase in reducing sugar noted to be significant in all the samples stored at both ambient and refrigerated condition A similar rise in reducing sugar was noticed in amla candy by Tripthi et al (1988)

The difference in overall acceptability was not significant in product stored at both ambient and refrigerated condition

Microbial tests

Periodical testing for the microbial growth in papaya candy revealed that in the product processed with

Table 31 Statistical analysis of the shelf life qualities of papaya candy based on initial and final values during storage

Shelf life quality tested		Pretreatments	Ambient Condition Initial	Final	t test	Refrigerator Initial	Final	t test
Acidity (%)	1	Control	0 50	0 64	3 00	0 50	0 70	3 60
	2	Blanching	0 50	0 70	4 40	0 50	0 67	4 24
	3	Sulphiting	0 76	0 89	2 90	0 76	0 86	2 81
	4	Exposure to sulphur fumes	0 70	0 86	1 66	0 70	0 83	2 72
	5	Immersed in citric acid solution	0 77	0 90	3 13	0 76	0 86	2 18
pH	1	Control	3 56	3 41	4 19	3 56	3 36	4 49*
	2	Blanching	3 51	3 35	4 59*	3 51	3 30	4 85*
	3	Sulphiting	3 10	2 72	10 20**	3 10	2 94	4 59*
	4	Exposure to sulphur fumes	3 00	2 62	8 27**	3 00	2 86	4 08
	5	Immersed in citric acid solution	3 18	2 75	10 46**	3 18	2 87	6 47*
Reducing sugar (%)	1	Control	21 70	25 00	7 24**	21 70	25 00	6 12**
	2	Blanching	20 80	25 00	9 08**	20 80	26 30	9 86**
	3	Sulphiting	23 80	29 40	11 94**	23 80	27 30	6 46**
	4	Exposure to sulphur fumes	22 80	29 45	11 90**	22 80	26 20	6 29**
	5	Immersed in citric acid solution	22 70	27 70	9 01**	22 70	27 00	7 82**
Overall Acceptibility	1	Control	3 30	3 00	3 40	3 30	3 00	3 40
	2	Blanching	3 90	3 40	3 06	3 90	3 50	3 40
	3	Sulphiting	3 80	3 25	3 32	3 80	3 50	2 04
	4	Exposure to sulphur fumes	4 55	4 05	2 04	4 55	4 20	2 30
	5	Immersed in citric acid solution	3 80	3 20	2 50	3 80	3 40	2 55

** Significant at 5% level

untreated fruits started spoilage after 4 months followed by various pretreated fruits like blanched fruits (5 months) fruits immersed in citric acid solution (6 months) fruits sulphited (8 months) and finally fruits exposed to sulphur fumes (9 months) The main organisms found responsible were yeast and mold The mold such as Aspergillus and Penicillium were identified (Table 32 and 33) Results on the same line were reported in dried pomegranates by Kahtani (1990)

An attempt was made to ascertain the influence of pretreatments on the shelf life quality of three different products from papaya The combined CRD analysis indicated that pretreatments had significant effect on the shelf life period

The fluctuations in the acidity level of the three products during storage period are illustrated in Table 34

For all the pretreatments there was no change in acidity for two months at ambient condition except in control samples after four months The rate of increase in acidity at ambient condition were observed to be high in products processed without any pre treatment (0 92 per cent) and it

Table 32 Yeast count (10^2/g) of the papaya candy at different time intervals

Intervals	Months							
	5	6	7	8	9	10	11	12
1 Control	4 5	–	–					
2 Blanching		4 0			–	–	–	–
3 Sulphited	–		–		3 5	–	–	–
4 Exposed to sulphur fumes		–	–			3 0	–	–
5 Immersed in citric acid solution			4 0	–	–	–		

Table 33 Mold count (10^2/g) of the papaya candy at different time intervals

Intervals	Months							
	5	6	7	8	9	10	11	12
1 Control	4 5				–	–	–	
2 Blanching		3 0	–	–		–		–
3 Sulphited	–		–		3 0	–		–
4 Exposed to sulphur fumes		–		–	–	2 5		–
5 Immersed in citric acid solution	–		3 0			–	–	

Table 34 Effect of pretreatments and storage temperature on acidity of papaya products during storage (Acidity expressed as per cent citric acid/g)

Treatments	Storage periods (Months) 1		2		3		4		5		6		7		8		9		10		11		12	
	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2
T_1	0 87	0 87	0 93	0 87	0 94	0 87	0 98	0 87	1 18	0 92	1 66	0 93	1 66	0 95	1 67	0 97	1 7	1 01	1 71	1 04	1 76	1 22	1 79	1 22
T_2	0 87	0 87	0 87	0 87	0 93	0 87	0 97	0 87	1 0	0 87	1 21	0 93	1 66	0 94	1 66	0 94	1 7	0 97	1 70	1 00	1 73	1 01	1 76	1 03
T_3	1 09	1 09	1 09	1 09	1 10	1 09	1 10	1 09	1 12	1 09	1 15	1 09	1 17	1 13	1 19	1 14	1 86	1 13	1 89	1 15	1 90	1 16	1 92	1 18
T_4	1 08	1 08	1 08	1 08	1 09	1 08	1 09	1 08	1 11	1 09	1 14	1 09	1 14	1 09	1 15	1 12	1 2	1 13	1 41	1 15	1 94	1 16	1 95	1 18
T_5	1 06	1 06	1 06	1 06	1 06	1 06	1 07	1 06	1 10	1 06	1 13	1 08	1 23	1 09	1 31	1 09	1 82	1 14	1 88	1 13	1 88	1 16	1 9	1 17
CD(0 05)	0 021		0 018**		0 017**		0 019**																	

** Significant at 1% level

S_1 Room temperature
S_2 Refrigerato

T_1 Control
T_2 Blanched
T_3 Immersed in sulphurd ox de solution
T_4 Exposed to sulphur fumes
T_5 Immersed to citric acid solut on

was followed by processed products from fruits exposed to sulphur fumes (0 87 per cent) fruits immersed in citric acid solution (0 84 per cent) processed with blanched fruits (0 83 per cent) and fruits sulphited (0 83 per cent) The rate of increase in acidity was less in refrigerated samples

