STUDIES ON STORAGE STABILITY OF GUAVA JUICE AND JELLY

A THESIS

BY

RASHEDA KHATUN

Examination Roll No.: 10 AEFT JD 01M
Registration No.: 32487
Session: 2005-2006
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MASTERS OF SCIENCE (MS)
IN
FOOD ENGINEERING

DEPARTMENT OF FOOD TECHNOLOGY AND RURAL INDUSTRIES
BANGLADESH AGRICULTURAL UNIVERSITY, MYMENSINGH

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The Author

ABSTRACT

The study was carried out to observe the storage qualities of guava juice and jelly prepared from guava juice. Microbiological status and sensory evaluation of guava juice and jelly were evaluated. Mature green guava were collected from the fruit improvement project (FTIP), Local Market of Bangladesh Agricultural University, Mymensingh. Different ingredients were added in the guava juice for long term storage to prepare jelly. Jelly was prepared from stored guava juice using critic acid. Critic acid increased acid concentration of guava juice which was increased jelly strength of pH 2.8. The analysis of chemical composition of guava juices were moisture 73.42%, total solids 26.3%, total soluble Solids 23%, ash 91%, acidity 0.56%, reducing sugar 4.41%, non-reducing sugar 17.95%, total sugar 22.36%, ascorbic acid 11.64 mg/ 100 ml. The analysis of composition of guava jellies were moisture 27.17%, vitamin C 9.21 mg/100ml, acidity 6.31%, total soluble solids 67%, pH 3.2%, reducing sugar 29.10%, non-reducing sugar 8.23%, Total sugar 31.63%. It was also observed that normal guava juices were rapidly changed at room temperature than that of juice using preservatives. Juice treated with 100 ppm KMS and Sodium Benzoate 250 ppm. On response of test panel on the sensory attributes of guava juice and jelly, sample B (250 ppm Sodium Benzoate) storage of guava juice was more acceptable than other samples and sensory attributes of jelly prepared from sample C (270 gm juice + 82.50 gm glucose + 287.5 gm sugar) revealed that colour flavor, texture and overall acceptability was more acceptable.

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ABBREVIATION

APHA	:	American Public Health Association
CFU	:	Colony Forming Unit
Contd.	:	Continue
DMRT	:	Duncan’s Multiple Range Test
Fig.	:	Figure
G	:	Gram
Kg	:	Kilogram
KMS	:	Potassium Meta by-Sulphate
LSD	:	Least Significant Difference
Mg	:	Milligram
MI	:	Milliliter
PCA	:	Plate count Agar
PDA	:	Potato Dextrose Agar
GJ	:	Guava Juice
PPA	:	Parts Per Million
RFT	:	Refrigerator Temperature (9±1°C)
RMT	:	Room Temperature (29-30°C)
SO_2	:	Sulphur dioxide
SPC	:	Standard Plate Count
TSS	:	Total Soluble Solids

CHAPTER I

INTRODUCTION

Guava is one of the most common and important fruits in Bangladesh. It claims to be the most important fruit in area and production after mango (Anoymous, 1995). It is a native of South America. At present the major guava producing countries are the USA, Cuba, Brazil, Taiwan, Mexico, Peru, China, Malaysia, India, Pakistan, Thailand and Bangladesh.

Guava is rich source of vitamin C (260 mg/100g of fruit) and pectin which has industrial use for jelly production (Bose and Mitra, 2011). Guava is also a good source of calcium and phosphorus. Guava contains 84.2% water, 9.68% total soluble solids, .50% ash, 4.45% reducing sugar, 5.23% non-reducing sugar, 1.25% acid, and 560 mg/100g vitamin C, which differ with the cultivar, stage of maturity, and season. It is mainly used in many countries as a dessert. It can be used in preparing, jam, marmalade and juice. Guava jelly is well known to all and it can be caned in sugar syrup or made into fruit butter. Its juice is used for the preparation of sherbets and ice cream. Guava contain vitamin C, 2 to 5 times more than that of fresh orange juice. In some countries the leaves are used for curing diarrhea, and also for dyeing and tinning.

After harvesting guava may be stored 5-15 days at room temperature. The taste and nutrient content in the guava varied at the time of storage. Guava is an export promising quick growing fruit grow in Bangladesh.

Guava stands fifth in production among the most important fruit crops of Bangladesh and can be grown in all over the country. The annual production of guava is about 45,000 m. tons in an area of about 10,000 ha.

