STUDIES ON THE PROCESSING TECHNOLOGY OF GUAVA (*Psidium guajava* L.) NECTAR

A Thesis Submitted To Haryana Agricultural University In Partial Fulfilment Of The Requirement For The Degree Of

MASTER OF SCIENCE

IN

HORTICULTURE

By

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HISSAR

1983

DEDICATED

TO MY

MOTHER

CERTIFICATE I

This is to certify that the thesis entitled "Studies on the processing technology of guava nectar (*Psidium guajava* L.)" submitted for the degree of Master of Science, in the subject of Horticulture of the Haryana Agricultural University, Hissar is a bonafide research work carried out by Sh. Sukhbir Pillania under my supervision and that no part of this thesis has been submitted for any other degree.

The assistance and help received during the course of investigation have been fully acknowledged.

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CERTIFICATE II

This is to certify that the thesis entitled "Studies on the processing technology of guava (Psidium guajava L.) nectar" submitted by Sh. Sukhbir Pillania to the Haryana Agricultural University, Hissar in partial fulfilment of the requirements for the degree of Master of Science in the subject of Horticulture, has been approved by the Student's Advisory Committee after an oral examination on the same, in collaboration with an External Examiner.

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Pillania 29.8.83.

Hissar. (Sukhbir Pillania)

CONTENTS

LIST OF TABLES

LIST OF ABBREVATIONS

AS	Allahabad Safeda
BS	Banarasi Surkha
SD	Sardar
TD	Tehsildar
et al	And Others
%	Percent
°B	Brix
C	Centigrate or Celsius
g	Gram
mg	Milligram
ml	Millilitre
Min.	Minute
V	Volume
W	Weight
N	Normality
nm	Nenometer
rpm	Revolution per minute
F	Fahrenheit
lb	Pound
cv	Cultivar
cvs	Cultivars
O.D.	Optical Density
ppm	Parts per million
HMF	Hydroxyl methyl furfuryl

MT ?

CHAPTER I

I N T R O D U C T I O N

INTRODUCTION

Guava (Psidium guajava L.) is indigenous to tropical America, belongs to Myrtaceae family alongwith other fruits like jamun, javaplum and cloves (Singh, 1979). It is the fourth most important fruit of India in area and production. It occupies an area of about 58 thousand hectares (Singh, 1979) and production is about 200,000 MT in India (Nagy and Shaw, 1980). Presently, area under guava in Haryana is about 2000 hectares and its production is about 175 thousand tonnes. (Source?) Guava requires a distinct winter for developing good fruit quality which is greatly influenced by the climate. However, it can be grown easily under aberrant soil and climatic conditions where most of the other fruits can not be grown successfully.

Guava fruit is a rich sourse of vitamin C (Singh, 1979; Goldberg and Levy, 1941; Miller and Bajore, 1945; Mustard, 1945; and Asenjo et al, 1968) and has 4 to 5 times more vitamin C than fresh orange juice. The fruit also has a fair amount of vitamin A, B and minerals like iron, calcium and phosphorous (Singh, 1979; Nagy and Shaw, 1980).

The fruit is highly perishable and seasonal in nature, being available in plenty during certain quarters of the year only and in the season, they are easily available and comparatively cheaper. Cold storage facilities are not within the reach of the growers, therefore, the crop has to be sold at unrumenrative prices. But cold storage is not the only solution to the problem, therefore, there is a necessity to develop some suitable technology for the beverage production

from guava which could be economical and made available to a large population. The palatable product made from it should have many of the dietary values of the fresh fruits. Hence, the preservation of fruits partially solves this problem and also helps to prevent 'glut' and very low prices in the market.

In India, at present, guava fruit is mostly consumed as fresh or utilized for canning and jelly making. Due to increasing cost of cans and sugar, both of the above products are losing market. On the otherside, the demand in India and other countries for some of the typical Indian fruit beverages such as mango nectar, guava nectar, banana and guava juice etc. is increasing and gaining momentum. Among these guava nectar has more potential for future expansion and may be one of the products which can be utilized throughout the year. The present opportunity, is highly favourable to the country and should not be left to go unexploited. According to Nagy and Shaw (1980) the guava production in India is largest in the world but it's processed products are lowest. This is probably due to the lack of systematic study done on the production technology of guava nectar and evaluation of various cultivars for its production.

An attempt was made by Yeh (1970) who explained the combersome process of pressing the guava juice through a centrifuge separator to remove coarse particles. Fungal enzymes have also been used to extract fruit juices from the

fruits (Waldt and Mohoney, 1967; Sreekantiah et al, 1968). An 85% yield of natural flavoured juice could be obtained by enzymatic treatment. Jain and Borker (1970) also prepared ready-to-serve beverage from guava fruit containing high pulp and suggested that the addition of ascorbic acid (vitamin C) greatly improved the flavour. Recently Kerure and Khedkar (1982) assessed the suitability of different varieties of guava for preparation of nectar, pretreatments for processing, standardization of blends and storage stability of the products.

Therefore, in order to exploite our guava production, there is a need to find out suitable processing technology for nectar production. The present investigation was undertaken with the following objectives.

1. To standardize the recipe for guava nectar.
2. To evaluate the guava cultivars for nectar production.
3. To study nutritional changes in stored guava nectar.
4. To study the storage stability of guava nectar at ambient temperature.

CHAPTER II

REVIEW OF LITERATURE

REVIEW OF LITERATURE

Some progress have been made on the utilization of arid zone fruits for the preparation of various products and different methods have been adopted for their processing. Various publications have appeared on the processing of guava for jam making, canning, dehydrated slices and powder etc. However, the information regarding the preparation of ready-to-serve beverages like nectar from guava is limited. Therefore, the results reported by various workers and other relevant information on the processing of fruits for beverage production have been recorded here.

2.1. Chemical composition of guava fruit

Guava bears mainly two crops in a year i.e. winter season crop and rainy season crop. The fruits of rainy season crop are larger in size than winter season crop as reported by Sachan *et al.*, (1969), Chundawat *et al.*, (1976) and Singh and Rajput (1977). They further observed that the total soluble solids, total sugar, acidity, pectin and ascorbic acid content were higher in winter guava fruit than rainy season guava fruit. Garg *et al.*, (1976) reported that Allahabad Safeda fruits contained 9.5 per cent total soluble solids, 0.45 per cent acidity, 148.5 mg vitamin C per 100 gram and 5.69 per cent total sugar. Rajput *et al.*, (1977) reported that guava fruit contained 9.9 percent

total soluble solids, 1.00 percent acidity, 8.0 percent total sugars, 5.05 percent reducing sugar, 195 mg ascorbic acid per 100 gram and 0.62 percent pectin content. According to Mehta and Tomar (1980), the fruits contained 10 percent total soluble solids, 76.9 percent moisture, 0.42 percent acidity, 5.76 percent total sugar, 3.68 percent reducing sugar, 1.04 percent pectin and 291 mg ascorbic acid per 100 gram.

Bagging of guava fruit with parchment paper improved the quality as compared to unbagged control (Chundawat et al, 1978). They further reported that the composition of guava fruit of different cultivars varies with cultivar to cultivar i.e. 13.3 to 15.1 percent total soluble solids, 0.572 to 0.832 percent acidity, 278.33 to 351.73 mg ascorbic acid 100 gram pulp, 3.82 to 4.45 percent reducing sugars and 2.09 to 4.19 percent non-reducing sugar content. Agnihotri and Ram (1971) found that fruits of Allahabad Safeda contained 11.2 percent total soluble solids, 154 mg ascorbic acid per 100 gram, 0.47 percent acidity, 5.0 percent reducing sugars and 8.73 percent total sugars.

Maturity and quality of fruit are closely associated with specific gravity, total soluble solids, acidity, sugar and starch percentage. The direct correlation between specific gravity and total soluble solids, total soluble solids and total sugar and specific gravity and total sugar were recorded by Teaotia et al, (1972). Specific

gravity, starch and solid matter of fruit decreases with advancement of maturity whereas total soluble solids, total sugars, acidity and ascorbic acid content increases as fruit approach to maturity and begin to ripe (Tripathi and Gangwar, 1971). The fruits of good grade and good quality for all purposes show specific gravity 0.96 percent, total soluble solids 12.6 percent, total sugar 9.98 percent, reducing sugar 5.18 percent, acidity 0.397 percent, ascorbic acid 0.18 percent and starch 1.54 percent.

Urea sprays have also been reported to be beneficial in improving the fruit quality. Singh and Rajput (1977) found highest total soluble solids (11.59 percent), reducing sugars (4.6 percent), total sugars (7.8 percent), ascorbic acid (234 mg/100 g) and pectin (0.82 percent) when 4 percent Urea spray was done. There was abrupt increase in total soluble solids, reducing sugars, total sugars and ascorbic acid content from mature to ripe stage where as ascorbic acid and acidity were maximum at ripe stage. Total pectin was found to be maximum at the maturity of fruit and gradually decreased as the fruits started becoming over ripe.

Guava fruits are a rich source of fruit pectin, Pectin content varies in different parts of the fruit. The pectin content of whole guava reported to be 0.74 percent as calcium pectate and distribution was 68.5, 11.3, 11.9 and 9.0 percent in fleshyshell, seed, peel and pulp

of seed core respectively (Jain et al, 1954). Cruess (1958) observed that protopectin was abundant in green fruits that have attained full size. Verma and Srivastava (1966) reported an increase in the total pectin content in Allahabad Safeda ranged from 0.59 percent to 1.10 percent while in Red fleshed it ranged from 0.43 to 1.07 percent. Further, there was an abrupt decrease in the total pectin content after attaining the full maturity.

Pectin content in different cultivars varied greatly and is influenced by the growing season. The pectin content of different guava cultivars was observed as 0.304 percent (Safeda), 1.261 percent (Lucknow-49) and 1.624 percent (Red Fleshed), (Teaotia, 1967).

2.2. Fruit products

The processing of fruit and vegetable serves two main purposes. In the first place, processing methods are generally also the methods of preservation which by arresting the natural progress of deterioration, can be used to creat outlets maintain supplies of perishable commodities during periods when and in region where, the fresh materials themselves would normally be unavailable. Secondly, processing provides a means of presenting the material to the consumer in a highly convenient form, requiring the minimum of preparation for the table.

The demand for fruit beverages is largely based on their nutritive value, flavour, aroma and colour. A

number of fruit juices are too acid, too strongly flavoured or too bland when filtered to give pleasing beverages. Delicious drinks, however, can be prepared by diluting them thin syrup to produce what are generally known as nectars. Most products contain greater than 40 percent natural juice with the exception of apricot nectar which have a minimum of 35 percent, papaya 33.3 percent and guava 25 percent (Woodroof and Phillips, 1974). The term "fruit nectar" is used by the industry to designate pulpy fruit juice blended with sugar syrup and citric acid to produce a ready-to-serve beverage. These beverages although they resembles to fruit juices in flavour, cannot be called fruit juices because of the added water, sugar and acid.

As early as 1942, Eddy and Veldhuis, have described a process of making nectar from fresh prunes. They recommended cooking the pitted prunes with 1/4 to 1/3 their weight of water for 8 to 10 minutes at 160 to 170°F. This cooking extracts sufficient colour from the skins, reduces the viscosity of the pulp so that it easily passes through the pulper and is not enough to cause the development of a cooked taste. The puree is diluted with sugar syrup to give it the proper sweetness (17 to 18°Brix) and consistency. The nectar than rapidly heated to 180° F filled into cans and processed in boiling water, 9 to 10 minutes for No. 1 tall cans and 12 to 13 minutes for No. 2 cans.

Several products have been prepared from guava fruits, however, the work on its beverage technology is very limited. A procedure for canning guava nectar of 12-14°Brix was described by Yeh (1970). The acidity was 0.17 to 0.20 percent as citric acid. The nectar contained 15-25 percent guava juice. The general procedures were similar to that described by Boyle et al, (1957), with the exception that guava nectar has to pass through a centrifuge separator to remove course particles. The nectar having 20 percent puree by weight is calculated so that the soluble solids of the finished product will be approximately 11 percent and the pH will be between 3.3 and 3.5 (Tressler and Joslyn, 1971). Further, it was reported that the brix readings of mango nectars are usually at 12-15°Brix and the acidity at 0.20 - 0.25 percent as citric acid. The present fruit juice in the beverage may vary from 20-30 percent. Similarly papaya nectar was made with approximately 10 parts of puree, 16.4 parts of water, 2.1 parts of sugar and citric acid, sufficient to adjust to pH to 4.0 (Stafford et al, 1966). Papaya nectar made from heat treated puree (210 F) were superior in flavour to nectar made from purees which had not been heated to inactivate enzymes. Milling the whole fruit resulted in a nectar inferior in flavour and mouth feel quality to the nectar prepared from skin separated puree. Removal of seeds by hand prior to mechanical pulping was shown to be unnecessary. Warm water treatment of the fruit before ripening caused

no adverse effects on the final nectar quality.

The bottled banana juice keeps well for about 2 months at room temperature. Thereafter, a deterioration in banana juice takes place. The dried fruit bars are of high quality and keeps well for more than a year at room temperature (Siddappa et al 1969). Where as Jaleel et al (1979) reported that bottled banana juice can be racked at room temperature (25-30°C) for over 6 months without any undesirable effects.

Blending of juice of different fruits influece the flavour, taste and consistency of the products. Rao et al (1979) reported that the beverage prepared by blending Rangpurlime and acid lime in the ratio of 15:10 or 20:5 were of good flavour and consistency. The blends prepared by mixing in ratio of 15:15 were not acceptable due to their contradictory effect on flavour.

Sulphur dioxide also helps in better retention of colour, flavour and higher retention of ascorbic acid. It acts not only as a preservative against microbial growth but also prevents browning reaction. Sarmah et al (1981) observed that kinnow juice had 13.5°Brix, 0.65 percent acidity as citric acid and 25 mg ascorbic acid/100 ml. The juice preserved with Sulphur dioxide had superior colour, flavour and higher retention of ascorbic acid as compared to heat processed juice over a period of 28 weeks storage. Pasteurized mango pulp in polypropylene pack has a shelf life of 3 months at 5°C and 2 months at 37°C while both

mango pulp and syrup preserved with Sulph-ur dioxide retain a better quality and has a shelf life atleast 5 months under ambient temperature (Ghosh et al, 1982).

Ready-to-serve beverage of phalsa juice with a Brix/acid ratio of 25.0 was liked best by a panel of seven judges (Khurdiya and Anand, 1981). Ready-to-serve beverage prepared from dried ber had 33.3 percent juice. The juice had pH of 3.75, 19.6°Brix and 0.56 percent acidity. The ber juice after processing at 80 C for 10 min. stored well for 9 months at room temperature (20-38 C). The beverage was organoleptically acceptable (Khurdiya, 1980).

Low temperature storage prolongs the storage life of fruit products. Kalra and Revathi (1981) noticed that guava pulp under refrigeration stored much longer as against at room temperature. After six months, pulp was utilized for juice preparation which was of good quality. Protein showed on upward trend during storage of guava pulp.