Variation in pH of the three products during storage period in comparison with pretreatments is presented in Table 35 There was variation in pH in samples both at ambient and refrigerated condition after the first month of storage except in products prepared from fruits exposed to sulphur fumes There was a gradual decrease in pH during storage but the rate of decrease was less in refrigerated samples The decrease in pH in the five pretreatments at ambient condition were observed to be high in products processed with blanched fruits (1 46) followed by products processed without any treatment (1 25) in fruits exposed to sulphur fumes (1 03) in fruits sulphited (0 88) and in fruits immersed in citric acid solution (0 69)

The fluctuation in reducing sugar levels during storage is presented in Table 36

able 35 Effect of pretreatments and storage temperature on pH of papaya products during storage

	Storage periods (Months)																									
reat	1		2		3		4		5		6		7		8		9		10		11		12	
ents	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2
1	3 42	3 42	3 39	3 41	3 26	3 40	3 21	3 36	2 85	3 33	2 41	3 30	2 39	3 27	2 33	3 24	2 31	3 18	2 23	3 16	2 21	3 03	2 17	3 00
2	3 37	3 37	3 31	3 36	3 28	3 32	3 15	3 28	2 99	3 26	2 66	3 22	2 08	3 21	2 06	3 16	2 01	3 12	1 98	3 08	1 94	3 05	1 91	3 02
3	2 85	2 86	2 83	2 85	2 77	2 81	2 71	2 79	2 61	2 76	2 46	2 71	2 44	2 69	2 38	2 69	2 05	2 66	2 01	2 63	1 98	2 59	1 97	2 57
4	2 82	2 82	2 82	2 82	2 67	2 80	2 63	2 77	2 58	2 72	2 50	2 64	2 46	2 61	2 42	2 57	2 35	2 55	2 16	2 53	1 82	2 51	1 79	2 48
5	2 96	2 96	2 95	2 96	2 90	2 92	2 79	2 89	2 72	2 88	2 57	2 83	2 45	2 83	2 43	2 79	2 39	2 74	2 31	2 68	2 30	2 66	2 27	2 63

D(0 05) 0 022 0 03* 0 011** 0 016**

Significant at 5% level
* Significant at 1% level

1 Room temperature
2 Refr gerator

1 Control
2 Blanched
3 Immersed in sulphurdioxide solution
4 Exposed to sulphur fumes
5 Immersed to citric acid solution

Table 36 Effect of pretreatments and storage temperature on reducing sugar of papaya products during storage (Reduced sugar exprressed as per cent glucose/g)

Treatments	Storage period (Months) 1		2		3		4		5		6		7		8		9		10		11		12	
	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2
T_1	17 68	17 65	18 57	17 66	19 69	18 48	20 59	18 50	19 63	18 50	5 55	19 37	5 55	20 10	6 25	20 42	6 25	20 95	7 14	21 40	7 14	20 95	7 74	20 95
T_2	17 87	17 87	18 71	17 86	19 66	17 88	20 77	18 72	21 99	18 70	22 00	19 66	5 55	20 03	5 55	20 22	5 55	21 08	5 90	21 40	5 90	22 78	6 25	22 85
T_3	19 80	19 80	20 44	19 81	21 55	19 83	21 10	20 08	22 52	20 65	23 05	20 85	24 98	21 52	26 08	2 67	8 33	22 88	8 33	23 58	8 33	24 28	9 16	24 28
T_4	20 08	20 08	20 10	20 10	21 11	20 10	21 13	20 10	22 27	20 75	22 61	21 08	23 91	21 12	24 6	22 12	26 43	22 92	25 97	23 30	8 33	23 91	9 16	23 91
T_5	19 20	19 20	19 20	19 20	20 60	19 23	2 03	20 21	22 23	20 55	23 22	20 75	22 33	21 40	23 98	21 40	7 14	23 00	7 4	23 00	7 75	23 62	8 33	24 03

CD(0 05) 0 038 0 09** 0 096** 0 089**

* Significant at 5% level
** Significant at 1% level

S_1 Room temperature
S_2 Refrigerator

T_1 Control
T_2 Blanched
T_3 Immersed in sulphurdioxide solution
T_4 Exposed to sulphur fumes
T_5 Immersed to citric acid solution

In all the five pretreatments there was no change in reducing sugar for one month at ambient condition and for two months in refrigerated samples There was a gradual increase in reducing sugar with storage The higher rate of increase was noticed in samples at ambient condition The rate of change in reducing sugar at ambient condition was observed to be high in products processed with fruits sulphited (6 35 per cent and in products from fruits exposed to sulphur fumes (6 28 per cent) followed by product processed with fruits immersed in citric acid solution (4 78 per cent) in product processed without any treatment (1 75 per cent) and in products from fruits blanched (4 13 per cent)

The changes in overall acceptability during storage is presented in Table 37

For overall acceptability the scores were fluctuating in samples both at ambient and refrigerated conditions A gradual decrease in acceptability was noticed in sample during storage and the rate of decrease was lower in refrigerated samples Difference in overall acceptability were observed to be high in product processed with fruits

ble 37 Effect of pretreatments and storage temperature on overall acceptability of papaya products during storage (Mean score)

	Storage period (Months)																							
eat nts	1		2		3		4		5		6		7		8		9		10		11		12	
	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2
	3 94	4 03	3 94	4 00	3 92	3 99	3 83	3 96	4 11	3 95	4 35	3 66	4 35	3 85	4 35	3 83	4 25	3 74	4 15	3 66	4 10	4 00	4 10	3 90
	4 28	4 33	4 27	4 33	4 18	4 31	4 03	4 23	3 94	4 19	3 95	4 17	4 43	4 08	4 35	4 09	4 35	4 04	4 20	3 92	4 20	3 90	4 10	3 80
1	4 17	4 20	4 18	4 18	4 09	4 18	4 03	4 15	3 98	4 08	3 85	4 00	3 70	4 02	3 72	3 99	4 15	3 93	4 05	3 88	4 10	3 85	4 00	3 80
1	4 44	4 45	4 44	4 48	4 40	4 47	4 37	4 45	4 32	4 40	4 18	4 37	4 12	4 23	4 05	4 21	3 99	4 14	3 95	4 10	4 10	4 10	4 00	4 05
5	4 13	4 21	4 13	4 18	4 11	4 15	4 03	4 08	3 88	4 05	3 78	4 03	3 95	3 87	3 98	3 88	4 23	3 90	4 05	3 80	4 60	3 70	4 00	3 75
D	0 048**		0 035**		0 039**		0 041**																	