Although guava grows through out the country it is confined in some areas where guava is cultivated for commercial purposes. During harvesting season a market glut is occurred in the guava producing areas. Due to lack of marketing, storage

facilities the growers bound to sell their produce at throw away prices and huge quantity of guava spoiled. As estimated by Lushly (1984) an approximately 30 - 50% fruit goes waste during post-harvest handling, storage and ripening. This post-harvest loss is highly prominent in guava because of its high perishability. Once it fully ripe, the fruit becomes soggy and its edibility and marketing quality deteriorates rapidly.

The prevention of losses of the seasonal surplus of the fruit by processing and preservation techniques at farmer's level and as well as industrial scale should be warranted. Such efforts will help the development of processing industries in the growing areas of the countries. Moreover this will stimulate an increase in production and bring better return to the guava growers.

In Bangladesh the guava is mostly consumed as fresh fruit. There is a wide prospect of producing guava products such as guava juice, pulp, jelly, squash, marmalade, ready to serve beverage, candy, vinegar, wine etc. But unfortunately the present technology of production, processing and preservation of guava in Bangladesh is not well developed up to the volume of its annual production. It is therefore essential to investigate to develop suitable inexpensive method for processing and preservation of guava. There are a number of methods for processing guava. It seems that guava juice and guava jelly could be stored at normal temperature by using preservatives. The sucrose used in jelly and juices becomes crystalline and evolved sugar flavour on storage, carrying all these views and points in mind. The above phenomena the present study are designed to fulfill the following objectives:

The major objectives of this study as following:

i) To prepare guava juice and jelly with some modification of original formula.

ii) To evaluate the quality, acceptability and shelf-life of the prepared juice and Jelly.

CHAPTER II

REVIEW OF LITERATURE

Guava (payara) a berry like fruit of any of various myrtaceous trees or shrubs of the genus Pisidium, especially *P. guajava* (family Myrtaceae). It originated in tropical America (Mexico to Peru), where it still occurs in the wild. Guava is often called the “apple of the tropics”. The plant was introduce by the Portuguese to the Indian subcontinent by the early 17th century.

Guava is also an important fruit in Bangladesh, but research works on guava juice storage and preparation of guava products are scarce. It has received much attention to the researchers throughout the tropics and sub-tropics. Some available research finding in this connection have been reviewed and presented below on the following heading.

2.1 Maturity

Mitra and Bose (1990) reported that the components responsible for flavor are the ester components which have the higher concentration (44.94%) in ripe fruits and the lowest (33.38%) in mature one.

Guava gets final size after maturity. Mukherjee and Dutta (1967) reported that guava cultivars, viz. Safeda, Pyrifrom, and L-49 took approximately 137, 110 and 106 to 138 days respectively to reach maturity.

2.2 Ripening stage of guava

Yamdagni (1987) worked on the guava fruit cultivars sardar, Allhabad Safeda and Banarasi Surkha and they divided the fruit into different ripening stages viz. i) Green mature ii) Colour break iii) Deep Yellow color and iii) over ripe stages.

Scientist divided the ripening process into a set of stages. They defined the stages on the basis of the eminent external changes at the onset and during the progress of

ripening in the colour of skin. Reyes and Paul (1995) divided the ripening period into the following colour stages-i) Mature green ii) Quarter yellow iii) Half yellow.

2.3 Physical properties of guava

The guava includes about 150 species, but only a few have horticultural value. There are generally two kinds of guava. The common guava (*P. guajava*), the most important species is Cattley Guava (*P. cattlecianum*), which is also grown commercially. The plant is a shallow rooted sharb or small tree (3 to 10m), branching close to the ground and often producing sukers from the roots. The leaves are opposite, oblong, elliptic and hairy beneath. Flowers are bisexual, white and 2.5 cm in diameter, brone on new growth from mature branches, either singly or in clusters of two or three. The multiseeded, globose fruits is a fleshy berry.

The common guava has the scientific name *Psidium guajava* and is a part of the myrtly and eucalyptus family. The tree is small, with copper-coloured bark. It has leaves with many veins, and white or cream coloured flowers.

The fruit of the common guava varies in size and shape, but it is usually 4-8 centimeters (11/2-3 inches) long.

As the guava ripens, the outside skin changes colour from green to light green or yellow. The flesh of the fruit may be white, yellow, pink or red. Inside the fruit are many stone-like seeds.

Another kind of guava is the Cattley guava, also called strawberry guava or Cherry guava. It is quite different from the common guava and has the scientific name *Psidium Caffleianum*.

The leaves of the Cattley guava are smaller, shinier and darker green than those of the common guava. The fruit is also small, rarely growing to more than 4 centimeters (11/2 inches) long. It is usually red or radish purple. Inside are several

large, nut-like seeds. Both kinds of guava trees usually bear their fruit during the hot, rainy season.