2.2.1. Sugars

Reducing sugar content of fruit products increased during storage at all storage temperature. Sulphur dioxide preserved pulps showed maximum increase in reducing sugar content whereas the non-reducing sugars followed a downword trend. Harnanan et al, (1980) while studying the effect of several heat treatment on quality and shelf life of a frozen nectar base reported that reducing sugar content of the pulp seemed to increase during storage. The increase was maximum in pulp extracted either by the cold or the hot method, but

preserved with sulpur dioxide. The non-reducing sugars followed down-ward trend but the main sugars in the stored pulp were of reducing type. Similar findings were also reported by Munsell et al (1950), Teaotia and Awasthi (1967) and Elzorkani (1968).

Total sugars and reducing sugars content of bael fruit increase and non-reducing sugars decreased. Roy and Singh, (1979), explained that this could be due to hydrolysis of polysaccharides and inversion of non-reducing sugars. However, accumulation of reducing sugars was found to be more in sulphur dioxide preserved pulp compared to canned one and in squash compared to nectar. This could be attributed due to higher acidity at the end of storage in sulphur dioxide preserved pulp and squash due to formation of sulphurous acid which caused the rapid inversion of non-reducing sugars.

The change in sugar content of the fruit products were affected by the temperature of processing and storage. Ranote and Bains (1982) reported that the reducing sugars content of kinnow juice increased more in heat processed samples irrespective of the season of picking. The changes were even more pronounced in the juices with natural pH (3.5) in contrast to with pH adjusted to 4.0. Processing of bottled juice in boiling water contributed to hydrolysis of sugars by acidity in the juice as compared to sulphur dioxide preserved bottled juice.

Increase in reducing sugars were correlated with the decrease of non-reducing sugar content. According to Brekke et al (1976) while studying storage temperature and containing linning on some quality attributes of papaya nectar reported that the decrease in sucrose content correlated with an increase in reducing sugars. Sarmah et al (1981) observed considerable increase in reducing sugar content in single strength kinnow mandarin juice in the samples at room temperature as compared to those kept at low temperature. Similar trend was observed in value of toned juice. The amount of non-reducing sugars decreased considerably with storage being more in those samples kept at room temperature than at the low temperature.

Storage temperature affect the reducing sugars, total sugars and non-reducing sugars of stored product. A slight decrease in total soluble solids of dried ber juice during storage for 9 months at room temperature was observed by Khurdiya (1980). However a gradual increase in reducing sugar content from 8.58 to 11.48 percent was noticed during 20 days storage at room temperature in phalsa beverage. The rate of increase in reducing sugars was much slower at 20 C and 30 C upto 100 days storage. Temperature does not effect the total soluble solids and total sugars content of phalsa beverage during storage (Khurdiya and Anand, 1981).

Krishnamurthy et al (1982) observed a reduction in total reducing sugars and increase of reducing sugar in

mango pulp stored in HDPF containers for 12 months at room temperature. Ghosh et al (1982) also reported and increase in reducing sugar content of mango pulp and mango syrup at ambient temperature of 5 months storage was 4.1 to 5.7 percent and 5 to 15 percent respectively. Reducing sugar content remain constant at 5 C upto 3 months of mango pulp but increase 8 and 9 percent at ambient temperature and 37 C upto 3 months was observed. Shrestha and Bhatia (1982) observed practically no change in total soluble solids of apple juice during storage. The statistical analysis of the data showed significant difference among the varieties. The reducing sugars content increased during storage. The increase of reducing sugars was more at 37 C than at room temperature indicating that further temperature during storage could lead to gradual inversion of non-reducing sugars to reducing sugars by hydrolysis. Total sugars and specific gravity remained practically unchanged.

2.2.2. Ascorbic Acid

The demand for fruit beverages is largely based on their nutritive value, flavour, aroma and colour. They are a source of vitamins, minerals, carbohydrates, amino acids, flavonoid compound and probably others still unidentified constituents.

Rahman et al (1964) studied the stability of vitamin C in canned tropical fruit juices and nectar. Guava nectar was fortified with vitamin C at seven levels of concentration ranging from the orifinal content to 300 mg/100 ml. The canned products were stored at room temperature and 100 F for six months. The loss of vitamin C was higher in samples stored at 100 F than at room temperature, regardless of concentration level. At the end of six months, the loss of vitamin C was less than 30 percent in samples stored at room temperature.

The losses of ascorbic acid in the heat processed bottled juice were higher than in the juice preserved with sulphur dioxide. Sethi and Anand (1982) observed that carrot and amla preserve had very low vitamin C compared to fresh fruit vitamin C content. Pruthi and Lal (1951) advocated canningof citrus juice for better retention of ascorbic acid. Similarly Ranote and Bains (1982) found that ascorbic acid content of kinnow juice decrease with processing and storage. The retention of ascorbic acid in sulphur dioxide preserved juice was higher than in the heat processed bottled juice. The pH has no effect on ascorbic acid retention.

Sarmah et al (1981) reported that there are clear evidence of the significantly higher loss of ascorbic acid in heat processed single strength and toned kinnow mandarin juice stored at room temperature over a

period of 28 weeks to the losses suffered by the low temperature was higher.

The sulphur dioxide treatment was more effective in the retention of ascorbic acid apart from inhibiting browning reaction. Ascorbic acid retention was the highest in frozen concentrate (95-98 percent) and quite high (90-97 percent) in sulphited orange juice concentrates stored at 41 F than 86 F (Pruthi, 1962).

The losses of ascorbic acid was higher at higher temperature compared to lower temperature. A loss of 19-25 percent of ascorbic acid in orange juice and 18-24 percent in grape fruit juice when stored for 6 months at 26.7 C as compared to 4-12 percent and 7-9 percent respectively when stored at 4.4 C (Stadman, 1948). This study further showed that at the end of 9 weeks the loss of total ascorbic acid ranged from 3 percent (at 10 C) to 75 percent (at 50 C). Similarly Fennema (1977) observed 1 percent and 5 percent of ascorbic acid losses in orange juice concentrate and grape fruit concentrate at 42 F and stored at 18 C for 9 months, respectively. During the study of 17 brands of reconstituted orange juice, Squires and Hanna (1979) noticed about 2 percent decrease of ascorbic acid per day during storage.

Sethi et al (1980) reported 29.95 to 17.64 mg ascorbic acid per 100 ml lost when stored at room temperature for 9 months. The decrease in ascorbic acid

content of freeze dried orange juice was linear with increased storage time at room temperature but at 30 ± 3 C losses of ascorbic acid during storage for 4 months were negligible. At 25 C, losses were slight, whereas at 37 C losses were considerable.

The reduction of ascorbic acid content was more in presence of oxygen due to oxidation than in air tight storage. The presence of oxygen in product depends upon the material used for packing. There was 85-86 percent retention of ascorbic acid in mango pulp when packed in glass and HDPE containers while its retention was only 55 percent in case of black HDPE containers. After storage of 12 months, the ascorbic acid content was very little in any of these samples. These losses of ascorbic acid may be ascribed to greater permeability of plastic containers to gases than tin or glass (Dan and Adsule, 1979).

Massaioli and Haddad (1982) reported the ascorbic acid content of orange juice was found to decrease slightly during storage over a 14 days period with the loss of ascorbic acid being dependent on the handling method used. Six of brands tested contained sufficient ascorbic acid at the end of the study to approximatly meet the minimum requirement for unopened juice.

Pasteurization of the product cause a great loss of ascorbic acid due to oxidation result in formation of anhydroascorbic acid. About 87 percent losses of ascorbic acid during pasteurization and 80 percent and 70 percent of residual content at ambient temperature (22-28 C) and 5 C during 30 days of storage of pineapple juice was observed by Ghosh et al (1982). They also noticed the losses in ascorbic acid content during pasteurization of mango pulp by 53 percent and reduction of 92 percent, 79 percent and 97 percent of residual content at ambient temperature (22-28 C), storage at 5 C and storage at 37 C respectively upto 3 months of storage.

A slight reduction in ascorbic acid content of jackfruit squash was noticed upto one year and the squash remained in good condition according to Sadasiram and Neelakantan (1975). Similar results are reported by Roy and Singh (1979) from bael fruit products during storage whereas only 6 percent retention of ascorbic acid was observed in guava slices by Mehta and Tomar (1980).

Harnanan et al (1980) reported that the retention of ascorbic acid was the highest in the canned guava pulps as compared to that of the chemically preserved pulps. Similar findings have been reported by Sanchez-Nieva et al (1970). They stored nectar bases (-10 F)

made from guava pulp and sugars in plain and enamelled cans. The retention of ascorbic acid was over 100 percent. The white fleshed guava pulp in comparison to that of red fleshed variety, exhibited higher retention of ascorbic acid as seen from the value at the end of 27 weeks of storage.

Shrikhande et al (1976) found that there was no appreciable difference in the ascorbic acid content of mango pulp stored for six months. But there was a significant loss of ascorbic acid after six months of storage.

Seventeen cultivars of mango were examined by Awasthi and Pandey (1980) for physico-chemical composition and suitability for canning and found that 40-48 percent ascorbic acid was retained in canned products after 6 months of storage.

2.2.3. Pectin

The pectin material, ranges from 3 to 12 percent of the weight of fruits and vegetables, located principally (Joslyn and Phaff, 1947, Kertesze, 1951) between the cells and giving to them cohesion and firmness. The pectin material determination is of great importance in preserve, jellies, jams or fruit pastes but less useful in fruit juices. However, soluble pectins are troublesome in clear fruit juices manufacture and are responsible for orange concentrate gelation of the pectin esterase is not entirely inactivated. On

the other hand, pectins giva a certain mellowness to the juices and posses antinfection properties and enteric transit regulating power. (Tressler & Joslyn, 1971).

During storage practically no change was observed in pectin content of preserved kinnow juice (Ronate and Bains, 1982). Similarly Harnanan (1980) found that pectin of guava pulp seemed to have been unaffected by the method of preservation and storage for 27 weeks. There was a slight variability in the values.

As early as in 1938, Rygg and Harvey (1938) found that there was no change in the ratio of soluble to insoluble pectin constituents in sample of grapefruit stored at temperature ranging from 7 C to 20 C for 8 weeks. Surprisingly, the total proportion of pectin substances increased to have the greatest increase in lots stored at the highest temperature.

The pectin extract obtained from guava fruit retained maximum pectin and gave a good jelly after 6 months storage of pectin when preserved with 770 ppm of sulphur dioxide rather than pasteurization at 212 F for 30 minutes or with benzoic acid at 10 percent level (Verma, 1952). Pruthi et al (1960) studied the condition for dehydration of guava for subsequent recovery of pectin in the off season and recommended a temperature

of 150 F as the optimum for the dehydration of guava fruit. They observed that the blanching of fruit prior to dehydration had a beneficial effect on the recovery and quality and pectin was best retained for 7 months when stored at 5 to 7 C.

Pectin had a beneficial effect on the texture during processing and storage. Rao and Roy (1980) reported that the addition of pectin in mango sheet preparation improved the texture, whereas addition of sugar increase the drying time in all the cultivars which addition of pectin had no such effect.

2.2.4. Acidity

In general acidity of fruit products reported to be increased with duration of storage but when product was cooked to a higher consistency a decrease in acidity was observed. Mehta et al (1974) reported that the acid percentage of dehydrated apricot fruits after 10 days had risen from four times to 5.5 and 5.6 in treatment in which fruits were not treated with sugar and under blaching and sulphur dioxide treatment respectively as compared to 1.3 percent at the fresh stage. However, in sugar treated fruits, the level of acidity remained almost the same. In contrast to this, the acidity was reduced to half in the dehydrated apricot fruits in treatments, here the fruits were cooked in syrup to a higher consistency. The total titrable acidity of amla

juice increased more rapidly in samples stored for 10 weeks at room temperature than those stored in refrigeration (Mehta and Rathore, 1976). The increase was from initial 2.07 to 3.22 percent at room temperature and to 2.8 percent in refrigerator. Similarly Sethi et al (1980) reported an increase in acidity from 1.35 to 2.35 percent after 9 months of storage of orange juice.

The acidity and pH of dried ber juice remain constant during storage at room temperature for 90 days (Khurdiya, 1980). Similarly Khurdiya and Anand (1982) observed not much changes in acidity in phalsa juice beverage during storage at all the three temperature. The pH remained stable.

Storage temperature affects the acid content of product. The decrease in acidity was higher at room temperature than 37 C. Nagi and Manjrekar (1976) while studying storage of apple cider found that acidity decreased from 0.50 to 0.44 percent at room temperature and to 0.463 percent at 37 C when stored for four months. Acids were selectively lost during freeze concentration of apple juice (Tannous and Lawns, 1981). But contradictory results are reported by Shrestha and Bhatia (1982) that changes in pH of stored apple juice occured at both temperature. Reduction of acidity was more at 37 C than at room temperature.

Sharma et al (1974) reported that there was no perceptible change in colour, flavour but there was a progressive increase in acidity of mango milk powder stored at room temperature (30 C). Rao and Roy (1980) also found that the acid content of mango sheet increased with increase in storage temperature. But a progressive decrease in acidity and ascorbic acid on storing at room temperature (25 ± 5 C) was observed by Dabhade and Khedkar, (1980).

Acidity of mango pulp was also affected by the different type of containers. Dan and Adsule (1979) reported that upto storage of six months, the increase in acidity was the same in all the samples but during subsequent storage period of six months, this increase was comparatively minimum in glass containers and maximum in black HDPE Pouches. Increase in acidity from 0.36 to 6.64 percent in glass containers after 12 months has also been reported.

2.2.5. Browning

Sugaramine interactions of the Maillard type (Reynolds 1963, 1965) and the resultant flavour changes (Hodge, 1967) are not as prominent in juices as in dried fruits, because of their aqueous nature and low pH. Organic acids and ascorbic acid are more involved in interactions with the sugars and amino acids. Kapoor et al (1958) studied the effect of four sugars and 10

organic acids in combination and observed that fructose caused maximum and glucose the minimum browning, oxalic and pyruvic acids caused maximum browning with fructose and sucrose. 5 Hydroxymethyl-2-furaldehyde (HMF) is produced in fruit juices from sugar, particularly ketones by heating during processing and can give rise to browning reactions with amino compounds (Diemair and Jury, 1965) and sugars and undergo further polymerization and rearrangment both in the pfesence and absence of oxygen (Koch and Kleesat, 1961).

Addition of Sulphur dioxide during the preparation delayes the browning and there by extended the storage life of the products. Ranote and Bains (1982) reported a slight browning in heat processed Kinnow juice after 8 weeks of storage as compared to the juice preserved with the sulphur dioxide which showed no change under similar conditions. The retention of natural colour of the juice seemed to have been better with the sulphur dioxide method of preservation than heat processing.

The guava pulp extracted by the cold method were brighter. Visible browning was observed after 15 weeks of storage in those pulps which contained sodium benzoate preservative. Of the three methods of preservation studies, 700 ppm of sulphur dioxide was adjudged as the best for retention of desirable colour of pulp, despite

slight bleaching which was more discriminable in the case of red fleshed guava pulp (Harnanan et al, 1980). Sulphur dioxide prevents browning reaction in stored mango pulp and syrup (Ghosh et al, 1982). The non-enzymatic browning of mango sheets was found to increase with the increase in temperature of storage and it was inversely proportional to sulphur dioxide content (Rao and Roy, 1982).