Significant at 5% level

2 Refr gerator

1 Control
2 Blanched
3 Immersed in sulphurd oxide solution
4 Exposed to sulphur fumes
5 Immersed to citric acid solut on

exposed to sulfur fumes (0 49) followed by in fruits sulphited (0 47) in fruits immersed in citric acid solution (0 35) in fruits blanched (0 34) and in product processed without any treatment (0 11)

The statistical analysis of the data revealed that pretreatments applied had significant effect in increasing the shelf life as a whole

4 2 Effect of processing techniques on the shelf-life quality of papaya products

The processing techniques selected for the study were squash jam and candy sugar was the medium used for the preservation of the fruit in the three products But the quantity of sugar used were varying depending on the processing technique In squash the sugar pulp ratio was 2 1 while in jam it was 1 1 and for candy the sugar used was depending upon the sugar absorbed during processing In the present study the sugar in the product candy was varying between 70 to 74 Studies conducted by Thirumaran et al (1985) revealed that final brix of candy varied between 70 to 75 Brix

Another significant variation in the three techniques applied was in heat application For squash sugar and water in the ratio of 2 1 was first boiled till the sugar dissolved cooled to room temperature and then was added to the fruit juice and mixed While in jam pulp and sugar mixture in the ratio of 1 1 was cooked until the jam consistency was obtained (30-45 mts/kg) But in candy sun drying was administered to dehydrate the products dipped in sugar solution

Parameters selected to study the effect of processing techniques on shelf-life quality were acidity pH reducing sugar and over all acceptability

The statistical analysis of the processing techniques on these parameters revealed that the processing techniques had significant effect on these shelf life qualities

The fluctuation in acidity values of the three products are illustrated in Table 38 A comparison of the three products revealed that except in squash there was no change in acidity for one month at ambient condition and in

Table 38 Effect of processing and storage temperature on acidity of papaya products during storage (Acidity expressed per cent citric acid/g)

Treatments	Storage periods (Months)																							
	1		2		3		4		5		6		7		8		9		10		11		12	
	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2
P_1	1 71	1 71	1 71	1 71	1 72	1 71	1 72	1 71	1 71	1 71	1 75	1 71	1 76	1 72	1 77	1 72	1 80	1 75	1 82	1 78	1 84	1 79	1 86	1 82
P_2	0 62	0 62	0 64	0 62	0 87	0 82	0 69	0 62	0 74	0 65	0 77	0 68	0 77	0 70	0 80	0 71	0 82	0 72	0 86	0 74		0 76		0 77
P_3	0 64	0 64	0 65	0 64	0 68	0 64	0 71	0 65	0 77	0 65	0 83	0 68	0 83	0 70	0 86	0 72	0 88	0 74		0 76		0 79		0 81
CD(0 05)	0 019		0 017**		0 013**		0 015**																	

* Significant at 5% level

P_1 Squash P_2 Jam P_3 Candy

S_1 Room temperature
S_2 Refrigerator

the refrigerated samples respectively There was a gradual increase in acidity values but the rate of increase was less in refrigerated samples Rate of increase in acidity in samples at ambient condition were observed to be 0 22 in squash 0 24 in Jam as well as in candy

Variation in pH content of the three products at ambient and refrigerated condition is presented in Table 39 There was no variation in pH value for the three products at ambient condition in one month and two months in refrigerated samples There was a gradual decrease in pH values during storage but the rate of decrease was less in refrigerated samples The decrease in pH in the three products at ambient condition was observed to be 0 66 in squash 1 01 in jam and 0 67 in candy

The fluctuation in reducing sugar levels of the three products are illustrated in Table 40 The reducing sugar levels for the three products there was no change for one month at ambient condition and two months in the refrigerated samples There was a gradual increase in reducing sugar content 2 81 per cent in squash 12 8 per cent in jam and 7 11 per cent in candy Moisture content of the

Table 39 Effect of processing and storage temperature on pH of papaya products during storage

Treatments	Storage period (Months)																							
	1		2		3		4		5		6		7		8		9		10		11		12	
	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2
P_1	2 57	2 57	2 56	2 57	2 46	2 56	2 44	2 55	2 38	2 53	2 25	2 49	2 23	2 48	2 21	2 47	2 15	2 42	2 10	2 38	2 05	2 34	2 02	2 30
P_2	3 40	3 40	3 35	3 40	3 26	3 34	3 10	3 26	2 93	3 20	2 67	3 13	2 44	3 03	2 37	3 00	2 44	3 00	2 39	2 97		2 95		2 92
P_3	3 29	3 29	3 27	3 29	3 20	3 26	3 15	3 25	3 05	3 21	2 78	3 21	2 78	3 20	2 71	3 17	2 62	3 14		3 09		3 01		2 99

CD(0 05) 0 015 0 03* 0 011** 0 014**

* Significant at 5% level
** Sign f cant at 1% level

P_1 Squash
P_2 Jam
P_3 Candy

Table 40 Effect of processing and storage temperature on reducing sugar of papaya products during storage (Reduced sugar exprressed as per cent glucose/g)

Treatments	Storage period (Months) 1		2		3		4		5		6		7		8		9		10		11		12	
	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2
P_1	5 6	5 61	5 6	5 6	5 67	5 61	5 67	5 61	5 72	5 61	6 32	5 61	6 32	5 67	6 72	5 84	7 26	5 99	7 52	6 44	7 74	6 54	8 42	6 67
P_2	28 84	28 82	29 81	28 83	31 73	29 17	32 48	30 21	34 98	30 82	36 39	31 30	38 38	38 32	10 40	55 32	60 41	55 35	40 41	60 36	54	37 30		37 60
P_3	22 34	22 33	22 72	22 33	24 07	22 52	24 75	22 94	25 63	22 93	26 34	23 41	27 01	25 82	28 54	24 05	29 45	24 77	25 42		26 18		26 70	