Some of the important varieties are known by the name of the places where these are grown commercially. Thus Swarupkathi is from Barisal, Mukundapury from Brahmanbaria and Kanchannagar from Chittagong.

Guava cultivars display a great diversity in the tree size, bearing habit and yield, as well as in fruit size, flesh and skin colour, taste and flavour and ripening season. There are three main types of guava: processing-type cultivars produce strong acidic fruit with coloured flesh, dessert-type produce less acidic fruits with mostly white flesh and attractive skin colour, while dual purpose-types produce less acidic fruits that are a compromise between processing and dessert requirements [Mamun-ur Rashid and Muhammad Nurul Amin].

Kazi, introduce in Thailand, is the only standard variety that has been released by the Bangladesh Agricultural Research Institute. It produces fruit weighing up to 500 g or even more. All other varieties have fruit weights ranging from 100 to 200 g.

Ullah *et al.* (1992) conducted an experiment at RaRa, Akbarpur Moulavibazar on physico-chemical characteristics on the fruits of nine guava cultivars. From the experiment it was found that Kazi piara was very large in size and weight (9.5cm × 8.59cm and 446.3g respectively) among the varieties. Weight of rest of the fruits ranged from 68.8 to 165.5g and size varied from 4.95cm, 4.66cm to 6.75×6.35cm. Number of seeds per fruit ranged from 222.2 to 426.8 minimum number of seeds was in Kanchan nagar and maximum number was in Kashi piara. Percent edible portion was the highest in Kazi piara (98.23%) and lowest in Syedi (96.65%)

Azad *et al.* (1987) conducted an experiment on physico-chemical characteristics of fruit of some guava varieties at BARI. The data indicated that Kazi piara produced significantly bigger fruits than other varieties.

Kazi piara was 505.10g in weight and 10cm×9.6cm in size, whereas weight of the ranged from 139.9 to 153.7g in rest of varieties. The minimum number of seeds per 100g fruits was found in Kazi piara (109.3) followed by Kanchannagar (206.0), Swarkathi (255.1), Mukundapuri (256.5 and Allahabad, Kanchannagar, Mukundapuri were yellow when ripe except Kazi less smooth except that of Kanchannagar, which was rough . 1000 seed weight was the highest in Kazi piara (121g) followed by Allahabad (103g) Swarupkathi (9.2g. the highest percent edible portion was found in Kazi piara (98.96) whereas rest of the varieties ranged from 97.28 to 98.13.

Haque (1992) carried out an experiment at BAU, Mymensingh on the vitamin C and mineral constituents of eleven guava varieties of Bangladesh. Among the varieties, Kazi piara and Thai were varying large in size and weight (424.77g and 388g), respectively. It is due to there genetical character. Soil fertility, management practices and environment also influenced fruit size.

Mitra *et al.* (1983) conducted an experiment on physico-chemical composition of fruits of some guava cultivars and found that fruit weight of Allahabad and luck now-49 were 86.160g and 95.8-145.0g, respectively. Fruit lengths were 5.4-6.4cm and 5.8-6.6cm respectively.

Mitra *et al.* (1983) conducted an experiment on physico-chemical composition of fruits of some guava varieties of west Bengal and found that lucknow-49 was superior in yield, fruit and weight among the varieties.

Islam *et al.* (1993) observed that fruit of Kazi piara is the most imported piara in Bangladesh were hand thinned (0, 25, 500, and 75% fruit per plant) when the fruit weight was about 20g , to leave remaining fruit uniformly distributed throughout the tree.

Yousof (1990) carried out an experiment on physico- chemical characteristics some guava varieties of Malaysia. Most of the local cultivars had diameter from 4.8 to

6.7cm and monocarp from 09 to 1.5cm, but the introduced varieties had diameter from 10 to 11cm and monocarp form 1.9 to 2.5cm. Monocarp colour of fruit varied from pink to red or white.

Shanker (1967) studied the ripe fruit of five guava varieties and found that fruit weight ranged from 81.0g in seedless to 163.0g Allahbad Safada, seeds per fruit were 4 in. seedless, 230 (Luchknow-49), to 521 (hafsi) in other fruit seeded variety.

Dhillon *et al.* (1987) conducted two seasonal trials on Allahabad Safeda and sardar and found that the pattern of fruit development in both cultivars followed a double sigmoid curve during both winter and seasons. Fruit length diameter and weight were more in winter season than in rain season. Specific gravity of the fruit in both cultivars were decreased from fruit set until harvest.

Zaman (1996) studied the effect of fruit thinning and use of growth regulator on the yield and quality of Kazi piara at the Bangladesh Agricultural University Mymensingh. It was reported that the size and weight of individual fruit were maximum (255.7g) when 75% fruits were thinned.