Control samples of pineapple rings became brown on storage only after one month and therefore secured lowest marks. No browning was observed in steeped dehydrated and unsteeped sulphited rings even after storage for more than six months and no reconstitution even after that period, very palatable rings were obtained (Mehta et al, 1982).

Browning was more pronounced at higher temperature. A gradual increase in browning and Hydroylmethyl furfuryl formation in phalsa beverage with increasing storage period. This was more pronounced at room temperature than at 20 C (Khurdiya and Anand, 1981).

Berk and Braveman (1958) studied the effect of pH on browning of straight and concentrated citrus juice. They found that in the range of pH 2-3.5, the extent of browning during storage at 30 C for 30 days was inversely proportional to the pH. The adjustment to different pH value were found no avail on colour stability in phalsa juice (Khurdiya and Anand, 1982). Hydroxy methyl forfuryl

(HMF) formation in the juice increased with lowering pH, increasing time and temperature of storage. Addition of sugar found to have a protective influence on the colour stability. Light did not have much effect on pigment stability in the juice. Loss of pigment in the juice increased with increase in temperature of processing.

Siddappa et al (1959) found that the intensity of browning in Coorg orange juice and squash increased with the concentration of added ascorbic acid upto level of 1 percent. According to Brekke et al (1970) the browning of guava puree concentrate was apparent after 2 months and became more pronounced with continued storage. The browning may be related to a rapid loss of ascorbic acid that was virtually complete after one month.

During aseptic processing of guava puree there was virtualy no loss of ascorbic acid and flavour but significant losses in colour (Harvey et al, 1982). After 6 months ambient storage, the ascorbic acid loss was about 30 percent and further colour changes and flavour losses occured. Samples stored at 30 C for 3 months showed an ascorbic acid loss of about 47 percent and losses in colour and flavour. They also observed that ascorbic acid content of papaya puree losses of about 6 percent and 56 percent occured during aseptic processing and after 6 months ambient storage, respectively. Colour changes during aseptic processing and first month of storage was

the carotenoids absorption spectra. Flavour of papaya puree stored at 38 C for 3 months changes significantly and ascorbic acid retention was 39 percent.

2.2.6. Organoleptic Evaluation

The demand for fruit beverages is largely based on their nutritive values, flavour, aroma and colour. They are a source of vitamins, minerals, carbohydrates, amino acids, flavonoid compounds and many other constituents. Many fruit juices are either too acidic or too strongly flavoured to pleasant beverage without diluting or blending or both (Pederson and Beattie, 1943). Often, these strong, tart juices are delicious after dilution with thin syrup or blend juice (Tressler, 1961; Luh, 1971).

A ready-to-serve beverage of ber having 33.3 percent juice and 20.8°Brix and an acidity of 0.5 percent was liked moderately by the panel of ten judges (Khurdiya, 1980).

Sulphur dioxide helps in maintaining good organoleptic quality of various products probably because it acts as a preservative and checks the oxidation of fruit constituents and growth of microorganisms which may produce off flavour. Ranote and Bains (1982) reported that the kinnow juice preserved with sulphur dioxide secured consistently maximum scores. Adjustment of pH of different juices to 4.0 had a marginal improvement in

the flavour scores. KMS (350 ppm sulphur dioxide) preserved juice had superior flavour and colour retention as compared to heat processed bottled juice which developed browning.

Temperature effects the retention of colour of ready-to-serve beverage during storage. Khurdiya and Anand (1981) found that the colour in phalsa beverage was best retained at 3 C followed by 20 C and at room temperature (31-36 C). The beverage can be best stored upto 100 days. The acceptability of the beverage goes down when stored at 20 C at room temperature. Similar findings are reported from bael fruit. Practically no changees in organoleptic quality in frozen pulp of bael fruit after six months and in case of other products stored at 37 C, the organoleptic quality remained much above the acceptable point (Roy and Singh, 1979).

Blending of different juice effect the organoleptic quality of the product. According to Rao et al (1979) the blends containing Rangpur lime and Acid lime juice in ratio of 12.5:12.5 indicated a clash in flavour, resulting in poor scoring. Whereas 15:10 and 20:5 were rated high both for flavour and consistency. Tannous and Lawn (1981) reported that the blends of American and Maharaji in ratio of 1:2 with 2 percent added sugar had the highest organoleptic score. It was noteworthy that the blending acidic Maharaji juice with sweet juice resulted in higher organoleptic scores. There was a little effect of storage on quality of blended juice

while significant effect of storage was seen in Ambri juice after 3rd month due to changes in colour and appearance. Addition of ascorbic acid improved both the colour and flavour of reconstituted apple juice. The test panel showed perference for the clarified apple juice.

Similarly mango pulp incorporation to limited extent, helps in maintaining salt balance of separated milk. Grewal and Jain (1982) revealed that maximum organoleptic accetability of 1:4 ratio (Mango pulp: separated milk) with decreasing order of acceptability 1:3, 1:5 and 1:2 ratio. The acceptability scores in case of 1:3 and 1:4 ratio products were more or less at par with one another.

Liquid nitrogen treatment prior to freeze drying improves the quality. Ramamurthy and Bengirwar (1979) observed that the sample of mango frozen by liquid nitrogen prior to freeze drying had higher rating (8-9 percent) whereas the slow frozen ones had scored of only 5-6 percent of TF (on plates) and 7-8 percent for CPF (Count plate freeze). Likewise, the product (Tuti fruiti of papaya) having one percent acid scofed maximum with respect to colour, flavour and taste compared to other lots and market samples (Khedkar et al, 1980).

Sulphur dioxide also improved the quality of fruit slices during storage. Mehta and Tomar (1980) observed that the guava slices steeped in 70°Brix syrup containing 1000 ppm sulphur dioxide gave the best product. But the retention of ascorbic acid was only six percent. Similar results were also found from papaya slices. Here

the retention of carotenoids in the dehydrated slices was 50 percent.

The nectar prepared from the mango pulp stored in all the containers was acceptable with reference to colour, taste and flavour. There was no perceptible off flavour to the use of HDPE containers, bottles, polyethyline and polypropylene pouches. The pulp content used for preparing mango based drink was 20 percent and during dilution sulphur dioxide concentration was maintained 70-80 ppm (Krishnamurthy et al, 1982).

Acid combination of 0.75 percent with 30°Brix of mango pulp in all the cultivars had more organoleptic score. But 25°Brix and 0.5 percent acidity combination was selected for all the cultivars because in the organoleptic scores was note conspicuous and the corresponding increase in the addition of sugar and acid, while the time taken for drying was more when the Brix was raised to 30 percent. Addition of pectin improved the texture of the product (Rao and Roy, 1980a). They again reported that the mango sheet with added sulphur dioxide was organoleptically acceptiable at all temperature and score for colour of the product increased. This could be due to better retention of carotenoids.

2.2.7. Microbial Growth

Microorganisms use our food material as a source of nutrients for their own growth. This, of course, can result in a deterioration of the food. By increasing

their numbers, utilizing more nutrients, producing enzymatic changes, contributing off flavours by breakdown of a product or synthesis of new compounds, they can spoil the food. They, at the same time produce mycotoxins and can cause serious diseases. These micro-organisms are either present in fruits or get incorporated into the products during processing and multiply tremendously during storage if proper treatment is not given. Therefore, if the microorganisms involved are pathogenic, their association with the products is critical from a public health point of view.

Microbiological spoilage of food is a competitive process occuring among yeasts, bacteria and moulds. These microorganisms elaborate mycotoxins and cause disease under diverse conditions. The favourable conditions for the development of these organisms are proper acidity, nutrients, oxidation-reduction potentials, temperature during storage and relative humidity.

According to Walker (1977), yeasts did not complete well with bacteria and mould but there could be an important spoilage agent under specific conditions. The species of yeasts that well develop and cause spoilage was due to a great extent by the composition of the food and the conditions under which it was stored. Strains of Candida from grape juice stored at low temperature grow optimally at 11 C and failed to grow at 21 C.

The microbial count increased more rapidly at 37 C than room temperature. Nagi and Majreker (1976) observed statistically increase in bactrial population at room temperature and at 37 C as well as the duration of storage had no significant effect on the bacteriological quality of apple cider.

Bowen et al (1950) observed higher percentage of moulds in jams made from berry fruits as compared to stone fruits. Preservation of fruits with sulphur dioxide gave uniformly low counts in marmalades and jellies. Malts chew sky (1955) isolated and identified nine types of mould from straw berry, cherry and plum confection and from the quince and currant jellies.

Guava puree concentrates containing 1000 ppm potassium sorbate showed no gross sign of spoilage during storage for 5 months at 45 F. During this period the initial number of yeasts decreased steadily to an insignficant level, where as the acidity in terms of flavour and aroma were good and did not deteriorate appreciably upto 4 months of storage.

Fruit and vegetable products when stored at temperature between 7 C and 21 C, a reduction in microbial counts by 90-96 percent after one month storage was observed by Von Schelbom (1951). It was also found that moulds can develop at temperature lower than any other type of micro-organism.

Maitra et al (1979) observed that the salt and

acid content of commercially cured mango slices were consistently low (6-10 percent) while there was a gradual increase in microbial load and incorporation of foreign matter in the mango slices during the process of peeling, slicing, transportation, handling, storage etc. The extent of survival of microflora after curing was influenced by the initial microbial load of the mango slices.

While studying physiological and microbiological quality of carrot and amla preserve, Sethi and Anand (1982) reported that the trade sample of carrot and amla preserves were contaminated with both yeast and bacteria.

Sulphur dioxide acts as preservative against microbial growth during storage of mango pulp and syrup (Ghosh et al, 1982). The pulp of Alphonso and Totapuri cultivars of mango can be stored in bulk and consumers packs of HDPE containers, glass bottles, polyethylene, and polypopylene pouches available in the country for a period of 2-12 months using low temperature storage and preservative. The spoilage of pulp due to a heterofermentative lactobacillus bacterium even though some yeasts and moulds were present.

CHAPTER III

MATERIAL AND METHODS

MATERIAL AND METHODS

The present investigation on the processing technology of guava (Psidium guajava L) nectar was carried out in Fruit Technology Laboratory, Department of Horticulture, Haryana Agricultural University, Hissar. The various experiments conducted were nectar preparation, evaluation of guava cultivars and to study the storage stability of guava nectar at ambient temperature (25 ± 5°C).

3.1. Material

3.1.1. Cultivar: Four guava cultivars commercially grown in Haryana were selected for present investigation.

a. Allahabad Safeda (AS)

b. Banarasi Surkha (BS)

c. Sardar (SD)

d. Tehsildar (TD)

The fruits for processing were harvested at firm ripe stage from experimental orchard of the Department of Horticulture, H.A.U., Hissar.

3.1.2. Chemicals: Most of the common chemicals used were either the product of Analar quality of BDH chemicals, India or E. Merok, India. Media chemicals for microbiological studies were of the Difco.

3.2. Methods

3.2.1. Preparation of fruits:

Firm ripe fruits were selected for the preparation of guava nectar. The fruits were washed in running tap water to remove dirt and dust particles. They were sliced into small

pieces.

3.2.2. Extraction of pulp:

The slices were blended by adding equal amount of warm water in a waring blender. The whole mass was then sieved to obtain a fine fruit pulp devoid of seeds and skin.

3.2.3. Mixing the ingredients:

After extraction, the requisite quantity of pulp i.e. 20, 25 and 30 percent were taken. A calculated amount of sugar and citric acid were added in the pulp to adjust the total soluble solids at 15 percent and acidity at 0.3 percent and 0.4 percent in the final product. The volume of the final product was made by adding water to 3.0 litre in each treatment and two replications in each treatment was taken. The following combinations of pulp and acid concentrations were made. Total soluble solids in each treatment was maintained at 15 percent.

Treatment-1: 20% pulp adjusted to 0.3% acidity

Treatment-2: 20% pulp adjusted to 0.4% acidity

Treatment-3: 25% pulp adjusted to 0.3% acidity

Treatment-4: 25% pulp adjusted to 0.4% acidity

Treatment-5: 30% pulp adjusted to 0.3% acidity

Treatment-6: 30% pulp adjusted to 0.4% acidity

3.2.4. Homogenizing:

The prepared nectar was again mixed and homogenized in a waring blender and sieved through a muslin cloth to obtain a product of uniform consistency.

3.2.5. Bottling:

The product was poured into hot, sterilized crown bottles of 200 ml capacity and corked air-tight.

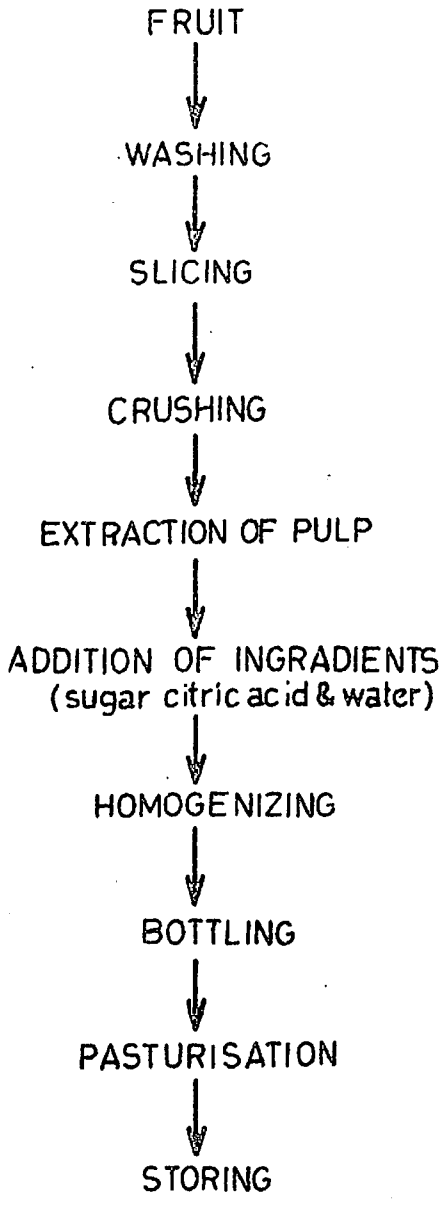

Fig. 1. FLOW SHEET FOR PREPARATION OF FRUIT NECTAR

3.2.6. Pasteurization:

The filled bottles were pasteurized in boiling water for 20 minutes till the temperature of product reaches 85°C. It took about 15 minutes to attain this temperature.

3.2.7. Storage:

The bottles of nectar were kept at ambient temperature (25 ± 5°C) for further studies. Samples were taken out in duplicate at monthly interval and analysed for the following constituents.

Reducing Sugars
Total Sugars
Total Soluble Solids
Ascorbic acid
Pectin
Acidity
Browning
pH
Organoleptic evaluation
Microbial examination

3.3. Chemical Analysis

3.3.1. Sugars:

Sugars were estimated by the method of Hulme and Narain (1931).