CD(0 05) 0 037 0 82** 14 1 44**

* Significant at 5% level
** Significant at 1 level

P_1 Squash P_2 Jam P_3 Candy

product might have a direct influence on the extent of the changes observed in the three different products

The fluctuation in overall acceptability among the three products at ambient and refrigerated condition is presented in Table 41

For overall acceptability among the products squash had no change for one month while the acceptability score was fluctuating in refrigerated samples for two months in squash and jam A gradual decrease in overall acceptability was noticed in samples during storage and the rate of decrease was less in refrigerated samples Decrease in overall acceptability in the three products were observed to be 0 55 in squash after 12 months 0 5 in jam after 10 months and 0 21 in candy after nine months at ambient condition

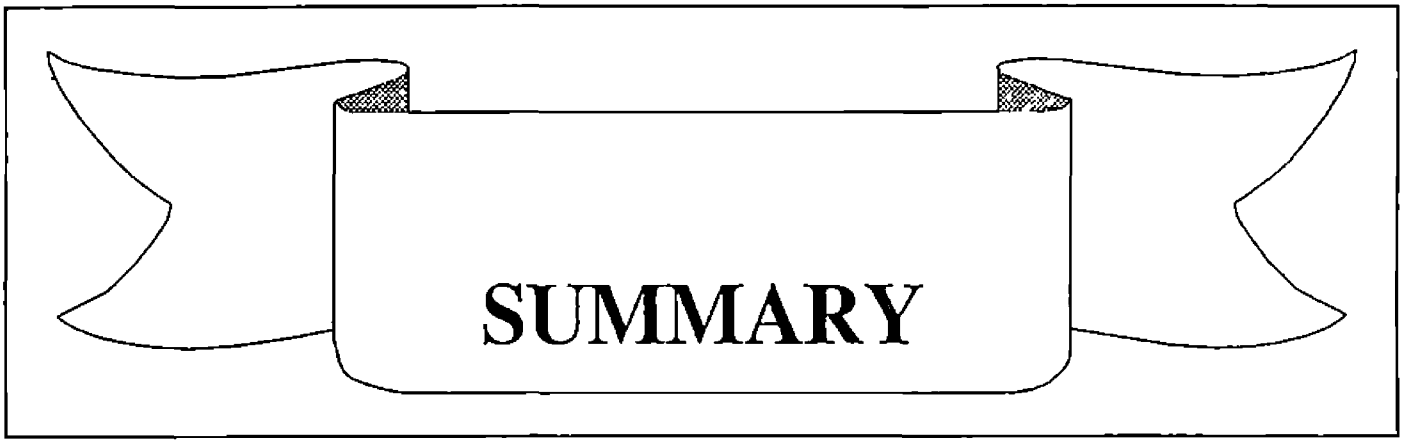
The statistical analysis of the data revealed that processing technique had signif cant effect in increasing the shelf life quality of the products

Table 41 Effect of Processing and storage temperature on overall acceptability of papaya products during storage (Mean score)

Treatments	Storage periods (Months)																							
	1		2		3		4		5		6		7		8		9		10		11		12	
	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2
P_1	4 51	4 55	4 52	4 55	4 54	4 54	4 49	4 54	4 45	4 52	4 33	4 44	4 26	4 38	4 28	4 37	4 23	4 31	4 12	4 19	4 10	4 20	4 04	4 14
P_2	4 23	4 23	4 21	4 25	4 13	4 25	4 06	4 17	3 92	4 11	3 78	4 09	3 78	3 98	3 72	3 95	3 78	3 89	3 75	3 84		3 80		3 77
P_3	3 85	3 95	3 85	3 89	3 75	3 87	3 63	3 81	3 68	3 76	3 64	3 75	3 75	3 75	3 7	3 69	4 05	3 65		3 57		3 70		3 65
CD	0 082**		0 06**		0 065**		0 069**																	

* Significant at 1 % level

P_1 Squash P_2 Jam P_3 Candy


SUMMARY

SUMMARY

The present investigation was undertaken to study the influence of pretreatments and processing technique on the shelf-life qualities of papaya products

The three products developed from papaya namely squash jam and candy were found to satisfy the specifications laid down by FPO Different pretreatments administered were blanching sulphiting exposure to sulphur fumes and immersion in citric acid solution

An analysis of the proximate composition of the three products developed from different pretreated fruits revealed that moisture reducing sugar and total sugar were high in papaya squash and jam pretreated with sulphur fumes while the candy processed with fruits immersed in citric acid solution was high in acidity reducing sugar and carbohydrates

The organoleptic qualities of the three products revealed that papaya squash was most acceptable However the

pretreatments applied did not have a significant effect on the acceptability of fresh papaya squash while results obtained from the other two products revealed significant effect among different pretreatments The pretreatment with sulphur fumes was effective in improving the appearance and colour of the product

The shelf-life qualities of the papaya products were assessed periodically for one year and the qualities analysed were acidity pH reducing sugars overall acceptability and mold count For papaya squash specific gravity total sugar acid soluble ash pulp content TSS and fermentation test were also estimated while for jam and candy bulk density was estimated

The periodical testing of stored papaya squash revealed that variation in specific gravity pulp content and acid soluble ash were negligible The fermentation test and mold count also gave negative results Monthly analysis of the acidity level in squash showed a gradual increase from 1 71 to 1 86 per cent at ambient condition while refrigerated samples produced a lesser rate of increase from 1 71 to 1 82 per cent It was noticed that the pretreatments had

significant effect on acidity and product processed with fruits exposed to sulphur fumes were very effective in maintaining the quality

The periodical testing of pH content in papaya squash showed a decreasing trend and the rate of decrease was lower in refrigerated samples The decrease in pH of the samples at ambient condition was from 2 57 to 2 02 while in refrigerated samples it was 2 57 to 2 30 The product processed with sulphur compounds and citric acid produced lower pH levels which was a desirable quality