2.4 Nutritive value

The guava significantly contributes to the nutrition of the people of this country. Guava contains nutritional value five times more than orange. The guava is a good source of Vitamin C and fibers in the pacific.

A seasonal (July-September) fruit, guava is rich in vitamin C (200-300 mg/100), carbohydrate, protein, iron, calcium and phosphorus and can be eaten fresh or processed to make guava juice, to prepare the juice for bottling, guava drink, guava sauce, guava milkshake, guava dumplings, guava Jelly, guava puree, stewed guava and dairy or bakery items. Besides fruits, the young leaves and root bark are used in local medicines [Mamun-ur Rashid and Muhammad Nurul Amin].

The amount of vitamin C found in guavas varies greatly, but one small common guava usually has nearly four times the amount of vitamin C needed by the children and adults for one day

El-Zorkani (1968) carried out an experiment to determine vitamin C content of pink fleshed, white and seedless guava at various stage of development. The pink fruits were found to contain more vitamin C than other varieties. The outer flesh of the fruit content more vitamin C than inner pulp. In pink fruit, vitamin C was decreased after ripeness had been attained. The similar result obtained in seedless fruit.

Palaniswamy and Shanmugavelu (1974) conducted on 11 varieties of guava and found that Anakaplti had the highest vitamin C content of 392mg/100g fresh fruit.

El-Buluk *et al.* (1997) stated that ascorbic acid was increased significantly with fruit maturity. Yamdagni (1987) also found the similar result with the cultivars sardar, Allahabad Safeda and Banarasi Surkha.

Esteves *et al.* (1984) carried out an experiment and stated that vitamin C was increased in all the cultivars during ripening and decreased during senescence.

Phandis (1970) analyzed the guava fruit to find out its composition and reported that the fruit contained 260mg vitamin C per 100g fruit, which differed with the variety, stages of maturity, ripening and season.

Pozo *et al.* (1983) reported that ascorbic acid content of samples ranged from 69.28 to 74.76-mg/100g) pulps. Nag (1988) reported that Kazi piara contained (318.28mg/100g), Local (257.30) and Swarupkathi (205.58mg/100g) at matured stage.

Azad *et al.* conducted an experiment at BARI, Gazipur and found the highest vitamin C in Kazi piara (202.4gm/100g) followed by Allahabad (165.2mg) Swarupkathi and Mukundapur (116.2mg).

2.5 Chemical composition

Yusof (1990) carried out an experiment of physico-chemical character ranged from teristics of some guava varieties of Malaysia stated that moister content of the fruits ranged from 79.2 to 85.9%.

El-Buluk *et al.* (1995) conducted an experiment on biochemical and physical changes of four Guava cultivars-Ganib, Pakistani, Shambati and Shendi during growth and development. They found that moister content was increased significantly with fruit growth and development in all cultivars and maximum of 76% in cv. Ganib.

Phandis (1970) worked on improvement of guava in India and reported that guava contained .48% ash, whereas in another experiment Wilson (1980) found 0.66% ash in guava. This difference might be due to varietals characteristics.

Nag (1998) carried out an experiment at the Bangladesh Agricultural University and observed the highest ash content in Swaruopkathi (90.475%) followed by Kazi piara (.46) and Mukundopuri (.48%), respectively at the mature stage.

Salma and Suhalila (1987) stated that titrable acidity fluctuated at maturity according to Tendon *et al.* (1983), White flashed guava contained 0.45% acidity.

Phandis (1970) observed that sadar guava contained acidity 2.45% Yusof (1990) carried out an experiment and stated that titratable acidity ranged from 0.26 to 0.52% in guava.

Rathore (1975) worked on the season on growth and chemical composition of guava fruits and stated that the acidity of guava fleshed ranged from 0.33 to0.99%.

Tripathi and Gangwar (1971) carried out an experiment on the bio chemical changes during maturity of guava and reported the acidity ranged from 0.342 to 0.408%.

Azad *et al.* carried out an experiment on the physico-chemical characteristics of fruits of some guava varieties such as Allahabad, Kanchannagar, Kazi piara, Mukundapur and Swarupkathi and found that TSS of fruits in the endocarp ranged from 10.8% in Swarupkathi to 13.2% in Mukundapuri. Ullah *et al.* (1992) carried out an experiment and found that TSS of fruit juice in the mesocarp varied from 7.1% in the Kazi piara to10.2%in Gu-oo8and in endocarp 10.7% in Kazi piara to 13.9% in Gu-008.

Palaniswami and Shanmugavelu (1974) while conducting an experiment in India with 11 varieties of guava that total soluble solid (TSS) varied from 4.0% in Lucknow-49 to 12.5% in smooth green and red fleshed fruits.