I Reagents:

A. Potassium ferricyanide solution:

Potassium ferricyanide	= 8.25 g
Anhydrous sodium carbonate	= 10.6 g
Volume	= 1 Litre

B. Potassium iodide solution:

Potassium iodide	= 12.5 g
Zinc Sulphate	= 25.0 g
Sodium chloride	=125.0 g
Volume	= 1 Litre

C. 5% Acetic acid solution (v/v):

Glacial acetic acid	= 50 ml
Volume	= 1 Litre

D. Sodium thiosulphate solution:

Sodium thiosulphate	= 2.419 g
Volume	= 1 Litre

E. Starch Solution (indicator):

Soluble starch	= 1.0 g
Sodium chloride	=20.0 g
Volume	= 100 ml.

II Extraction:

Fruit: A suitable portion of the macerated sample was weighed and about four to five extractions were taken by adding distilled water by keeping on the water bath and diluted to appropriate concentration.

Nectar: Five ml of guava nectar diluted to appropriate concentration was taken for estimation.

III Estimation:

a. Reducing Sugars:

Five ml of sugar solution and five ml of potassium ferricyanide solution were taken in a test tube (1" wide x 7" long). The tubes were covered and kept for 15 minutes in boiling water both. The tubes were cooled under the tap

water and 5 ml of iodide-Zinc solution followed by 3 ml of acetic acid solution (5% V/V) were added in each tube. The librated iodine was titrated with sodium thiosulphate (N/100) using starch as an indicator. The end point was the disappearance of blue colour and appearance of milky white colour. A blank with 5 ml of distilled water was also run simultaneously. The results were calculated by the following formula and expressed in g sugar per 100 gram or ml.

(ml of sodium thiosulphate used in blank) - (ml of sodium thiosulphate used in unknown) + 0.05) X 0.34 = mg of sugar

b. *Total sugars:*

To 25 ml of sugar extract added 4 ml of Hydrochloric acid in flask and kept for 10 minutes at 68 C. After hydrolysis the volume was made to 50 ml. The acidity was neutrilized by adding anhydrous sodium carbonate till the effervesence stopped. Total sugars were, then, determined by the method as described in reducing sugar.

3.3.2. Total soluble Solids:

Total soluble solids were observed at ambient temperature by Hand Refractometer and readings were corrected for 20 C.

3.3.3. Ascorbic acid:

The ascorbic acid was determined by A.O.A.C. (1980).

Reagents

1. Extracting solution:

Oxalic Acid = 4 g

Volume = 1 Litre

2. 2, 6 - Dichlorophenol indophenol solution:

2, 6 - Dichlorophenol indophenol	= 50 mg
Sodium bicarbonate	= 42 mg
Volume	= 200 ml

Extraction:

Ascorbic acid was extracted from fruit pulp by macerating a suitable portion of weighed sample with extracting solution. The extract was filtered and appropriate volume was made. To five ml of aliquot (extracting solution) 5 ml of 0.4 percent oxalic acid was added and titrated against standardized dye (2, 6-Dichlorophenol indophenol) till the light pink colour appeared. The results were expressed as mg ascorbic acid per 100 g or ml of sample.

3.3.4. Pectin:

Total pectin as calcium pectate was determined by the method of Ranganna (1977).

Reagents:

a. 1 N Acetic acid:

Glacial acetic acid	= 30 ml
Volume	= 500 ml

b. 1 N Calcium chloride:

Anhydrous calcium chloride	= 27.5 g
Volume	= 500 ml

c. 1 N Sodium hydroxide:

Sodium hydroxide	= 20 g
Volume	= 500 ml

d. 1% Silver nitrate:

Silver nitrate	= 1 g
Volume	= 100 ml.

Extraction:

Fruit:

Twenty five gram of macerated pulp was taken and 200 ml of distilled water was added (1:8 W/V). It was then kept on hot plate for one hour. Replaced the water lost during boiling. The flask was cooled, volume was made to 250 ml. The contents were filtered through Whatman filter paper No. 4 and filtrate was collected.

Nectar:

100 ml of guava nectar was filtered through Whatman filter paper No. 4 and filtrate was collected.

Estimation:

To 25 ml portion of above filtrate added 25 ml of distilled water and 2.5 ml of 1 N NaOH and kept over night. Next day 12.5 ml of acetic acid solution and after 5 minutes 6.25 ml of 1N Calcium chloride solution was added with stirring. After allowing it to stand for one hour, boiled for one minute and filtered through oven dried, weighed Whatman filter paper No. 41. The precipitates were washed with distilled water until they are free from chloride (Tested with 1 percent silver nitrate solution). The precipitates were again dried at 100°C for 24 hours, cooled in a dessicator and weighed. The amount of pectin was

expressed as calcium pectate.

Calculation:

$$\% \text{ Calcium pectate} = \frac{\text{wt of calcium pectate x Vol of content x 100}}{\text{ml of filtrate taken x wt of sample for estimation}}$$

3.3.5. Total acids:

Total acid content was estimated by titrating 5 gram of the macerated fruit pulp or 5 ml of nectar against standard solution of 0.1 N sodium hydroxide using phenolphthlein as an indicator. The end point appear as light pink colour. The acidity was expressed as gram citric acid per 100 gram or ml respectively.

3.3.6. Browning:

Browning was observed by taking transmittance of the solution on Speetronic-20. The samples for browning were centrifuged for 15 minutes at 4000 rpm. To 10 ml of centifugate added 15 ml of alcohol to make 60 percent aqueous solution and kept for half an hour. It was, then filtered through Whatman filter paper No.1 to obtained clear solution. The colour was measured at 420 nm using 60 percent aqueous alcohol as blank. The increase in absorbance of a sample at 420 nm was taken as a measure of non-enzymatic browning.

3.3.7. pH:

The pH of the nectar was taken on an Elico pH meter.

3.3.8. Organoleptic evaluation:

The nectar prepared from four cultivars of guava were subjected to sensory evaluation by a panel of five judges following the Hedonic Rating tests (see Appendix 1) as described by Ranganna (1977). The products were evaluated for colour, flavour, consistency/texture/feel and taste.

The characters with mean scores of 5 or more out of 9 marks were considered acceptable. The overall acceptability of products was based upon the mean scores obtained from all these characters studied under the test. The product with an overall mean score of 20 or above was considered acceptable. The mean scores obtained by different products were calculated.

3.3.9. Microbial Examination:

The microbial examination was done by the method as suggested by Sharf (1966). The media used for plating had the following composition.

Tryptone	= 5.0 g
Yeast extract	= 2.5 g
Glucose	= 1.0 g
Agar-agar	= 15.0 g
Distilled water	= 1 Litre

The media was sterilized at 121° C at 15 lb for 20 minutes.

Procedure:

One ml of guava nectar from each sample was plated with plate count agar medium. Plates were incubated at 30 C for 2 days. Total number of colonies were counted and expressed per ml of sample.

CHAPTER IV

RESULTS AND DISCUSSION

RESULTS AND DISCUSSION

This chapter of the manuscript deals with experimental results pertaining to the investigation followed by the discussion of the same. The presentation of the results and discussion ~~has~~ have been arranged under the following heads.

1. Chemical composition of fruits.
2. Biochemical changes in nectar during storage.
3. Organoleptic evaluation of nectar.
4. Microbial examination of nectar.

4.1. Chemical composition of the fruits:

Data pertaining to the proximate composition of fruits of different guava cultivars are presented in Table 1.

There was a great variation in their chemical constituents of four guava cvs (Table 1). This is probably due to their differential genetical makeup. Total soluble solids varied from 8.5 percent (Sardar) to 13.0 percent (Allahabad Safeda). Banarasi Surkha and Tehsildar had 9.0 percent total soluble solids. Total titrable acidity was observed higher in fruits of cv. tehsildar (0.56 percent) followed by Banarasi Surkha (0.553 percent), Allahabad Safeda (0.525 percent) and Sardar (0.511 percent). Ascorbic acid content varied from 54.7 mg to 132.0 mg. The highest ascorbic acid content was found in fruits of cv. Sardar (132 mg) followed by Banarasi Surkha (113 mg), Tehsildar (67.5 mg) and Allahabad Safeda (54.7 mg). A very little

Table 1: Proximate composition of guava fruit at harvest

Character / Cultivar	Total Soluble Solids (%)	Acidity (%)	Ascorbic Acid (mg/100 g)	Total sugar (%)	Reducing sugar (%)	Non-reducing sugar (%)	Pectin (mg/100 g)
Tehsildar	9.0	0.560	67.5	6.24	1.85	4.39	1120
Banarasi Surkha	9.0	0.553	113.0	6.76	2.21	4.55	1060
Sardar	8.5	0.511	132.0	6.88	2.89	3.99	1010
Allahabad Safeda	13.0	0.525	54.7	7.56	3.23	4.33	950

variation in their total sugar content was observed in fresh fruits of all the cultivars whereas, a marked variation in reducing sugar content and non-reducing sugar content was noticed. Total sugars range from 6.24 percent to 7.56 percent in cvs. Tehsildar and Allahabad Safeda. Cv. Allahabad Safeda contained the highest (3.23 percent) content of reducing sugars followed by Sardar (2.89 percent), Banarasi Surkha (2.21 percent) and Tehsildar (1.85 percent). Non-reducing sugars range from 3.99% in cv. Sardar to 4.55 percent in cv. Banarasi Surkha. The pectin content of fruits was found higher in cv. Tehsildar among all the cultivars whereas cv. Allahabad Safeda had the lowest. Almost similar values for this constituent in different cultivars ~~have~~ been reported by earlier workers (Chundawat and Gupta, 1975), (Chundawat et al, 1976). The results of pectin content in these studies also confirmed the findings of Dhingra (1979).

4.2. Biochemical changes in nectar during storage:

4.2.1. Reducing Sugars

The reducing sugar content of nectar prepared from various guava cultivars with different pulp and acid levels and stored at ambient temperature was recorded and results are presented in Table 2.

It is evident that there was an increase in reducing sugars with the increase period of storage. After, the preparation of guava nectar, significantly higher amount of reducing sugars were observed in cv Tehsildar (7.91 percent) followed

Table 2: Effect of different treatments on the reducing sugar content of stored guava nectar (g/100ml)

Cultivar Treatment	Storage period in days													
	0					30					60			
	AS	BS	SD	TD	Mean	AS	BS	SD	TD	Mean	AS	BS	SD	TD	Mean
20% Pulp 0.3% Acidity	5.51	3.88	3.60	8.30	5.32	6.87	5.81	6.40	9.45	7.13	8.30	8.11	6.65	10.14	8.30
20% Pulp 0.4% Acidity	7.41	3.60	4.97	7.81	5.94	9.38	5.91	8.51	9.32	8.28	9.38	9.92	9.93	9.93	9.79
25% Pulp 0.3% Acidity	7.28	3.60	5.24	6.15	5.56	9.38	5.40	8.65	9.66	8.27	9.86	7.75	9.60	9.72	9.23
25% Pulp 0.4% Acidity	9.59	3.74	3.92	7.44	6.17	10.74	6.09	4.46	9.32	7.65	10.95	8.35	8.02	10.95	9.57
30% Pulp 0.3% Acidity	5.24	4.29	5.10	8.85	5.87	5.51	4.93	8.27	10.95	7.42	7.28	6.94	10.27	11.09	8.90
30% Pulp 0.4% Acidity	6.87	4.69	6.87	8.91	6.84	9.45	5.61	8.85	9.97	8.47	10.47	8.85	9.33	10.71	9.84
Mean	6.98	3.96	4.95	7.91		8.56	5.92	7.52	9.77		9.37	8.32	8.96	10.42	

C.D. at 5%

Cultivar	0.16	0.07	0.06
Treatment	0.20	0.09	0.08
Cultivar X Treatment	0.40	0.18	0.16

Contd....2.

Contd....table 2.

Cultivar Treatment	Storage period in days									
	90					120				
	AS	BS	SD	TD	Mean	AS	BS	SD	TD	Mean
20% Pulp 0.3% Acidity	9.11	8.84	7.28	11.56	9.20	11.56	10.01	8.02	12.03	10.41
20% Pulp 0.4% Acidity	9.86	10.30	9.99	10.27	10.10	10.01	11.14	11.29	10.54	10.75
25% Pulp 0.3% Acidity	10.75	10.54	10.40	10.93	10.66	12.20	11.56	11.56	11.22	11.64
25% Pulp 0.4% Acidity	12.10	10.47	10.22	11.22	11.00	12.65	12.56	11.19	12.31	12.18
30% Pulp 0.3% Acidity	8.35	9.92	10.71	11.50	10.12	8.57	10.68	11.17	12.03	10.61
30% Pulp 0.4% Acidity	11.36	10.10	11.36	11.22	11.01	12.11	11.36	12.03	11.76	11.82
Mean	10.25	10.02	9.99	11.12		11.34	11.21	11.21	11.65	

C.D. at 5%

Cultivar	0.06	0.06
Treatment	0.08	0.08
Cultivar X Treatment	0.15	0.16

by Allahabad Safeda (6.98 percent), Sardar (4.95 percent) and Banarasi Surkha (3.96 percent) irrespective of the treatments. The same trend was followed throughout the storage period upto 120 days. But after 90 days of storage, nectar of cv. Sardar had the minimum reducing sugars which were at par with nectar of cv. Banarasi Surkha. The percent increase in reducing sugars during storage upto 120 days was maximum in nectar of cv. Banarasi Surkha (183.08 percent) followed by Sardar (126.46 percent), Allahabad Safeda (69.17 percent) and Tehsildar (47.28 percent).

Among various concentrations of pulp used after preparation reducing sugars were significantly higher in nectar with 30% pulp and 0.4 percent acidity irrespective of cultivars and minimum was found in nectar with 20 percent pulp and 0.3 percent acidity. Almost same trend was maintained upto 90 days of the storage period. After that the reducing sugar content was significantly higher in nectar where 25 percent pulp and 0.4 percent acidity used. However, after preparation the maximum reducing sugars were in cv. Allahabad Safeda (9.59 percent) and minimum in cv. Sardar (3.60 percent) were noticed where 25 percent pulp with 0.4 percent acidity and 20 percent pulp with 0.3 percent acidity used respectively. Almost same trend was maintained throughout the storage period upto 120 days. There were some variations in reducing sugar content at 60 days

storage but these were not significant. At the end of storage period, reducing sugar content was significantly higher in cv. Allahabad Safeda (12.65 percent) with 25 percent pulp and 0.4 percent acidity which was at par with nectar of cv. Banarasi Surkha with 25 percent pulp and 0.4 percent acidity. Among the acidity treatments reducing sugar content of nectar with 0.4 percent acidity was significantly higher than the nectar with 0.3 percent acidity just after the nectar preparation and the same trend was followed throughout the storage period except at 30 days of storage, where nectar with 0.3 percent acidity contain slightly higher amount than 0.4 percent acidity.