An increase in the reducing sugar during storage at ambient condition and in refrigerated samples was observed However the rate of inversion of sugar which is an undesirable quality was slower in refrigerated samples The samples at ambient condition showed and increase from 5 61 per cent to 8 42 per cent while in refrigerated samples it was from 5 61 per cent to 6 67 per cent

The periodical analysis of total sugar of papaya squash showed a slight increase in the total sugar of the product The decrease was from 71 03 per cent to

61 99 per cent in samples at ambient condition while in refrigerated samples it was from 71 03 per cent to 65 17 per cent The storage at lower tempe ature had no significant effect on the total sugar levels

The monthly assessment of the acceptability of the product showed a decreasing trend in acceptability with storage The rate of decrease was more or less the same in refrigerated samples The acceptability level decreased from 4 51 to 4 04 in samples at ambient condition while it was from 4 53 to 4 14 in refrigerated samples The pretreatment with sulphur dioxide helped to preserve good colour and quality of the product during storage

There was fluctuation in TSS levels in papaya squash during storage and the increase was greater in samples stored at ambient condition The fluctuation was from 57 4 to 57 8 per cent in samples at ambient condition and it was from 57 4 to 57 6 per cent in refrigerated samples

The analysis of the storage period of papava jam revealed that storage at low temperature was effective in increasing the shelf life period Among the samples at

ambient condition jam processed from fruits exposed to sulphur fumes showed a long shelf life of 84 per cent and the least shell life period was observed in control sample (43 per cent)

The periodical evaluation of bulk density of papaya jam had shown that variation was negligible at both storage temperatures

The periodical assessment of acidity in papaya jam showed a gradual increase from 0 62 to 0 86 per cent in samples at ambient condition and 0 62 to 0 77 per cent in refrigerated samples The study indicated that storage temperature had significant effect on shelf-life period Storage in refrigerator decreased the rate of increase in acidity

The monthly evaluation of pH in the product indicated a decreasing trend The changes in pH at ambient condition were observed to be a decrease from 3 40 to 2 39 while in refrigerated samples it was from 3 40 to 2 92 The storage at low temperature was effective in controlling the changes in pH

The variation in reducing sugar in jam showed an increase with storage The increase in reducing sugar at ambient condition was observed to be from 28 84 per cent to 41 6 per cent while in refrigerated samples it was from 28 82 to 37 60 per cent The storage temperature had significant effect on the rate of change The storage at room temperature increased the rate of increase in reducing sugar level

The orgenoleptic evaluation of the product during storage showed a decrease in acceptability of the product with increase in storage time The decrease in acceptability at ambient condition was observed to be from 4 23 to 3 75 It was from 4 23 to 3 77 in refrigerated samples

The evaluation for microbial attack of the product showed that the causative organisms were bacteria yeast and mold Among all the five pretreatments fruits exposed to sulphur fumes were found to be more effective in preventing microbial attack and showed maximum storage life The refrigerated samples were found fresh even after one year storage

The statistical analysis of the shelf life period of papaya candy revealed that the pretreated refrigerated samples had longer shelf-life when compared to control product processed with fruits exposed to sulphur fumes showed the highest shelf life period of 75 per cent the least was observed in product processed with untreated fruits (34 per cent) The control sample stored in refrigerator also showed the least shelf life period of 92 per cent among refrigerated samples

The variation in bulk density during storage indicated only negligible variation during storage at both storage temperature

The monthly assessment of acidity in papaya candy had revealed an increasing trend with storage The change in acidity was observed to be an increase from 0 64 to 0 88 per cent at ambient condition and in refrigerated samples it was from 0 64 to 0 81 per cent The rate of increase was less in refrigerated samples

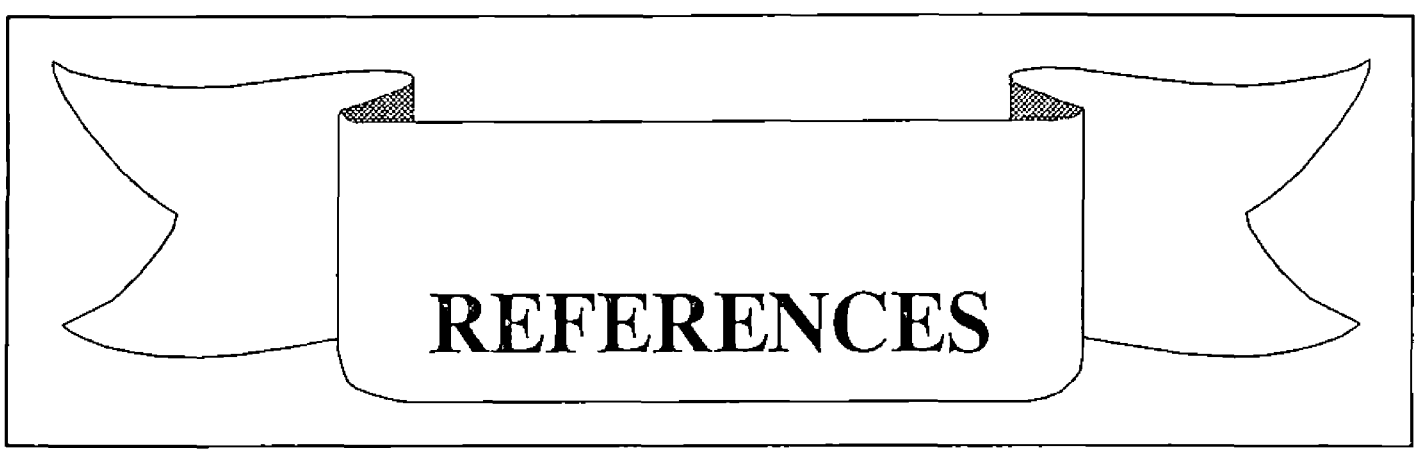
The variation in pH during monthly analysis showed a decrease with storage The decrease was from 3 29 to 2 62 in samples at ambient condition while it was from 3 29 to 2 99 in refrigerated samples The deteriorative changes were more at ambient condition compared to refrigerated samples