2.6 Storage

Josly *et al.* (1961) investigated that the effects of length and temperature of storage and relationship of oxygen, light, sugar, pH and ascorbic acid to deteriorative changes in colour of these factors. Storage temperature and oxygen content were the most specific for colour injury of both juices and isolated pigments. Exposure to light caused little deterioration in colour adjustment of acidity within the range of pH 2 to 4.5 or sugar addition had little effect on colour retention in fruit juices during storage.

Mitra (1997) studies on post harvest physiology and storage on tropical and subtropical fruits. He showed in his food that tropical and subtropical fruits are becoming increasingly important food items in countries where they are produced and also in an increasing number of importing countries in non-tropical areas. His book deals with the post harvest storage. Physiology and conservation of all of the economically important tropical and subtropical fruits. It should be of particular interest to all horticultural researchers' fruits. It should be particular interest to all horticultural researchers' exports and imports within the interest concerned with tropical and subtropical fruits.

2.7 Guava jelly

Desrosier (1977) reported that gel formation occurs only without certain range of hydrogen ion concentration, the optimum acidity figure for jelly being pH 3.2. the gel strength falls slowly on decreasing and rapidly on increasing the pH value. Beyond pH value 3.4 jelly formation occurs at the usual soluble solid range. The optimum concentration so sugar is about 67.5%, it is however possible to make jellies with high content of pectin and acid containing less than 60% sugar. Too high concentration of sugar results also in a jelly of stick consistency. The quality of pectin necessary to form a gel depends largely on the quality of pectin. One per cent should be sufficient to produce a firm jelly.

El-Mubarak *et al.* (1977) observed that by using 100 grade pectin solution from citrus waste/kg pulp Guava good setting and flavor of jam manufacture from guava.

Stavrov *et al.* (1997) investigated that the effect of 0.30 to 50.35% NaCl to the jellies produced from the sugar solution and syrups with citric acid resulted in 25% reduced composition of jelling agents, the physical and sensory properties of jellies as well as there resistance to the unfavorable action of acids at high temperature remained unchanged. Parashkova (1932) conducted that, fruit jelly manufacture with low sugar content preserved well. The aroma and flavor of fresh fruit due to shorter heating time.

Donchonka *et al.* (1983) observed that at pH 6.0the strength of jam/jelly was 4 kpa; increasing citric acid concentration resulted in increased jelly (strength) at pH 3.2the strength was 40.0 kpa and at pH (2.8 it was 53.2 kpa). pH values in the range 2.8-3.2 are considered optimum for maximum strength of jelly.

CHAPTER III

MATERIALS AND METHODS

The experiment was conducted in the laboratory of the Department of Food Technology & Rural Industries, Faculty of Agricultural Engineering and Technology, Bangladesh Agricultural University, Mymensingh-2202, during the period 'July -December' 2011.

3.1 Materials

The experimental materials guava and citric acid were collected from the Local Market of Mymensingh. The guavas were carefully chosen in order to obtained the optimum maturity because its pectin contain depends on maturity. Sugar, citric acid and relevant materials required for the experiment were received from the laboratory stocks.

3.2 Methods

3.2.1 Extraction of guava juice

Fresh guava was weighted and washed thoroughly in cold water. The washed guava was cut into several small pieces with a stainless steel knife. Then 1 kg of guava pieces was boiled in 1 liter of water. The boiled pieces were crushed and strained through a thick cloth to remove the suspended matter consisting of fruit tissue, seed, skin, gums and protein in colloidal form. The strained juice was then preserved in a deep freeze at -10°C for future use.

3.2.2 Formulation and preparation of guava juice

Table 3.1: Formulation and preparation of guava juice

Ingredients (in % based on Final product weight)	A	B	C
Extracted guava juice	20	26	32
Sugar	13.00	15.00	17.00
Acid (as citric acid)	1.10	1.15	1.20
Preservative	100 ppm KMS	250 ppm Na-benzoate	(100+250) ppm KMS+Na-benzoate

The strained guava juice sugar, acid and water are calculated according to the guava juice formulation. Calculated amount of sugar and water are mixed and boiled to make syrup. The extracted guava juice are then added and homogenized.

The juice is then filled in a glass-bottle. The can or bottle with content is then heated to boiling for another 20 minutes. The juice bottle is then cooled, labeled and stored for further studies.