It is, therefore, clear from the results that the reducing sugar content varied in different treatments and in different cultivars just after the preparation of nectar, which could be due to the presence of higher initial concentration of pulp and acid in the product. These results confirm the finding of Rao and Roy (1980) who reported higher initial reducing sugars in mango sheet and stated that it could be due to the higher initial acidity present in the pulp. An increase in reducing sugars were observed during storage when kept at room temperature. This increase was observed in all the cultivars and all the treatments, which might be due to the hydrolysis of polysaccharides and inversion of non-reducing sugars into reducing sugars in the acidic medium. These results are in confirmation with

finding of (Krishnamurthi et al, 1982) on preservation of mango pulp, in phalsa beverage (Khurdiya and Anand, 1981), and in amla juice (Shrestha and Bhatia, 1982) when stored at ambient temperature. They further reported that conversion of non-reducing sugars were higher at room temperature than at low temperature.

4.2.2. Total Sugars

Total sugar content of nectar prepared from various guava cultivars as affected by various pulp and acid percentage and storage period at ambient temperature was ascertained and the data was presented in Table 3.

A perusal of the data given in Table 3 indicate that the total sugar content of guava nectar stored at ambient temperature increased with the duration of storage irrespective of cultivar and treatment. Initially, both the cvs i.e. Allahabad Safeda and Banarasi Surkha (14.0 percent) contained significantly higher total sugars than the others. Nectar from cv. Sardar had significantly less total sugar content (13.8 percent) among all the cultivars. Nectar from cv. Allahabad Safeda showed significantly higher total sugar upto 60 days storage but after 90 days, the nectar from cv. Sardar had the highest content which was maintained upto the end of storage. The percent increase in total sugars were maximum in cv. Sardar (19.56 percent) followed by cvs. Allahabad Safeda (17.57 percent), Tehsildar (16.54 percent) and Banarasi Surkha (16.42 percent) over the initial values.

Table 3: Effect of different treatments on total sugar content of stored guava nectar

(g/100ml)

Cultivar Treatment	Storage period in days														
	0					30					60				
	AS	BS	SD	TD	Mean	AS	BS	SD	TD	Mean	AS	BS	SD	TD	Mean
20% Pulp 0.3% Acidity	14.01	14.42	13.30	14.10	13.95	14.41	14.49	14.40	14.80	14.52	15.25	15.25	14.40	14.90	14.95
20% Pulp 0.4% Acidity	13.90	14.28	13.60	13.80	13.90	14.10	14.42	14.10	14.20	14.20	15.50	15.25	14.70	14.40	14.96
25% Pulp 0.3% Acidity	14.41	13.80	14.10	14.20	14.13	14.60	14.50	14.80	14.40	14.58	15.00	15.40	15.50	15.30	15.30
25% Pulp 0.4% Acidity	14.00	14.00	13.80	14.00	13.95	14.60	14.40	14.20	14.80	14.50	15.50	15.20	14.90	15.40	15.25
30% Pulp 0.3% Acidity	13.90	13.80	14.40	13.90	14.00	14.40	14.20	15.25	14.10	14.49	15.00	15.70	15.64	15.30	15.40
30% Pulp 0.4% Acidity	14.10	13.70	13.83	13.70	13.83	15.40	14.40	14.10	14.00	14.48	16.00	14.90	14.70	14.40	15.00
Mean	14.00	14.00	13.80	13.90		14.60	14.40	14.50	14.40		15.40	15.30	15.00	14.90	

C.D. at 5%			
Cultivar	0.09	0.12	0.12
Treatment	0.11	0.15	0.15
Cultivar X Treatment	0.23	0.29	0.29

Contd....2.

Contd.....table 3.

Cultivar / Treatment	Storage period in days									
	90					120				
	AS	BS	SD	TD	Mean	AS	BS	SD	TD	Mean
20% Pulp 0.3% Acidity	15.50	15.40	15.70	15.90	15.62	16.32	16.90	16.20	16.20	16.40
20% Pulp 0.4% Acidity	15.95	15.40	15.50	14.80	15.41	16.86	15.80	16.70	16.00	16.34
25% Pulp 0.3% Acidity	16.00	15.90	16.20	15.70	15.70	16.30	16.60	16.70	15.90	16.62
25% Pulp 0.4% Acidity	15.50	15.70	15.70	15.60	15.62	16.30	16.30	16.00	16.00	16.18
30% Pulp 0.3% Acidity	16.00	15.90	15.95	15.80	15.91	16.20	16.30	16.70	16.70	16.48
30% Pulp 0.4% Acidity	16.30	15.70	16.50	14.90	15.85	16.80	15.90	16.80	16.20	16.43
Mean	15.80	15.66	16.10	15.45		16.46	16.30	16.50	16.16	

C.D. at 5%		
Cultivar	0.11	0.12
Treatment	0.13	0.14
Cultivar X Treatment	0.26	0.29

Among the treatments the nectar prepared with 25 percent pulp and 0.3 percent acidity maintained its supermacy upto the end of storage period except 90 days storage where 30 percent pulp with 0.3 percent and 0.4 percent acidity recorded significantly higher total sugars. From the data it is seen that the treatments where 0.3 percent acidity level was maintained, total sugar contents were comparatively higher than the treatments with 0.4 percent acidity level. The same trend was maintained throughout the storage period but in some cases the differences were not significant.

From the various combinations of treatments and cultivars, initially, it was observed that nectar from cv. Banarasi Surkha with 20 percent pulp and 0.3 percent acidity contained higher total sugar content (14.42 percent) followed by cv. Allahabad Safeda (14.41 percent) with 25 percent pulp and 0.3 percent acidity. At the end of 120 days storage period, nectar of cv. Banarasi Surkha showed comparatively higher total sugars than any other combination where 20 percent pulp with 0.3 percent acidity was used.

From the results, it is clear that there was a progressive increase in total sugar content throughout the storage period. The statistical analysis of the data also showed significant differences among the cultivars. Among the treatments the increase in total sugars were pronounced in the nectar with lower acid content however in some cases

higher acidity level also resulted in higher sugar content. These variations in total sugars could be during the processing of bottled nectar in boiling water which might have resulted the hydrolysis of polysaccharides like pectin, cellulose and starch etc. and its conversion into simple sugars. Roy and Singh (1979) also supported this fact for the increase in sugar content during processing in bael beverage and later on supported by Ranote and Bains (1982) while processing of the Kinnow juice in heat processed samples. Increase in total sugar content was also noticed by Adsule and Roy (1974) during 6 months storage of canned slices but in frozen slices and syrup the sugars remained unchanged during storage. Therefore, the temperature of the storage is one of the main factor which contributes towards the changes in total sugar content of the product. Shrestha and Bhatia (1982) also suggested maximum changes in stored apple juice at room temperature than at lower temperature which indicate that temperature during storage could lead to the gradual inversion of polysaccharides into sugars and non-reducing sugars into reducing sugars by hydrolysis.

4.2.3. Total Soluble Solids

The data pertaining to the effect of various cultivars and treatments on the total soluble solid content of nectar stored at ambient temperature was recorded and presented in Table 4.

Table 4: Effect of different treatments on total soluble solids of stored guava nectar

(Percent)

Cultivar Treatment	Storage period in days													
	0					30					60			
	AS	BS	SD	TD	Mean	AS	BS	SD	TD	Mean	AS	BS	SD	TD	Mean
20% Pulp 0.3% Acidity	15.00	15.00	15.00	15.00	15.00	16.00	15.00	16.00	16.00	15.75	16.00	16.00	16.00	16.50	16.13
20% Pulp 0.4% Acidity	15.00	15.00	15.00	15.00	15.00	15.50	15.50	16.00	16.00	15.75	16.50	16.00	16.50	16.00	16.25
25% Pulp 0.3% Acidity	15.00	15.00	15.00	15.00	15.00	15.50	15.50	16.00	16.00	15.75	16.00	16.00	16.50	16.50	16.25
25% Pulp 0.4% Acidity	15.00	15.00	15.00	15.00	15.00	15.50	16.00	16.50	16.00	16.00	16.00	16.00	16.50	17.00	16.37
30% Pulp 0.3% Acidity	15.00	15.00	15.00	15.00	15.00	15.50	16.00	16.00	16.00	15.87	15.50	16.50	16.50	16.00	16.13
30% Pulp 0.4% Acidity	15.00	15.00	15.00	15.00	15.00	16.00	16.00	16.50	16.00	16.13	16.00	16.50	16.50	16.50	16.37
Mean	15.00	15.00	15.00	15.00		15.66	15.67	16.10	16.00		16.00	16.17	16.40	16.33	

C.D. at 5%

Cultivar	N.S.	N.S.	N.S.
Treatment	N.S.	N.S.	N.S.
Cultivar X Treatment	N.S.	N.S.	N.S.

Contd....2.

Contd.....table 4.

Cultivar Treatment	Storage period in days									
	90					120				
	AS	BS	SD	TD	Mean	AS	BS	SD	TD	Mean
20% Pulp 0.3% Acidity	16.00	16.00	16.50	16.50	16.25	16.50	16.50	17.00	17.00	16.75
20% Pulp 0.4% Acidity	16.50	16.00	16.50	16.50	16.37	17.00	16.00	17.00	16.50	16.62
25% Pulp 0.3% Acidity	16.50	16.50	17.00	16.50	16.62	17.00	16.50	17.50	16.50	16.87
25% Pulp 0.4% Acidity	16.00	16.50	17.50	17.00	16.75	16.50	17.00	17.50	17.50	17.12
30% Pulp 0.3% Acidity	16.00	16.50	17.00	16.50	16.50	16.50	17.00	17.50	17.00	17.00
30% Pulp 0.4% Acidity	17.00	17.00	17.50	17.00	17.12	17.00	17.00	17.50	17.50	17.25
Mean	16.33	16.42	16.75	16.75		16.75	16.67	17.33	17.00	

C.D. at 5%

Cultivar	N.S.	N.S.
Treatment	N.S.	N.S.
Cultivar X Treatment	N.S.	N.S.

It is evident from the data given in table 4 that the total soluble solids of stored nectar increased during storage irrespective of the cultivar and treatment. The percent increase in total soluble solids was more in cv. Sardar (15.53 percent) that other cultivars during 120 days storage period followed by Tehsildar (13.33 percent), Allahabad Safeda (11.66 percent) and Banarasi Surkha (11.13 percent). Further it was observed that the total soluble solids were more in nectar with 30 percent pulp and 0.4 percent acidity. However increase was more when 0.4 percent acidity level was maintained than 0.3 percent acidity level. The results, therefore, reveal that there was a gradual increase in total soluble solids in all the treatments upto the end of storage period but changes were statistically not significant.

Khurdiya and Anand (1981) also did not observe any change in total soluble solids during the storage of phalsa beverage at room temperature. Instead, a slight decrease was noticed in total soluble solids in one of the experiment on dried ber juice during storage for 9 months at room temperature (Khurdiya, 1980). In the present investigations the reason for this slight increase in total soluble solids of the nectar during storage could be explained by the fact that the polysaccharides which are present in the fruit pulp might be converted into sugars during hydrolysis process.

4.2.4. Ascorbic Acid

The data pertaining to the effect of various treatment on the ascorbic acid content of nectar prepared from different guava cultivars was ascertained and presented in Table 5.

The data revealed that the ascorbic acid content of guava nectar decreased significantly with the increase in duration of storage irrespective of the cultivar and treatment. The content varied from 2.43 mg to 6.67 mg in cvs. Tehsildar and Sardar respectively. This higher initial ascorbic acid content in cv. Sardar might be due to its varietal character. After nectar preparation, the ascorbic acid content was significantly higher in cv. Sardar (6.67) followed by Allahabad Safeda (4.17 mg), Banarasi Surkha (3.53 mg) and Tehsildar (2.43 mg). Almost same trend was observed upto 120 days. At the end of 120 days period, nectar of cv. Sardar contained the maximum content (4.26 mg) of ascorbic acid which was significantly higher than all other cultivar. However, the percent retention of ascorbic acid was maximum in cv. Allahabad Safeda (66.43 percent) followed by Sardar (63.87 percent), Banarasi Surkha (44.20 percent) and Tehsildar (37.87 percent) over the initial values.

Further it was observed that ascorbic acid content was significantly higher in nectar prepared with 30 percent pulp and 0.3 percent acidity than in other treatments and the lower being in nectar with 20 percent pulp and 0.4 percent acidity. It's content varied from 3.03 mg to

Table 5: Effect of different treatments on the ascorbic acid content of stored guava nectar

(mg/100 ml)

Cultivar Treatment	Storage period in days													
	0					30					60			
	AS	BS	SD	TD	Mean	AS	BS	SD	TD	Mean	AS	BS	SD	TD	Mean
20% Pulp 0.3% Acidity	2.55	3.66	5.49	2.41	3.53	2.41	3.27	4.96	2.09	3.18	2.24	2.46	4.28	1.72	2.67
20% Pulp 0.4% Acidity	2.39	2.95	4.36	2.40	3.03	2.25	2.72	3.66	1.97	2.65	1.81	2.59	3.47	1.63	2.40
25% Pulp 0.3% Acidity	4.07	4.13	7.56	2.68	4.61	3.66	3.45	6.03	2.22	3.84	3.46	2.89	5.00	2.04	3.35
25% Pulp 0.4% Acidity	3.21	3.69	7.32	2.01	4.06	2.84	3.10	7.22	1.97	3.66	2.67	2.85	6.02	1.73	3.32
30% Pulp 0.3% Acidity	8.66	3.42	6.03	2.47	5.15	8.45	3.18	5.48	2.22	4.83	8.35	3.02	4.75	2.16	4.57
30% Pulp 0.4% Acidity	4.15	3.35	9.30	2.68	4.87	4.07	3.08	7.20	2.32	4.17	3.70	3.02	6.63	2.09	3.86
Mean	4.17	3.53	6.67	2.43		3.94	3.13	5.76	2.13		3.70	2.80	5.03	1.89	

C.D. at 5%

Cultivar	0.03	0.02	0.02
Treatment	0.03	0.03	0.03
Cultivar X Treatment	0.06	0.06	0.05

Contd....2.

Contd.....table 5.

Cultivar / Treatment	Storage period in days									
	90					120				
	AS	BS	SD	TD	Mean	AS	BS	SD	TD	Mean
20% Pulp 0.3% Acidity	2.15	2.35	4.02	1.37	2.47	1.39	1.02	3.62	0.85	1.72
20% Pulp 0.4% Acidity	1.57	1.82	3.41	1.55	2.08	1.48	1.22	2.59	0.85	1.53
25% Pulp 0.3% Acidity	3.15	2.55	4.63	1.98	3.07	2.37	1.85	3.62	0.95	2.19
25% Pulp 0.4% Acidity	2.44	2.47	5.52	1.55	2.99	1.56	1.22	5.42	0.85	2.26
30% Pulp 0.3% Acidity	8.15	2.85	4.28	1.75	4.26	6.94	1.77	4.28	1.05	3.51
30% Pulp 0.4% Acidity	2.72	2.96	6.30	1.63	3.40	2.37	2.31	6.00	0.95	2.90
Mean	3.36	2.50	4.69	1.64		2.77	1.56	4.26	0.92	

C.D. at 5%		
Cultivar	0.02	0.02
Treatment	0.03	0.02
Cultivar X Treatment	0.06	0.05

5.15 mg in nectar with 20 percent pulp containing 0.4 percent acidity and 30 percent pulp containing 0.3 percent acidity respectively and almost same trend was followed during storage upto 90 days. At the end of 120 days storage period, nectar with 30 percent pulp and 0.3 percent acidity maintained supermacy by retaining 3.51 mg ascorbic acid. The minimum amount was found in nectar with 20 percent pulp and 0.3 percent acidity. It is clear from the data that the percent retention of ascorbic acid was maximum (68.1 percent) in nectar with 30 percent pulp and 0.3 percent acidity whereas it was minimum (47.5 percent) in treatment where 25 percent pulp and 0.4 percent acidity was used.