The periodical evaluation of the reducing sugar content of papaya candy showed an increase in the values with storage The increase in reducing sugar was from 22 34 to 29 45 per cent in samples at ambient condition and in the refrigerated samples it was from 22 33 per cent to 26 70 per cent The storage temperature had significant effect on the reducing sugar In the study the rate of increase was higher at ambient condition compired to that in refrigerator

The organoleptic evaluation of the product during shelf-life period indicated a decrease in organoleptic acceptability with storage The change in acceptability was observed to be from 3 85 to 3 64 in samples at ambient cond tion and it was trom 3 85 to 3 7 in the refrigerated samples Th rate of decrease was more in the samples at amb ent cond t on

The microbial eva uation of the damaged product had revealed that the major organisms causing damage were yeast and mold Asperigillus and pencillium were identified among molds from stored papaya candy

Like any other conventional fruits papaya also proves to be ideally scented to process various products Pretreatments attempted in the study indicates the advantage of there procedures with respect to the shelf life qualities of the products Among there pretreatments exposure to process to be the most ideal one is a very simple technology which can easily be adopted by moderately educated farm women


REFERENCES

REFERENCES

Aina and Adesina (1991) Quality attributes of jams from low usage tropical fruits Food Chemistry 40(3) 345 351

*Alien A M El Shini N M Abd-El Magied M M A and Tawadrous A G (1986) Heat resistance of B coagulam spores isolated from tomato juice Egyptian Journal of Food Science 14(2) 323-330

Azizi A and Renganna S (1993) Spoilage organism of canned acidified mango pulp and their relevance to thermal processing of acid foods Journal of Food Science and Technology 30(4) 244 245

Bailey (1990) Anti stick packaging for hygroscopic foods Food patents 14(1) 82

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

*Bengtsson B L (1969) Journal of Food Science and Technology 4 141

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

Bose T K and Mitra S K (1990) Fruits Tropical and Subtropical Naya Prakash Culcutta

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

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

*Briston J (1971) Plastics for food packaging I Food Manufacturer 46 71 75

*Briston J (1976) New plastic material for packaging film Packaging Review 96(3) 71 73-74

*Chopra R N (1958) Indigenous Drugs of India 2nd edition (P 319-311) U N Dhur Calcutta

Cristofaro P (1990) Comparative study on keeping quality of fruit juices in various pack types Food Science and Technology abstracts

Crowell and Ough (1987) Food Science and Technology abstracts

Cruess W V (1958) Commercial Fruit and vegetable products Mc Graw Book Company New York

Donchesko L V and associates (1983) Effect of active acidity on strength of jam and jelly Horticultural abstracts

Eyten O Weinert I A G and Mc Gill A E J (1991) Effect of salad dressing and citric acid dip on storage quality of shredded cabbage and carrot packed under modified atmoshpere Food science and Technology International Journal 25(5) 445

FAO report (1987) Fruits - tropical and subtropical by Bose ane Mitra (1990) Naya Proleash Calcutta

*Fields M L Zamera A F and Bradsher M (1977) Microbial analysis of some canned tomatoes and green beans Journal of Food Science 42 931 934

Gupta G K Amba Dan and Anand J C (1971) Control of fermentation in vegetable sauce Indian Food Packer 25(5) 5

*Hayes S (1933) Uses of papaya In - International Review of Agriculture (Bailey ed) 24 454

Herrington K (1991) Sensery evaluation or getting the taste right Dairy Industries International 56(3) 31-32

Hodgson A A (1990) Physical and chemical characteristics of partially clarified guava juice concentrate

Hofmeyr J P J (1938) Genetical studies of carica papaya L I & II Un S Afr Dept Agri for Sci Bull 189 5-64

Horticultural project of Kerala State Horticultural products Development Corporation 1992

*International commission on Microbiological specification for foods (1980) Microbial ecology of foods Vol I Academic Press London

Iyer C P A (1987) in Fruits Tropical and Subtropical by Bose and Mitra (1987) Naya Prakash Culkutta

Jayaraman K S and Gupta D K D (1991) Quality characteristics of some vegetable dried by direct and indirect sunlight Indian Food Packer 45 16 23

*Joslyn M A and Braverman J B S (1954) The chemistry and technology of the pretreatment and preservation of fruit and vegetable product with sulpherdioxide and sulphite Advanced Food Reasearch 5 97 160

Kahtani H A (1990) Intercultivar differences in quality and post harvest life of pomegranate influenced by partial drying Horticultrual Abstracts

Kalra C L (1990) Role of blanching in vegetable processing Indian Food Packer 44(5) 3-13

*Kalra S K and Revathi G (1981) Storage studies on guava pulp Indian Food packer 3566) 29-33

Kalra S K Tandon D K and Singh B P (1991) Evaluation of mango-papaya blended beverage Indian Food Packer 45(1) 33 36

Kawamata S (1977) Studies on determining the sugar composition of fruits Bulletin of Tokyo Agricultural Experimental station 10

Krawger D A Kruger R G and Maxiel J (1992) Composition of pineapple juice Journal of AOAC International 75(2) 280-282

Kulwal L V Patwardhan M V and Sulladnath V V (1985) Studies on chemical changes and corrosion in canned products of papaya Indian Food Packer 39(4) 33-37

*Labuza T P Tannenbaum S R and Karel M (1970) Water content and stability of low moisture and intermediate moisture foods Food technology 29 35-42

Maini S B Diwan B and Gupta S K (1982) A solar drier for fruits and vege Indian Horticulture 27(1) 21

Manan J K Kulkarni J G and Shukla I C (1992) Studies on preparation and storage of pulp squash nectar and ready to serve beverage from two varieties of apricots in UP Beverage and food World 19(4)

Mehta U and Bajaj S (1983) Effect of storage and method of preservation of the physico-chemical characteristics of citrus juices Indian Food Packer 37(4) 42 50

Menezes H C (1980) Technological aspects of tropical fruits and their products Abstracts on tropical Agriculture

Mir M R and Nath N (1993) Storage changes in fortified mango bars Journal of Food Science and Technology 30(4) 279 282

Mohammed S Kyi K M and Sharif Z M (1993) Protective effect of system HCI on vitamin C in dehydrated pickled/candied pineapple and guava Food Science and Technology Abstracts A b No 6J56 25(6)