3.2.3 Formulations and preparation of guava jelly

Table 3.2: Formulation and preparation of guava jelly

Ingredients (in % based on Final product weight)	Formulations		
	A	B	C
Guava juice	45	45	45
Sugar (Sucrose:Glucose)	55 (1:1)	55 (1:2)	55 (1:3)
Acid (as citric acid)	1.10	1.15	1.20
Pectin	0.015	0.20	0.30

The extracted guava juice is used to prepare the guava Jelly. The standard conventional formula is used for the preparation of Jelly. The amount of guava juice, water, pectin, acid and sugar are calculated according to the formulation. The pulp, pectin, water and small amount of calculated sugar are then mixed and for 3-5 minutes under agitation. Heating is continued and the rest of sugar was then added. The end point is indicated by 65-68 per cent Total Soluble Solids in the mixture is determined by Refractometer. The Jelly is then filled in a glass jar. It was then covered with melted wax and cooled. After cooling the cans or jars are labeled and stored for further studies.

3.3 Chemical analysis

The fresh sample of matured guava, guava juice and guava Jelly were analyzed for moisture, ash, vitamin-C (ascorbic acid), total soluble solid, pH, titrable acidity,

reducing sugar, non- reducing sugar and total sugar content as per the methods of Ranganna (1992).

3.3.1 Moisture content

5 gm fruit was taken in crucible and placed in an oven at 80°C for72 hours until constant weight attained. Percent moister content was calculated using following formula:

$$\% \text{ Moister} = \frac{IW-FW}{IW} \times 100$$

Where,

IW = Initial weight of guava

FW= Final weight of oven dried peel

3.3.2 Total solids

Percent total solid content was calculated by using the data obtained during moisture estimation using the following formula:

Percent total solids = 100 – percent moisture content.

3.3.3 Ash content

Ash content is the inorganic residue remaining after destruction of organic matter. 10 g dried fruit was taken in a pre-dried weighed crucible. It was then burned to charcoal. The charcoal was then taken in a muffle furnace and heat at around 600°C for 4 hrs till the charcoal is completely removed. The crucible is then taken out of the furnace. Cool it in a desiccator carefully and then weighed.

$$\text{Ash content} = \frac{W_3-W_1}{W_2-W_1} \times 100$$

Where,

W_1 = The weight of dried empty crucible

W_2 = The weight of dried empty crucible with sample

W_3 = The weight of the crucible with ash

3.3.4 Vitamin C content

The reagents used for the estimation of vitamin C were as follows:

i) Meta phosphoric acid (3%)
ii) Standard ascorbic acid solution
iii) Dye solution

Standardization of dye solution: Five ml standard ascorbic acid solution was taken in a conical flask and 5 ml Meta Phosphoric acid (HPO_3) was added to and shaken. A micro burette was filled with dye solution then the ascorbic acid solution was treated by dye solution using phenolphthalein as an indicator, till the end point (light pink colour) is reached. The pink color will persists at least for 15 seconds. Dye factor was calculated using the following formula:

$$\text{Dye factor} = \frac{0.5}{titre}$$

Preparation of sample: 20 gm sample was taken in a blender and homogenized with 3% meta phosphoric acid and then the blended material was filtered. The filtrate was transferred to a 250 ml volumetric flask and the volume was made up to the mark with Meta phosphoric acid.

Titration: 5 ml of Meta Phosphoric acid extract was taken in a conical flask and titrated with standard dye solution, using phenolphthalein as an indicator. The end point will be light pink colour which persist at least for 15 seconds.

Vitamin C content was calculated by using the following formula:

$$\text{Vitamin C content} = \frac{T \times D \times V}{V_2 \times W} \times 100$$

Where

T = Titration

D = Dye factor

V_1 = Volume made up

V_2 = Volume of extract taken for estimation

W = Weight of sample taken for estimation

3.3.5 Titratable acidity

Fifty gm sample was taken in a blender and homogenized with distilled water, The blended materials were then filtered and transferred to a 250 ml volumetric flask and the volume was made up to the mark with distilled water. Five ml solution was taken in a conical flask and titrated with 0.1N NaoH solution using phenolphthalein as an indicator. The end point shows colourless to pale pink and will stand 15 seconds. The titration was done for several times for accuracy.

Percent titratable acidity was calculated using the following formula:

$$\% \text{ Titratable acidity} = \frac{T \times N \times V_1 \times E}{V_2 \times W \times 100} \times 100$$

Where,

T = Time

N = Normality of NaoH

V_1 = Volume made up

E = Equivalent weight of acid

V_2 = Volume of sample taken for estimation and

W = Weight of sample

3.3.6 Total soluble solids (TSS)

Total soluble solids of extracted juice were estimated by using Abbe refractometer. A drop of guava juice placed on prism of refractometer on its prism. Percent TSS was obtained directly from the scale of refractometer.