The combined effect of treatment and cultivar showed that nectar of cv. Sardar with 30 percent pulp and 0.4 percent acidity had significantly higher content of ascorbic acid (9.30 mg) than any other combination just after its preparation but after 30 days of stroage, nectar prepared from cv. Allahabad Safeda with 30 percent pulp and 0.3 percent acidity had significantly higher amount of ascorbic acid upto the end of storage period.

It is, therefore, revealed that the treatment containing higher pulp percentage had the higher ascorbic acid content in comparison to the nectar prepared with lower pulp percentage. It was also noticed that the

treatments where 0.3 percent acidity were maintained had significantly higher ascorbic acid than 0.4 percent acidity in the same pulp concentration throughout the storage period except at 120 days storage where the contents were comparatively higher in treatment in which 0.4 percent acidity was used with 25 percent pulp.

From the results, it is revealed that there was a significant decrease in ascorbic acid content with the increase in storage period. Losses of ascorbic acid content were also noticed by Gaikwad et al (1982) in storing mango nectar at room temperature and even in refrigerated condition when stored for 3 months. However, the losses were minimum at lower temperature. Similarly Papanicolaou and Sauregeot (1979) observed a linear decrease in the vitamin C content with increased storage period upto 4 months and the losses were slight at 25 C and considerable at 37 C. The increased loss of ascorbic acid with increasing time has also been reported in grapefruit juice by Smoot and Nagy (1979) whereas no losses of ascorbic acid content in Vacuum concentrated tomato juice in the forced circulation evaporation on storage were observed (Anon. 1978-79).

Therefore, processing technology followed for the preparation of product plays a leading role in the retention of nutrients like ascorbic acid. This loss of

ascorbic acid might be due to the heat processing and the presence of oxygen in glass bottles during storage. Such losses can be minimized by eliminating oxygen during filling and handling as suggested by Johnson and Toledo (1975). Performance of the cultivars showed that cultivar with higher initial ascorbic acid content retain the maximum during storage. No clear cut differences could be exhibited in nectar prepared from white fleshed and red fleshed guava pulp as far as retention of ascorbic acid is concerned. Whereas Sanchez Nieva et al (1970) observed the higher retention of ascorbic acid in white fleshed guava pulp during 27 week storage.

4.2.5. Pectin

Data pertaining to the effect of various treatments on pectin content of the nectar prepared from various guava cultivars during storage at ambient temperature was presented in Table 6.

The results indicate that the pectin content of the nectar prepared from four guava cultivars decreased during processing and thereafter in storage as compared to the pectin content of fresh fruits (Table 6). Analysis for pectin, just after nectar preparation showed that cv. Banarasi Surkha had significantly higher amount of pectin (781 mg) irrespective of the treatments. And the lowest being found in cv. Sardar (641 mg). The pectin content of cv. Allahabad Safeda remained significantly higher from 30 days storage period upto 120 days at ambient temperature.

Table 6: Effect of different treatments on pectin (as Calcium pectate) content of stored guava nectar

(mg/100 ml)

Cultivar Treatment	Storage period in days													
	0					30					60				
	AS	BS	SD	TD	Mean	AS	BS	SD	TD	Mean	AS	BS	SD	TD	Mean
20% Pulp 0.3% Acidity	588	616	580	680	616	496	496	504	632	532	488	468	460	628	511
20% Pulp 0.4% Acidity	612	728	772	748	715	524	592	700	688	626	424	564	696	480	541
25% Pulp 0.3% Acidity	580	700	504	888	668	548	500	384	564	499	496	456	372	464	447
25% Pulp 0.4% Acidity	864	748	672	904	707	772	620	624	712	662	672	608	568	560	602
30% Pulp 0.3% Acidity	912	938	656	660	792	864	704	548	594	678	852	584	524	544	626
30% Pulp 0.4% Acidity	920	960	660	720	815	900	848	640	624	753	872	816	468	540	674
Mean	746	781	641	766		684	626	566	636		644	582	574	536	

C.D. at 5%

Cultivar	8	7	7
Treatment	9	8	8
Cultivar X Treatment	19	16	16

Contd....2.

Contd.....table 6.

Cultivar Treatment	Storage period in days									
	90					120				
	AS	BS	SD	TD	Mean	AS	BS	SD	TD	Mean
20% Pulp 0.3% Acidity	464	432	432	496	456	424	332	386	396	385
20% Pulp 0.4% Acidity	384	464	572	456	469	348	324	408	352	358
25% Pulp 0.3% Acidity	472	412	312	460	414	388	386	284	436	374
25% Pulp 0.4% Acidity	588	420	356	444	452	568	332	336	348	358
30% Pulp 0.3% Acidity	756	542	428	476	551	744	524	384	416	517
30% Pulp 0.4% Acidity	744	716	448	516	606	736	652	380	376	536
Mean	568	497	424	474		534	425	365	387	

C.D. at 5%

Cultivar	5	7
Treatment	7	9
Cultivar X Treatment	13	17

At the end of storage, maximum degradation of pectin was observed in nectar from cv. Tehsildar (49.42 percent) followed by Banarasi Surkha (45.58 percent), Sardar (43.36 percent) and Allahabad Safeda (28.41 percent). It was also noticed that pectin content varied significantly in nectar prepared from various treatments. The lowest pectin content was noticed in nectar with 20 percent pulp and 0.3 percent acidity and the highest content was observed in treatment where 30 percent pulp with 0.4 percent acidity was used. After 30 days storage the low pectin was noticed in nectar with 25 percent pulp and 0.3 percent acidity. At 120 days, the pectin was minimum in nectar with 0.4 percent acidity with 20 percent and 25 percent pulp.

Pectin content was found significantly higher in 0.4 percent acidity level as compared to 0.3 percent acidity level upto 90 days after that pectin content with 0.3 percent acidity at 20 and 25 percent pulp was found more. Similarly, fruit pulp percentage also affected the residual pectin content in nectar. It was found comparatively higher in nectar which initially had more amount of fruit pulp. The nectar of cv. Banarasi Surkha with 30 percent pulp and both the acid concentrations obtained significantly higher pectin content after preparation. After 30 days, nectar of cv. Allahabad Safeda had the higher content of pectin with 30 percent pulp and 0.4 percent acidity.

It has been observed that all the treatments resulted in a significant decrease in pectin content during processing. The breakdown of pectin with losses of juice viscosity and consistency readily might have occured during juice extraction and preparation in period between disintegration of the tissue and heat inactivation of the enzymes (Hulme, 1971). Further, the reduction in pectin content during storage also exhibited the possibility of breakdown of pectin by the leftover active enzymes in the acidic medium at room temperature. In the present studies, a reduction upto 50 percent was noticed during storage. However, the results are contrary to the finding of Ronate and Bains (1982) who practically did not observe any change in pectin content in the preserved kinnow juice during storage. Similarly Harnanan et al, (1980) also of the view that method of preservation and storage did not seem to have affected the pectin content of guava pulp. Luh and Dasture (1966) reported that the texture of canned apricot was influenced by ripeness level of the fresh fruit and processing time. The canned product gradually softened during storage, while water soluble pectin in the syrup increased and protopectin in the fruit decreased. Syrup viscosity increased during storage of canned apricots. Chauhan (1981) reported that there was a gradual decrease in pectin content

Table 7: Effect of different treatments on titrable acidity of stored guava nectar

(g citric acid/100 ml)

Cultivar / Treatment	Storage period in days														
	0					30					60				
	AS	BS	SD	TD	Mean	AS	BS	SD	TD	Mean	AS	BS	SD	TD	Mean
20% Pulp 0.3% Acidity	0.301	0.301	0.301	0.301	0.301	0.329	0.329	0.322	0.308	0.322	0.329	0.339	0.322	0.329	0.330
20% Pulp 0.4% Acidity	0.399	0.399	0.399	0.399	0.399	0.420	0.430	0.420	0.420	0.423	0.430	0.441	0.420	0.434	0.431
25% Pulp 0.3% Acidity	0.301	0.301	0.301	0.301	0.301	0.322	0.329	0.322	0.308	0.320	0.339	0.343	0.346	0.318	0.337
25% Pulp 0.4% Acidity	0.399	0.399	0.399	0.399	0.399	0.430	0.420	0.420	0.399	0.417	0.441	0.427	0.430	0.430	0.432
30% Pulp 0.3% Acidity	0.301	0.301	0.301	0.301	0.301	0.339	0.329	0.301	0.308	0.318	0.339	0.339	0.343	0.322	0.336
30% Pulp 0.4% Acidity	0.399	0.399	0.399	0.399	0.399	0.420	0.430	0.399	0.410	0.415	0.430	0.441	0.430	0.427	0.432
Mean	0.350	0.350	0.350	0.350		0.376	0.378	0.364	0.358		0.385	0.388	0.382	0.377	

C.D. at 5%			
Cultivar	N.S.	0.005	0.003
Treatment	0.009	0.007	0.004
Cultivar X Treatment	N.S.	0.013	0.008

Contd...2.

Contd.....table 7.

Cultivar / Treatment	Storage period in days									
	90					120				
	AS	BS	SD	TD	Mean	AS	BS	SD	TD	Mean
20% Pulp 0.3% Acidity	0.336	0.336	0.336	0.329	0.334	0.339	0.339	0.332	0.339	0.338
20% Pulp 0.4% Acidity	0.430	0.437	0.427	0.427	0.430	0.437	0.434	0.423	0.430	0.431
25% Pulp 0.3% Acidity	0.346	0.346	0.346	0.336	0.344	0.343	0.343	0.343	0.329	0.340
25% Pulp 0.4% Acidity	0.437	0.441	0.427	0.423	0.432	0.434	0.434	0.423	0.420	0.429
30% Pulp 0.3% Acidity	0.346	0.339	0.339	0.339	0.341	0.339	0.332	0.332	0.332	0.334
30% Pulp 0.4% Acidity	0.441	0.441	0.430	0.430	0.436	0.423	0.434	0.423	0.423	0.426
Mean	0.389	0.390	0.384	0.381		0.386	0.386	0.380	0.379	

C.D. at 5%

Cultivar	0.004	0.003
Treatment	0.005	0.004
Cultivar X Treatment	N.S.	N.S.

Among treatments the increase in acidity was observed throughout the storage period only in nectar with 20 percent pulp while in 25 and 30 percent pulp, increase in acidity was observed only upto 90 days, thereafter, a slight decrease was noticed. Highest percent increase in acidity was observed in nectar with 25 percent pulp and 0.3 percent acidity i.e. 14.28 percent in 90 days over initial value, thereafter a further decrease of 1.17 percent was noticed. A minimum increase (7.51 percent) upto 90 days was observed from the nectar with 20 percent pulp and 0.4 percent acidity but after 120 days of storage the minimum increase (6.75 percent) was observed from the nectar with 30 pulp and 0.4 percent acidity. The decrease in acidity between 90 days to 120 days was more in nectar with 30 percent pulp and 0.4 percent acidity which reduced from 0.436 to 0.426 percent. Therefore, a decrease of 2.29 percent in acidity was observed after 90 days to 120 days of storage. The overall percent increase in acidity was comparatively higher in nectar with 0.3 percent acidity level than the nectar with 0.4 percent acidity level.

In the present investigation, a progressive increase in acidity was observed in guava nectar stored upto 90 days at ambient temperature thereby the degradation of pectin substances into the soluble acids might have contributed towards an increase in acidity of the product (Conn and Stumrf, 1976). Increase in acid content in

different products have also been reported by various workers. Rao and Roy (1980) reported that during storage of mango increase in storage temperature. The reason for increase in acidity might be due to formation of sulphurous acid. Mehta and Rathore (1976) also observed a more rapid increase in total titrable acidity in amla juice in samples stored at room temperature than stored in refrigerator for 10 weeks.

Contradictory results have also been reported by various workers during storage of various products. Dabhade and Khedkar (1980) observed a progressive decrease in acidity on being stored at room temperature in case of mango powder (Amchur). Similarly, Nagi and Manjrekar (1976) reported that there was a decrease in acidity in apple cider at room temperature from 0.48 to 0.46 percent at 37 C when stored for four months. However, no change in acidity level was noticed by Awan et al (1980) in sour soap (drink) during storage for 3 months.

Further, the maximum percent increase in acidity at the end of storage period was observed in treatments where less acidity was maintained i.e. 0.3 percent. This acidity level might have created optimum conditions for the pectin degrading enzyme to work efficiently to hydrolyse more of insoluble form of pectin to soluble form i.e. pectin acids which might be contributed towards acidity. However, the reason for the various degrees of increase in acidity in

of the products with increased days of storage with less losses at low temperature in comparison to room temperature.

4.2.6. Acidity

The data pertaining to the effect of pulp and acid content on the acidity of stored nectar of four guava cultivars at ambient temperature are presented in Table 7.

It is clear from the results that the acidity of stored guava nectar increased throughout the storage period irrespective of the treatments and cultivar. Since the acid levels i.e. 0.3 and 0.4 percent were maintained during nectar preparation, variation after its preparation was not observed. But after 30 days interval, significantly higher acidity was observed in cv. Banarasi Surkha (0.378 percent) than cvs. Sardar (0.364 percent) and Tehsildar (0.358 percent) but the values were at par with cv. Allahabad Safeda (0.376 percent). Almost same trend was maintained upto 90 days of storage at which cv. Banarasi Surkha had significantly higher acid content (0.390 percent) than cvs. Sardar (0.386 percent) and Tehsildar (0.381 percent) but the values were at par with cv. Allahabad Safeda (0.389 percent). After 90 days of storage, the acid content of nectar generally decreased in all the cultivars but it was very slight. Cv. Allahabad Safeda and Banarasi Surkha (0.386 percent) had significantly higher acidity than cvs. Sardar (0.380 percent) and Tehsildar (0.379 percent) after 120 days of storage.

Among treatments the increase in acidity was observed throughout the storage period only in nectar with 20 percent pulp while in 25 and 30 percent pulp, increase in acidity was observed only upto 90 days, thereafter, a slight decrease was noticed. Highest percent increase in acidity was observed in nectar with 25 percent pulp and 0.3 percent acidity i.e. 14.28 percent in 90 days over initial value, thereafter a further decrease of 1.17 percent was noticed. A minimum increase (7.51 percent) upto 90 days was observed from the nectar with 20 percent pulp and 0.4 percent acidity but after 120 days of storage the minimum increase (6.75 percent) was observed from the nectar with 30 pulp and 0.4 percent acidity. The decrease in acidity between 90 days to 120 days was more in nectar with 30 percent pulp and 0.4 percent acidity which reduced from 0.436 to 0.426 percent. Therefore, a decrease of 2.29 percent in acidity was observed after 90 days to 120 days of storage. The overall percent increase in acidity was comparatively higher in nectar with 0.3 percent acidity level than the nectar with 0.4 percent acidity level.