Okoli E C and Ezenwelie L O (1990) Formulation and shel life of bottled papaya juice beverage International Jouranl of Food Science and Technology 25(6) 706 710

*Palaniswamy K P and Muthukrishnan C R (1974) Studies on the physico chemical characters of lemon juice and squash during storage Indian Food Packer 28(4) 37 41

Pawar S G Kulkarni D N Shere D M Kulkarni K D and Patil V K (1992) Effect of pretreatments on chemical composition and drying rates of solar dried figs Indian Food Packer 46(1) 36-44

Pawar V D Patil D A Khedkar D M and Singh V M (1985) Studies on drying and dehydration of pumpkin Indian Food Packer 39(4) 58

Pederson (1947) In preservation of Fruits and Vegetable (1986) Published by ICAR

Perlette (1992) Grape juice Effect of extraction method sulphur dioxide concentration and storage on the physico chemical composition Indian Food Packer 46(6) 5-13

*Pruthi (1950) Effect of different methods of preservation and other factors on the keeping quality of citrus juice during storage Indian Food Packer 4(6) 21-22

*Pruthi J S (1954) Some observations on the processing of pineapple CFTRI Bulletin 4(2) 41

*Pruthi J S (1959) Physico chemical changes in lemon concentrate during commercial scale vaccum concentration Food Science 8 (2) 39-43

*Pruthi J S (1960) Freeze drying of passion fruit juice Food Science 9 336 338

*Pruthi J S and Lal G (1959) Chemical composition of passion fruit J Sci Food Agric 3 188-92

*Purseglove J W (1968) Tropical Crops Dicotyledons The English language Book Society

Purushottam V Mahadeviah M Gowramma R V and Naresh R (1992) Packaging of some fruits and vegetable products in glass containers Journal of Food Science and Technology 26(6) 368-370

Quisumbing E (1951) Medicinal plants of the Philippines Bureau of Print Manila p 632-637 *

Ranganna S (1977) Manual of Analysis of Fruit and vegetable products Tata Mc Graw Hill Publishing Company Limited New Delhi

Rao B S (1989) Processed foods Market in India Present and future prospects Indian Food Packer 43(4) 67-70

Renganna S and Padival A J (1981) Chemical preservation and antioxidants Indian Food Packer 35(3) 30 44

Renote P S Bawa A D and Saini S P S (1992) Thermal process for kinnow RTS Indian Food Packer 46(2) 16 20

Renote P S Saini S P S and Bawa A S (1993) Shelf life of processed knnow juice Research and Industry India 38(1) 15 18

Sandhu G S Bawa A S and Bains G S (1988) Studies on the effect of variety processing and storage on the quality of grape juice Indian Food Packer 42(4) 36 42

Scow Tan and Lim (1991) Production of firmer textured canned and frozen tropical fruits Asean Food Journal 6(3) 104 108

Sethi V (1985) A simple and low cost preservation of litchi fruit Indian Food Packer 39(4) 42 48

Sethi V (1993) Prospects and constraints for export of indigenous fruit and vegetable products Indian Food Packer 47(3) 37 41

Sethi V (1994) Efficacy of various preservatives for preserving while tomato concentrate Indian Food Packer 48 (1) 11 15

Sethi V and Malini S B (1989) Appropriate technology for reducing post harvest losses in fruits a d vegetables Indian Food Packer 43(2) 42-54

Sethi V and Alini (1991) Studies on storage of mango pulp Indian Journal of Horticulture 48(3) 228-231

Shah G H and Bains G S (1992) Storage studies on canned peach and apricot pulp Indian Food Packer 46(6) 15-17

Sharma T R Sekhon K S and Saini S P S (1993) Colour changes during drying of Apricots Journal of Food Science and Technology 30 (4) 306-308

*Shoenfied E and Margalith P (1962) Thermophitic aerobacillus from banana purce Applied Microbiol 10 309-310

Sian and Ishak (1991) Carotenoid and anthocyanin contents of papaya and pineapple Influence of blanching and preheating treatment Food Chemistry 39(2) 175 185

Siddappa G S Lal G and Tandon G L (1986) Preservation of fruits and vegetables Published by ICAR New Delhi

Singaravelu M and Arumugam R (1993) Solar drier Food Digest 16(3) 140 143

Singh I D (1990) Papaya Oxford and IBH Publishing co Pvt Ltd New Delhi

*Singh K and Mathur P B (1953) Indian Journal of Horticultural '0 115 121

Singh R Kapoor A C and Gupta 0 P (1983) The effect of cultivars seasons and storage on the nutritive value of guava cheese Indian Food Packer 37(5) 71 77

*Swaminathan M (1974) Diet and Nutrition in India In essentials of food and nutrition II Applied Aspects Ganesh & Co Madras 17 361 367

*Teotia M S Kalra C L Raina B L and Pruthi J S (1983) Influence of pretreatments on the quality of canned okra-a comparative study Indian Food Packer 37(3) 50-56

Thirumaran A S Seralathan M A and Malathi D (1985) A simple processing technique for papaya candy TNAU Newsletter 15(6) 3

Thirumaran A S Seralathan A M and Malathi D (1992) Preparation of carrot based RTS South Indian Journal of Horticulture 40(1) 49-52

Thirumaran A S Seralathan M A Sundararajan and Malathi D (1986) Utilization of papaya in South India South Indian Journal of Horticulture 39(4) 258-262

Thirumaran A S and Seralathan M A (1990) Studies on packaging and storage of tomato concentrate South Indian Journal of Horticulture 38(4) 228 231

Thirumaran A S and Seralathan M A (1993) A paper on the scope of the export of papya and mango products Department of Food Science and Nutrition TNAU Times of India (1993) March 27