3.3.7 pH of fruit juice

Reagent:

Buffer solution of pH 4

Buffer solution: A buffer solution may be defined as a solution which maintains a nearly contain pH value respite the addition of substantial quantities of acid and base. Generally it consists of mixture of an incompletely dissociated acids and its conjugated base. Buffer solution of any known pH may be used.

Procedure (Potentiometer):

An electrolytic cell composed of two electrodes (calomel electrode and glass electrode) was standardized with buffer solution of pH 4. Then the electrodes were dipped into the test sample (guava juice and Jelly). A voltage corresponding to the pH of the solution indicated by the instrument.

3.3.8 Sugars

The sugar content in a food sample is estimated by determining the volume of the unknown sugar solution required to completely reduce a measured volume of Fehling's solution.

3.3.9 Preparation of Fehling's solution

Reasents:

1. Fehling's solution (A): Dissolve 69.28 g of copper sulphate ($CuSO_4$.$5H_2O$) in water, dilute to 1000 ml and if necessary, filter through No. 4 Whatman paper.
2. Fehling's solution (B): Dissolve 346 g of Rochelle salt (potassium sodium tartrate, $KNaC_4H_4O_6$. $4H_2O$) and 100 g NaOH in water and make up to 1,000 ml.
3. Methylene blue indicator: Dissolve 1 g of methylene blue in 100 ml of water.
4. 450% Neutral lead acetate solution: Dissolve 225 g of neutral lead acetate in water and dilute to 500 ml.

5. 22% Potassium oxalate solution: Dissolve 110 g potassium oxalate ($K_2C_1O_4$. H_2O) in water and dilute to 500 ml. An excess of lead acetate in the sugar solution will result in an error in the titration. Determine the exact amount of potassium oxalate solution necessary to precipitate the lead from the lead acetate solution. To obtain this value, pipette 2-ml aliquots of the lead acetate solution into each of six 50-ml beakers containing 25 ml water. To the beakers, add 1.6, 1.7, 1.8, 1.9, 2.0 and 2.1 ml potassium oxalate solution respectively. Filter each through a 41H Whatman paper and collect the filtrate in a 50-ml conical flask. To each of the filtrates, add a few drops of potassium oxalate solution. The correct amount of potassium oxalate required is the smallest amount which, when added to 2 ml of lead acetate solution, gives a negative test for lead in the filtrate. In the presence of lead, the filtrate gives white precipitate with HCl or yellow precipitate with potassium chromate solution. The equivalent volume should be marked on the bottle and employed when the solution is used in sugar determinations.
6. Standard invert sugar solution: Weigh accurately 9.5 g of AR sucrose into a 1-litre volumetric flask. Add 100 ml water and 5 ml conc HCI. Allow to stand for 3 days at 20-25° C or 7 days at 15° C for inversion to take place, and then make up to mark with water. This solution is stable for several months.

Pipette 25 ml of the standard invert solution into a 100-ml volumetric flask and add about 50 ml water. Add a few drops of phenolphthalein indicator and neutralize with 20% NaOH until the solution turns pink. Acidify with 1 N HCl adding it dropwise until one drop causes the pink colour to disappear. Make up to mark with water (I ml = 2.5 mg of invert sugar)

Standardization of the Fehling's Solution

Mix equal quantities of Fehling's solutions (50 nil of A and 50 ml of *B).* Accurately pipette out 10 ml of the mixed solution into a 250-ml conical flask. Add 25 to 50 ml of water. Take the standard invert sugar solution prepared by inversion of sucrose in a 50-ml burette. Add to the mixed Fehling's solution almost the whole of the standard invert sugar solution (18 to 19 nil) required to effect the reduction of all

the copper, so that not more than 1 ml will be required later to complete the titration. Heat the flask containing the cold mixture over a hot plate or burner covered with asbestos filled wire gauze. When the liquid begins to boil, keep it in moderate ebullition for 2 min. Without removing from the flank, add 3 drops of methylene blue indicator solution and complete the titration in a further one minute, so that the reaction mixture boils altogether for 3 min without interruption. The end point is indicated by the decolourization of the indicator. Note the volume of the sugar solution required for completely reducing 10 ml of Fehling's solution. The equivalent volume should be 20.37 ± 0.05 ml. Small deviations front the tabulated factors may arise front variations in the individual procedures or composition of the reagents. If the variation is too wide, adjust the concentration of the Fehling's solution such that the equivalent volume of neutralized sugar solution for 10 ml of Fehling's solution is 20.37 ± 0.05 ml.

$$\text{Factor for Fehling's solution} = \frac{Titre \times 2.5}{1000}$$

(g of invert sugar)

3.4.1 Preparation of Sample

***a. Fruit juices*:** Weigh 25 g of filtered (Whatman No. 4) juice and transfer to 250-ml volumetric flask. Add about 100 ml of water and neutralize with 1 *N* NaOH. Add 2 ml of lead acetate solution. Shake and let it stand for 10 min. Add the necessary amount of potassium oxalate solution to remove he excess of]cad, make up to volume with water, and filter.