In the present investigation, a progressive increase in acidity was observed in guava nectar stored upto 90 days at ambient temperature thereby the degradation of pectin substances into the soluble acids might have contributed towards an increase in acidity of the product (Conn and Stumrf, 1976). Increase in acid content in

different products have also been reported by various workers. Rao and Roy (1980) reported that during storage of mango increase in storage temperature. The reason for increase in acidity might be due to formation of sulphurous acid. Mehta and Rathore (1976) also observed a more rapid increase in total titrable acidity in amla juice in samples stored at room temperature than stored in refrigerator for 10 weeks.

Contradictory results have also been reported by various workers during storage of various products. Dabhade and Khedkar (1980) observed a progressive decrease in acidity on being stored at room temperature in case of mango powder (Amchur). Similarly, Nagi and Manjrekar (1976) reported that there was a decrease in acidity in apple cider at room temperature from 0.48 to 0.46 percent at 37 C when stored for four months. However, no change in acidity level was noticed by Awan et al (1980) in sour soap (drink) during storage for 3 months.

Further, the maximum percent increase in acidity at the end of storage period was observed in treatments where less acidity was maintained i.e. 0.3 percent. This acidity level might have created optimum conditions for the pectin degrading enzyme to work efficiently to hydrolyse more of insoluble form of pectin to soluble form i.e. pectin acids which might be contributed towards acidity. However, the reason for the various degrees of increase in acidity in

different pulp concentration could be due to the presence of different concentration of inherent enzyme (pectin degrading) of the fruits.

4.2.7. pH

Effect of various pulp and acidity levels on the pH of the nectar prepared from four guava cultivars and stored at ambient temperature for 120 days was ascertained and the data is presented in Table 8.

pH of the nectar stored at room temperature decreased with increase in duration of storage irrespective of treatments and cultivars. The higher pH was observed in nectar of Allahabad Safeda (4.30) which was at par with cvs. Banarasi Surkha (4.29) and Sardar (4.27) but significantly higher than cv. Tehsildar (4.24). Almost same trend was observed upto the end of storage except in nectar from cv. Sardar which had significantly low pH value (3.80) at 90 days storage period.

Among treatment, pH ranges from 4.18 (in nectar with 20 percent pulp and 0.4 percent acidity) to 4.34 (in both 25 and 30 percent pulp with 0.3 percent acidity). The nectar with 20 percent pulp and 0.4 percent acidity had lowest pH value whereas with 30 percent pulp and 0.3 percent acidity higher pH value was noticed throughout the storage period. It was also observed that pH value of guava nectar was comparatively higher in 0.3 percent acidity level to that of 0.4 percent acidity level.

Table 8: Effect of different treatments on pH of stored guava nectar

Cultivar / Treatment	Storage period in days: 0 AS	0 BS	0 SD	0 TD	0 Mean	30 AS	30 BS	30 SD	30 TD	30 Mean	60 AS	60 BS	60 SD	60 TD	60 Mean
20% Pulp 0.3% Acidity	4.30	4.25	4.30	4.20	4.26	4.10	4.05	4.25	4.10	4.13	4.05	3.95	4.10	3.95	4.01
20% Pulp 0.4% Acidity	4.20	4.20	4.20	4.10	4.18	4.10	4.05	4.15	4.05	4.09	3.95	3.80	4.00	3.90	3.91
25% Pulp 0.3% Acidity	4.35	4.40	4.25	4.35	4.34	4.20	4.30	4.10	4.20	4.20	4.10	4.10	3.95	4.05	4.05
25% Pulp 0.4% Acidity	4.30	4.25	4.20	4.25	4.25	4.20	4.15	4.10	4.10	4.14	4.05	4.00	3.80	3.80	3.91
30% Pulp 0.3% Acidity	4.40	4.35	4.35	4.25	4.34	4.30	4.30	4.20	4.10	4.23	4.15	4.10	4.05	4.05	4.09
30% Pulp 0.4% Acidity	4.25	4.30	4.30	4.20	4.26	4.15	4.20	4.10	4.10	4.14	4.00	4.05	3.95	3.90	3.98
Mean	4.30	4.29	4.27	4.24		4.17	4.17	4.15	4.11		4.07	4.00	3.97	3.94	

C.D. at 5%

	0	30	60
Cultivar	0.04	0.05	0.04
Treatment	0.05	0.07	0.05
Cultivar X Treatment	0.10	0.13	0.10

Contd...2.

Contd.....table 8.

Cultivar Treatment	Storage period in days									
	90					120				
	AS	BS	SD	TD	Mean	AS	BS	SD	TD	Mean
20% Pulp 0.3% Acidity	3.85	3.85	3.90	3.80	3.85	3.75	3.70	3.70	3.70	3.71
20% Pulp 0.4% Acidity	3.80	3.70	3.80	3.80	3.78	3.70	3.65	3.65	3.65	3.66
25% Pulp 0.3% Acidity	3.95	3.95	3.75	3.85	3.88	3.85	3.80	3.70	3.75	3.78
25% Pulp 0.4% Acidity	3.90	3.80	3.70	3.75	3.79	3.80	3.70	3.65	3.65	3.70
30% Pulp 0.3% Acidity	3.90	3.95	3.85	3.95	3.93	3.80	3.85	3.75	3.90	3.83
30% Pulp 0.4% Acidity	3.85	3.90	3.80	3.90	3.86	3.75	3.80	3.70	3.85	3.78
Mean	3.88	3.85	3.80	3.84		3.77	3.75	3.69	3.75	

C.D. at 5%

Cultivar	0.03	0.04
Treatment	0.04	0.04
Cultivar X Treatment	0.08	0.09

Among cultivars, the decrease in pH was more in cv. Sardar (13.58 percent) followed by Banarasi Surkha (12.58 percent), Allahabad Safeda (12.32 percent) and Tehsildar (11.55 percent). It is clear from the results that decrease in pH value was more in nectar with 25 percent pulp and 0.4 percent acidity (12.94 percent) and less in nectar with 30 percent pulp and 0.4 percent acidity (11.26 percent).

Reduction in pH noticed in the nectar during storage might be due to the simultaneous increase in acidity. Various workers have also observed the change in pH in the products during storage. Rao and Krishnamurthy (1982) showed negligible change in pH during storage of tomato crush and tomato juice concentrate packed in different containers and stored at room temperature or low temperature. However, Khurdiya and Anand (1981) did not report any change in pH of phalsa beverage during storage. Similarly, Shrestha and Bhatia (1982) also observed the change in pH in stored apple juice at various temperatures, however, the differences were not significant.

4.2.8. Browning

Storing of fruit products often results in deterioration of colour due to enzymatic or and non-enzymatic browning pigments which impare the quality of the product. In the present studies, nectar prepared by using various pulp and acid concentrations from different cultivars were stored at ambient temperature and browning was observed at

Table 9: Effect of different treatments on browning of stored guava nectar

(O.D. at 420 nm)

Cultivar Treatment	Storage period in days													
	0					30					60			
	AS	BS	SD	TD	Mean	AS	BS	SD	TD	Mean	AS	BS	SD	TD	Mean
20% Pulp 0.3% Acidity	0.051	0.061	0.056	0.066	0.059	0.056	0.061	0.066	0.086	0.067	0.092	0.076	0.071	0.092	0.083
20% Pulp 0.4% Acidity	0.066	0.056	0.051	0.076	0.062	0.071	0.066	0.066	0.086	0.072	0.092	0.071	0.071	0.096	0.083
25% Pulp 0.3% Acidity	0.056	0.066	0.071	0.076	0.067	0.071	0.097	0.076	0.102	0.087	0.097	0.097	0.081	0.102	0.094
25% Pulp 0.4% Acidity	0.071	0.086	0.076	0.081	0.079	0.080	0.092	0.092	0.081	0.086	0.080	0.097	0.102	0.092	0.093
30% Pulp 0.3% Acidity	0.071	0.071	0.078	0.092	0.078	0.086	0.081	0.081	0.097	0.086	0.092	0.102	0.102	0.119	0.104
30% Pulp 0.4% Acidity	0.081	0.081	0.081	0.096	0.085	0.086	0.086	0.096	0.101	0.092	0.094	0.102	0.140	0.102	0.110
Mean	0.066	0.070	0.070	0.078		0.074	0.079	0.079	0.087		0.091	0.091	0.094	0.104	

C.D. at 5%

	0	30	60
Cultivar	0.003	0.003	0.003
Treatment	0.004	0.004	0.004
Cultivar X Treatment	0.008	0.007	0.007

Contd....2.

Contd.....table 9.

Cultivar / Treatment	Storage period in days									
	90					120				
	AS	BS	SD	TD	Mean	AS	BS	SD	TD	Mean
20% Pulp 0.3% Acidity	0.102	0.086	0.086	0.119	0.098	0.108	0.092	0.092	0.123	0.104
20% Pulp 0.4% Acidity	0.119	0.086	0.102	0.114	0.105	0.125	0.086	0.108	0.131	0.113
25% Pulp 0.3% Acidity	0.108	0.102	0.114	0.119	0.111	0.111	0.108	0.114	0.119	0.113
25% Pulp 0.4% Acidity	0.102	0.102	0.108	0.114	0.107	0.108	0.114	0.114	0.119	0.114
30% Pulp 0.3% Acidity	0.097	0.119	0.114	0.125	0.114	0.105	0.119	0.119	0.131	0.119
30% Pulp 0.4% Acidity	0.114	0.125	0.149	0.123	0.128	0.119	0.131	0.168	0.132	0.138
Mean	0.107	0.103	0.112	0.119		0.112	0.108	0.119	0.126	

C.D. at 5%

Cultivar	0.004	0.004
Treatment	0.005	0.005
Cultivar X Treatment	0.010	0.010

30 days interval upto 120 days. Optical density of the samples was taken as an index of browning and the data obtained are presented in Table 9.

The data from Table 9 reveal that optical density of nectar stored at ambient temperature increased during storage irrespective of cultivar and treatment. The minimum optical density was observed from nectar of cv. Allahabad Safeda (0.066) irrespective of the treatments just after its preparation. This trend was maintained upto 60 days of storage period. After 90 days, optical density was minimum in nectar from cv. Banarasi Surkha (0.103). The maximum optical density was observed in cv. Tehsildar (0.078) after preparation and the same trend was maintained upto the end of storage. After 120 days, Tehsildar had 0.126 optical density.

Browning of guava nectar also affected by various pulp and acid concentrations. The results revealed that optical density was lowest in nectar (0.059) where 20 percent pulp and 0.3 percent acidity was taken and same trend was maintained upto 120 days of storage. Further it was noticed that with the increase in pulp percentage in nectar the optical density of the product also increased. Therefore, nectar prepared with 30 percent pulp exhibited more browning after processing and during storage.

Similarly, nectar which contained high acidity level showed more browning as compared to the samples with

less acid content. The nectar of cv. Allahabad Safeda prepared with 20 percent pulp and 0.3 percent acidity developed the minimum browning during processing. After 60 days storage the lowest optical density was observed in nectar of cv. Banarasi Surkha with 20 percent pulp and 0.4 percent acidity which is at par with nectar of same cultivar prepared with 20 percent pulp and 0.3 percent acidity and that of cv. Sardar with 20 percent pulp and 0.3 percent acidity. The nectar prepared from various cultivars showed lowest percent increase in browning in cv. Banarasi Surkha (54.28 percent) followed by Tehsildar (61.53 percent), Allahabad Safeda (69.69 percent) and Sardar (70.00 percent) upto end of storage. The nectar of cv. Banarasi Surkha prepared with 20 percent pulp and 0.4 percent acid developed significantly lowest browning upto end of storage which could be the best combination as far as development of brown pigment is concerned. Therefore, from the results, it is clear that there was a progressive increase in browning during processing and thereafter in storage. However the development of brown pigment in product was comparatively higher during storage.

The present results of browning are in agreement with those of Brekke et al.,(1970) who also noticed browning in guava concentrates after 2 months of storage and this became more pronounced with continued storage. Khurdiya and Anand (1981) also reported a gradual increase in browning and HMF formation in phalsa beverage with increasing

storage period and it was more pronounced at room temperature than at lower temperature. Decline in ascorbic acid content in the product could also be a possible reason for the development of browning in the product during storage (Stadtman, 1948).

A gradual increase in browning with increase in storage period at room temperature in this product could be well understood as the increase in browning with length of storage period could be due to enzymatic and non-enzymatic reactions in the product. The possibility of browning due to enzymes in product is almost stopped at such a high temperature during processing. Therefore, in this case the browning might have taken place through the non-enzymatic reaction and oxidation of various phenolics and other compounds which lead to the formation of brown pigments. Although the browning was more in nectar of Banarasi Surkha at the initial stage, the rate of increase was lowest during storage. This can be explained as this cultivar contained pigments in the fresh which give deep colour to the product at the initial stage. But low rate of browning during storage might be due to the presence of some antioxidants in the product which check the process of oxidation of pigments upto some extent.

4.3. Organoleptic Evaluation

Organoleptic evaluation of nectar prepared from four guava cultivars with different pulp and acid concentrates and stored under ambient temperature was evaluated at 30 days

Table 10: Effect of different treatments on organoleptic quality of stored guava nectar

(Out of 36 Scores)

Cultivar Treatment	Storage period in days													
	0					30					60			
	AS	BS	SD	TD	Mean	AS	BS	SD	TD	Mean	AS	BS	SD	TD	Mean
20% Pulp 0.3% Acidity	21	23	27	24	24.0	19	22	26	22	22.0	20	19	26	23	22.0
20% Pulp 0.4% Acidity	23	22	26	21	23.0	22	20	24	22	22.0	19	18	23	18	20.0
25% Pulp 0.3% Acidity	26	25	29	26	26.5	25	24	29	24	25.5	23	23	27	25	24.5
25% Pulp 0.4% Acidity	24	24	27	25	25.0	24	23	26	22	24.0	22	21	25	21	22.5
30% Pulp 0.3% Acidity	22	22	21	21	21.5	19	19	22	19	20.0	18	18	21	20	19.5
30% Pulp 0.4% Acidity	21	20	22	19	20.5	19	21	21	18	20.0	20	19	19	17	19.0
Mean	22.8	22.6	25.3	22.6		21.3	21.5	24.4	21.1		20.3	19.6	23.5	20.6	

C.D. at 5%

Cultivar	2.0	2.0	1.0
Treatment	2.0	2.0	1.0
Cultivar X Treatment	N.S.	N.S.	3.0

Contd....2.

Contd.....table 10.