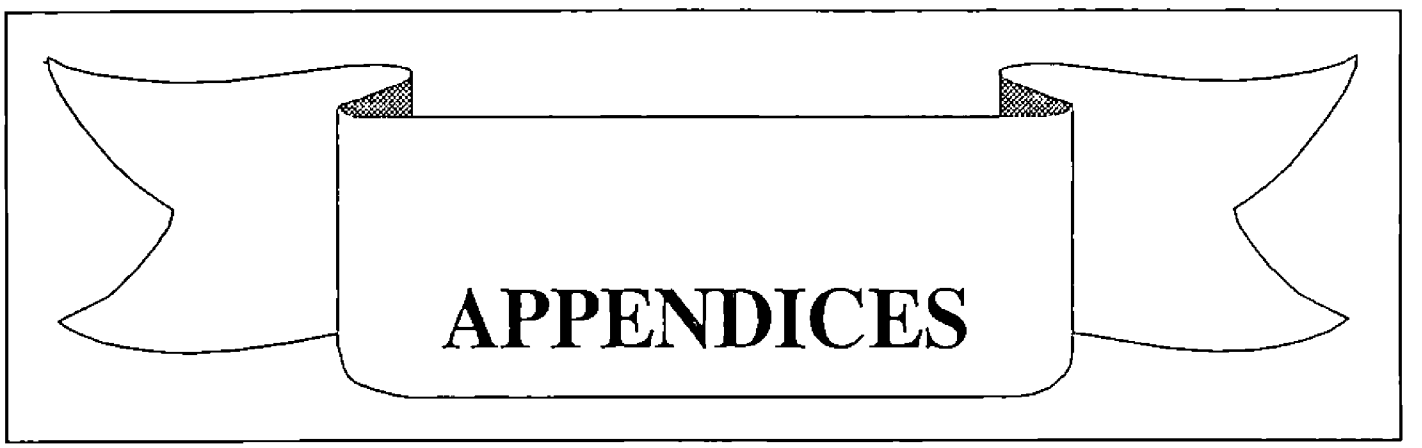
Tripathi V K Singh M B and Singh S (1988) Studies on comparative compositional changes in different preserved products of amla var Banarasi Indian Food Packer 42(4) 60 65

*Vas K and Ingram M (1949) Preservation of fruitjuices with sulpherdioxide Food manufacture 24 414-416

*Weeny D J Bitliffle P O Powell R C T and Spark A S (1969) Maillard reaction its inhibition by sulphite Journal of Food Science 34 641 -643

Woodroof J G and Luh B S (1975) Commercial Fruit Processing The AVI Publishing Company West Port Connecticut

* Originals not seen


APPENDICES

Appendix 1 Organoleptic Evaluation
Evaluation card for triangle test

In the triangle test three sets of sugar solutin of different concentration were used Of the three sets two solution were of identical concentrations and the women were asked to identify the third sample which is to different concentration

Name of the Products Sugar solution

Note Two of the three samples are identical Identify the odd sample

Sl No	Code No of samples	Code No of the identical sample	Code No of the odd sample
1	XYZ		
2	ABC		

APPENDIX I

Score Card

Criteria		A	B	C	D	E
1. Appearance						
Very good	(5)					
Good	(4)					
Fair	(3)					
Poor	(2)					
Very poor	(1)					
2. Flavour						
Very pleasant	(5)					
Pleasant	(4)					
Neither pleasant nor unpleasant	(3)					
Unpleasant	(2)					
Not at all pleasant	(1)					
3. Texture						
Very good	(5)					
Good	(4)					
Fair	(3)					
Poor	(2)					
Very poor	(1)					
4. Tongue						
Excellent	(5)					
Very good	(4)					
Good	(3)					
Fair	(2)					
Poor	(1)					

IMPACT OF PRE-TREATMENTS AND PROCESSING ON THE SHELF LIFE QUALITY OF PAPAYA PRODUCTS

by

SHEEJA N

ABSTRACT OF THE THESIS
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VELLAYANI, THIRUVANANTHAPURAM

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ABSTRACT

The present investigation was undertaken to study the influence of pretreatments and processing on the shelf life quality of papaya products

The papaya squash jam and candy developed were found to satisfy the FPO recommendations The pretreatments administered were blanching sulphiting exposure to sulphur fumes and immersion in citric acid solution

An analysis of the proximate composition of the three products revealed that moisture and sugars were high in squash and jam pretreated with sulphur fumes while candy pretreated with citric acid solution was high in acidity sugars and carbohydrates

The organoleptic evaluation of the fresh products indicated that squash was most acceptable The pretreatment with sulphur fumes was affective in mproving the appearance and colour of all the three products

The shelf life qualities of the three products were assessed periodically for one year Periodical testing of stored papaya squash showed little variation in acid soluble ash specific gravity and pulp content Negative results were obtained for fermentation test and mold content

The periodical testing for acidity reducing sugar total sugar and TSS in squash showed an increase during storage while pH and overall acceptability decreased with storage

The monthly evaluation of papaya jam revealed that storage at low temperature was effective in retaining the quality Among the pretreatments products prepared with fruits exposed to sulphur fumes showed the maximum shelf-life period (84 per cent) compared to control (43 per cent) which showed the least shelf-life

The periodical evaluation of papaya jam indicated negligible changes in bulk density Acidity and reducing sugar showed an increase while pH and overall acceptability decreased with storage

The microbial evaluation of jam revealed that the main causative organism were bacteria yeast and mold The pretreatment with sulphur fumes was effective in preventing the microbial attack At the same time the refrigerated samples were found fresh even after one year

The analysis of the shelf life period of papaya candy revealed that pretreated refrigerated samples had a longer shelf life of more than one year than control At ambient conditions samples processed fruits from exposed to sulphur fumes had the highest shelf life period (75 per cent) compared to the control (34 per cent) which was the least

The periodical evaluation of candy showed only negligible variation in bulk density Acidity and reducing sugar was found to increase while pH and overall acceptability showed a decrease with storage

The microbial evaluation of the damaged product revealed that the major causative organism were yeast and mold

The shelf life evaluation of the products indicated that the refrigerated samples gave quality products compared to that at ambient condition All the refrigerated samples showed a slower rate of change in the chemical constituents

The evaluation of the three products revealed that pretreatment with chemical compounds especially with sulphur compounds produced a better effect both qualitatively and orgnoleptically

Pretreatments attempted in the study indicates the advantages of there procedures with respect to the shelf life qualities of the products Among there pretreatments exposure to sulphur fumes process to be the most ideal one is a very simple technology which can easily be adopted moderately educated farm women