Cultivar / Treatment	Storage period in days									
	90					120				
	AS	BS	SD	TD	Mean	AS	BS	SD	TD	Mean
20% Pulp 0.3% Acidity	18	20	24	19	20	19	18	23	20	20
20% Pulp 0.4% Acidity	22	18	22	19	20	21	19	23	19	21
25% Pulp 0.3% Acidity	26	23	28	24	25	24	22	28	22	24
25% Pulp 0.4% Acidity	23	21	23	23	23	21	20	25	21	22
30% Pulp 0.3% Acidity	20	18	19	19	19	19	18	19	19	19
30% Pulp 0.4% Acidity	18	19	20	18	19	18	17	18	17	18
Mean	21.2	19.6	22.6	20.3		20.3	19.0	22.6	19.5	

C.D. at 5%

Cultivar	1	1
Treatment	1	1
Cultivar X Treatment	2	2

interval by a panel of five judges. The scores recorded are presented in Table 10.

Freshly prepared nectar on evaluation for their organoleptic evaluation showed that nectar from cv. Sardar scored significantly higher marks among all the cultivars (Table 10). Although the scores of other three cvs were at par, however, they rank in order of Allahabad Safeda, Tehsildar and Banarasi Surkha. The same trend was maintained upto the end of storage period. Further, it was observed that nectar from Banarasi Surkha and Tehsildar remained acceptable upto 30 days and 90 days of storage respectively due to the lower scores obtained which were below the acceptable limit.

Among various treatments, the nectar prepared with 25 percent pulp and 0.3 percent acidity scored the highest marks compared to other treatments. It was followed by 25 percent pulp and 0.4 percent acidity when evaluated just after preparation. This trend was maintained throughout the storage period. On the other hand, nectar prepared by taking 30 percent pulp with different acidity levels was found below acceptable limit when evaluated after 60 days of storage. Overall combinations of various treatment and cultivar show that nectar from cv. Sardar with 25 percent pulp and 0.3 percent acidity adjudged the best as far as organoleptic evaluation of the product is concerned. It maintained the good taste and flavour of the product when

stored at room temperature upto the end of storage period.

The perusal of the data reveal that there was a gradual decrease in organoleptic quality during storage at room temperature. It is obvious because there are many extrinsic factor which determines the storage stability of the product and among them, temperature of storage is the major one. Because, there are certain biochemical changes which take place under low pH and high temperature which leads to formation of brown pigment and produce off flavour, thus masking the original flavour of the fruit. Khurdiya and Anand (1981) reported that the acceptability of ready-to-serve beverage of phalsa goes down when stored at 20 C or at room temperature. From the various treatment combinations it is observed that the nectar prepared with 25 percent pulp containing 0.3 percent acidity was highly acceptable even upto 120 days of storage. Rao and Roy (1980a) also agreed that nectar prepared with 25 percent pulp gave the best results, however, they maintained a little higher acidity level in the product, However, Kerure and Khedkar (1982) assessed that guava nectar with 20 percent pulp and 20°B with 0.5 percent acidity was adjudged as best. They further suggested that the shelf life of the product can be increased manifolds by low temperature storage.

The differences in organoleptic rating of guava nectar prepared from various cultivars is obvious

as the quality of these cultivars are variable in terms of flavour, colour, taste and texture. However, nectar prepared from cv. Sardar dominated in organoleptic quality throughout the storage period followed by Allahabad Safeda and Tehsildar. Nectar prepared from cv. Banarasi Surkha lost acceptability within 60 days. It could be mainly due to that the cultivar has a coloured pulp and presence of more seeds increase the level of phenolic compound which may cause browning of the product and sometimes produce off flavour during storage by combining with other compounds of the fruit pulp.

4.4. Microbiological Examination

In the present investigation the microbial examination of guava nectar prepared from four cultivars by using different pulp and acid combinations was done at regular interval to check whether storage conditions have any effect on the microbial growth. The data thus, recorded with respect to total microbial counts for yeast, moulds and bacteria are presented in Table 11.

Data given in Table 11 show that there was gradual increase in the total number of microbial counts during storage. Initial examination of the product reveal that the counts were found minimum in nectar of cv. Sardar and maximum were in cv. Banarasi Surkha. Nectar prepared by different recipe showed that nectar with 30 percent pulp had comparatively higher total counts which includes

Table 11: Effect of different treatments on microbial counts in stored guava nectar

(Total counts/ml)

Cultivar Treatment	Storage period in days														
	0					30					60				
	AS	BS	SD	TD	Total	AS	BS	SD	TD	Total	AS	BS	SD	TD	Total
20% Pulp 0.3% Acidity	-	-	-	2B*	2	-	-	-	-	-	2A*	2F*	-	6B	10
20% Pulp 0.4% Acidity	2B	2A 4B	-	-	8	4B	-	-	-	4	-	-	4B	2F	6
25% Pulp 0.3% Acidity	-	-	-	-	-	-	-	2B	2B	4	6A	-	-	-	6
25% Pulp 0.4% Acidity	-	4A 6B	-	1B	11	-	-	-	-	-	-	4A 8B	-	4B	16
30% Pulp 0.3% Acidity	2B	-	2B	8A	12	-	-	2B	2B	4	-	-	-	-	-
30% Pulp 0.4% Acidity	-	2F	-	-	2	-	-	-	-	-	-	-	-	-	-
Total	4	18	2	11		4	-	4	4		8	14	4	12	

A* - Actinomycetes
B* - Bacteria
F* - Fungi

Contd....2.

Contd.....table 11.

Cultivar Treatment	Storage period in days									
	90					120				
	AS	BS	SD	TD	Total	AS	BS	SD	TD	Total
20% Pulp 0.3% Acidity	-	5A 4B	-	2F	11	2F	-	-	10A	12
20% Pulp 0.4% Acidity	-	12A	-	-	12	-	6B 8A	2F	4F	20
25% Pulp 0.3% Acidity	10A	-	-	-	10	-	-	2F	-	2
25% Pulp 0.4% Acidity	-	-	2F	-	2	2F	8B 4A	4F	4B	22
30% Pulp 0.3% Acidity	4F 2B 2A	-	2B	8A	18	2F	6A 4F	4A	9A	25
30% Pulp 0.4% Acidity	-	10F	-	-	10	4B 4F	4F	-	2B 2F	16
Total	18	31	4	10		14	40	12	31	

fungal and bacterial colonies. Similarly, the nectar prepared from the same pulp concentration had the highest total counts upto the end of 120 days storage period and the minimum counts were observed in nectar with 25 percent and 0.3 percent acidity combination. Under this combination the total counts were found minimum throughout the storage period.

From the observations on microbial population in the freshly prepared and stored nectar, it is clear that nectar with high pulp concentration had more microbial population which could not be eliminated completely during processing. During storage a little increase in microbial population was noticed. However the total maximum number of counts found in various treatments and in different cultivars were far below the safety limits from the public health stand point.

The variations observed in total microbial counts might be due to some contaminations occured during examination. Increase in microbial population mainly depends upon the environment available to the microbes and the storage temperature. Nagi and Manjrekar (1976) observed that the microbial counts increased at 37 C more rapidly than at room temperature which was much lower than this temperature. They further stated that this increase in microbial population at room temperature and at 37 C and also that during storage had no significant effect on the quality of apple cider.

Brekke et al (1970) reported that guava puree concentrate containing 1000 ppm potassium sorbate showed no gross sign of spoilage during storage for 5 months at 45 F. During this period, initial number of yeasts decreased steadily to an insignificant count level. Although the total no of microbial counts is considered a criteria for the wholesomeness of the product even than high total numbers do not necessarily imply a public health hazard unless there is presence of some pathogenic organisms.

It is, therefore, concluded that the nectar prepared from cv. Sardar was the best among the other cultivars and remained good during storage. Nectar containing 25 percent pulp was considered best for its preparation along with 0.3 percent acidity level. Presence of more acid or pulp concentrate in the nectar does not have any benificial effects. The nectar from cv. Tehsildar prepared with 30 percent pulp and 0.4 percent acidity was found below the acceptable level just after its preparation. Total and Reducing Sugars increased during storage of the product. Increase in total soluble solids was more where higher pulp and higher acid concentrations were taken. Nectar of cv. Allahabad Safeda retained comparatively higher ascorbic acid content when 30% pulp and 0.3 percent acidity used. During storage, the retention of pectin was higher in nectar prepared from Allahabad Safeda and

lower in nectar from Banarasi Surkha. Pectin content was higher in nectar with 0.4 percent acidity than 0.3 percent acidity. Acidity increased upto 90 days storage thereafter a slight decline was noticed. Product prepared from various cultivars differ in organoleptic quality. The observation revealed that a good quality product can be prepared from cv. Sardar followed by Allahabad Safeda, Tehsildar and Banarasi Surkha. Browning was higher in cv. Tehsildar throughout storage but higher increase in browning was noticed in nectar from cv. Sardar and lower in Banarasi Surkha. The small no of micro-organism present in product did not shown any deterioration effect in the product. Storage studies have shown that the product can be stored at ambient temperature (25 $\pm$ 5 C) upto 120 days without much deterioration in the quality.

CHAPTER V

S U M M A R Y

SUMMARY

The present investigation was undertaken with a view to standardize the recipe for nectar, to evaluate the guava cultivars for nectar preparation, to study nutritional changes in nectar during storage and to study the storage stability at ambient temperature (25 ± 5C) for 120 days. Experimental work was carried out in Fruit Technology Laboratory of the Department of Horticulture, Haryana Agricultural University, Hissar. Fresh fruits from four guava cultivars were harvested at colour break stage. They were analysed for proximate components like pectin, acidity, ascorbic acid, total sugar, reducing sugar and total soluble solids. Nectar was prepared by mixing different ratios of pulp and acid content. Total soluble solids of the nectar was maintained at 15 percent by adding cane sugar. The nectar was stored at ambient temperature upto 120 days. During storage, nectar was analysed periodically at monthly interval for its chemical composition such as reducing sugar, total sugar, total soluble solids, ascorbic acid, pectin, acidity, pH, optical density, organoleptic evaluation and micro-organism examination.

Fresh fruits of cv. Allahabad Safeda had highest total soluble solids and the lowest pectin content among all the other cultivars understudy. Highest content of

ascorbic acid was found in cv. Sardar followed by Banarasi Surkha, Tensildar and Allahabad Safeda. Acidity expressed in terms of citric acid was the lowest in cv. Sardar and highest in cv. Tehsildar.

Reducing sugars of the nectar have shown an increasing trend during storage. The percent increase in reducing sugars were maximum in cv. Banarasi Surkha and minimum in cv. Tehsildar. Maximum reducing sugars were observed in nectar from cv. Tehsildar and lowest in cv. Banarasi Surkha after processing. Comparatively higher amount of reducing sugars were observed in nectar containing 0.4 percent acidity than 0.3 percent acidity. Nectar containing 30 percent pulp and 0.4 percent acidity, initially, have higher reducing sugars content upto 90 days of storage but at 120 days storage, nectar with 25 percent pulp and 0.4 percent acidity contained significantly higher reducing sugars.

Total sugar content was also increased in nectar during storage. Maximum increase in total sugars were noticed in nectar from cv. Sardar. Among various combinations nectar prepared with 25 percent pulp and 0.3 percent acidity had higher total sugar content throughout the storage period. Percent increase in total sugars were maximum in nectar from cv. Sardar prepared with 20 percent pulp and 0.4 percent acidity.

Total soluble solids were found to be increased in nectar gradually during storage. The highest increase was observed in nectar from cv. Sardar and the lowest from cv. Allahabad Safeda at end of storage period. Increase in total soluble solids content was comparatively more in nectar prepared from 30 percent pulp and 0.4 percent acidity than other combinations. Higher pulp and acid concentration in nectar were found to be responsible for higher increase in total soluble solids.

After processing maximum ascorbic acid was retained in nectar from cv. Sardar and the lowest in nectar from cv. Tehsildar. However, higher percentage of ascorbic acid was retained in cv. Allahabad Safeda and it was minimum in cv. Tehsildar during storage. Nectar prepared from higher pulp content retained comparatively higher ascorbic acid content during storage.

Pectin content reduced remarkably during processing and storage. Maximum pectin content after processing of nectar was observed in cv. Banarasi Surkha, however, its retention was maximum in nectar from cv. Allahabad Safeda and minimum in cv. Banarasi Surkha during storage. Nectar prepared from higher pulp and acid concentration contained the higher pectin content.

The acidity of the product has shown an upward trend when analysed during storage. Increase in acidity was continued upto 90 days, thereafter, a slight decline

was observed. The percent increase in acidity was, however, maximum in nectar prepared from cv. Banarasi Surkha. Similarly the percent increase was more in nectar containing 0.3 percent acidity than 0.4 percent acidity.

A gradual decline in pH of nectar was observed throughout storage period. Increase in acidity might be resulted in reduction in pH. During storage pH remained higher in cv. Allahabad Safeda throughout the period. At end of storage period, the percent decrease was found maximum in nectar prepared from cv. Sardar.

Storage of nectar at ambient temperature caused browning of the product. A progressive increase in browning was noticed throughout storage period, however, the percent increase in browning was more in nectar prepared from cv. Sardar than others. Nectar containing higher content of pulp and acid developed more browning than nectar which contain lower concentration.

Organoleptic evaluation have shown that nectar prepared from cv. Sardar was rated best among all other cultivars. Nectar prepared from various pulp and acid combinations differ in their consumer's acceptability. However, nectar prepared with 25 percent pulp and 0.3 percent acidity scored the maximum points and adjudged best by the panel of judges. And the same combination

retain better, its organoleptic quality even upto end of storage. Nectar prepared from cv. Tehsildar containing 30 per cent pulp and 0.4 per cent acidity scored below the acceptable limit even after processing. Therefore, the product prepared with 25 percent pulp containing 0.3 percent acidity from cv. Sardar was considered the best combination.

Microbial examination of the guava nectar showed that the presence of micro-organisms in nectar during storage were far below the safety limits of International Food Standard. However, the organisms which present were mainly yeasts, moulds and bacteria.

It is observed from the present studies that the cultivars Sardar followed by Allahabad Safeda have been found suitable for nectar preparation on commercial scale. Nectar prepared with 25 per cent pulp containing 15 per cent sugar and 0.3 per cent acidity is, therefore, recommended on the basis of maximum consumer's acceptance. Storage studies have indicated that the nectar prepared from above recipe can be kept well at room temperature (25 + 5 c) upto 4 months without much deterioration in their quality.

CHAPTER VI

LITERATURE CITED

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Appendix-I

HEDONIC RELATING TEST

Name_____ Date_____

Product_____

Taste these samples and check how much you like or dislike each one. Use the appropriate scale to show your attitude by assigning points that best describes your feeling about the sample. Remeber you are the only one who can tell what you like. An honest expression of yours personnal feeling will help us.

Sr. No.	Colour	Flavour	Consistency/ Texture/Feel	Taste	Total	Remarks

Rating	Organoleptic score
Like extremely	9
Like very much	8
Like moderately	7
Like slightly	6
Neither like nor Dislike	5
Dislike slightly	4
Dislike moderately	3
Dislike very much	2
Dislike extremely	1