Fruit jellies: Place 50 g of the blended jam in a 500-ml husker and add 400 ml of water. Neutralize the soution with IN NaOH using phenolphthalein indicator. Boil gently for 1 hr with occasional stirring. Add boiling water to maintain *the* original level. Cool and transfer to a 500-nil volumetric flask. Make up to volume and filter through No. 4 Whitman paper. Pipette a 100-ml aliquot into a 500-ml volumetric flask. Add 2 ml of neutral lead acetate solution and about 200 ml of water. Let it

stand for 10 min, then precipitate the excess of lead with potassium oxalate solution. Make up to mark and filter.

3.4.2 Procedure: Reducing Sugar

Standard method of titration: Pipette 10 ml of mixed Fehling's solution into each of two 250-tal conical flasks. Fill the 50-ml burette with the solution to be titrated. Run into the flask almost the whole volume of sugar solution required to reduce the Fehling's solution, so that 0.5 ml to 1.0 ml is required later to complete the titration. Alix the contents of the flask, heat to boiling and boil moderately for 2 min. Then add 3 drops of the methylene blue solution, taking care not to allow it to touch the side of the flask. Complete the titration within 1 min by adding .2 to 3 drops of sugar solution at 5 to 10 sec intervals, until the indicator is completely decolorized. At the end point, the boiling liquid assumes the brick-red colour of precipitated cuprous oxide, which it had before the indicator was added, Note the volume of the solution required.

3.4.3 Total sugars

Pipette 50 ml of the clarified solution into a 250-ml conical flask. Add 5 g of citric acid and 50 ml of water. Boil gently for 10 min to complete the inversion of sucrose, then cool. Transfer to a 250-ml volumetric flask and neutralize with 1 N NaOH using phenolphthalein as indicator. Make up to volume.

For inversion at room temperature, transfer 50 ml aliquot of clarified and deleaded solution to a 250-ml flask. Add 10 ml of HCI (1+1) and allow to stand at room temperature (20° C or above) for 24 hr. Neutralize with cone N.OH solution and make up to volume.

Take an aliquot and determine the total sugars as invert sugars.

CALCULATION

a = % Reducing sugars = $\frac{mg\ of\ \ Invert\ sugar \times Dilution \times 100}{Titre \times We\ or\ volume\ the\ sample \times 100}$

b = % Total sugars as = Calculate as in (a) making use of the titre value obtained in the determination of total sugars after inversion

c = % Total invert sugars-% Reducing sugars originally present × 0.95

d = % Reducing sugars + % Sucrose

% Reducing sugars = $\frac{Faactor \times Dilution \times 100}{Titre \times Wt\ or\ volume\ of\ \ the\ sample}$

3.5 Storage studies of guava products

The prepared guava juice and jellies were bottled and stored at room temperature (29-33°C) and R.H. 80-85% for three months. Then stored for three month at room temperature (29-33°C) and R.H. 80-85%. The bottles were opened at every 15 days interval to determine its pH, TSS, acidity and moisture content.

3.6 Measurement of sediment

Same size and same brand bottles were utilized to determine sediment of bottled juice. The settling behavior was observed and sediment was measured in cm by subtracting the clear juice volume on the top of the bottle from the whole juice volume of the bottle at an interval of 15 days until settling was stable.

3.7 Microbiological examination

Bacterial plate counts (Pour Plate Method)

Total viable bacterial count was done through the Standard Plate Count (SPC) technique (Pour Plate Method).

3.7.1 Sample preparation

The reliability of the analysis and interpretation of the results depend largely on the correct manner in which the sample is taken. The sample should be a true representative of the whole mass. For this purpose the product is thoroughly well mixed so that sample would be the representative of the whole mass of the products. 25 g of this well mixed guava products were taken in 250- ml flask. Phosphate buffer water (0.6mM KH_2 PO_4 7.2) was used for dilution of the sample. About 100 ml of the buffer water was added to the beaker and mixed well by up- and down or to-and-fro movement. The volume was made up with the same buffer water. All the apparatus, solutions and other tools used should be sterilized i.e. heated at 121^{o}C for 15 minutes. The prepared sample is new become diluted to 10 times i.e. 1×10^{-1}times dilution and used as stock solution.

3.7.2 Dilution

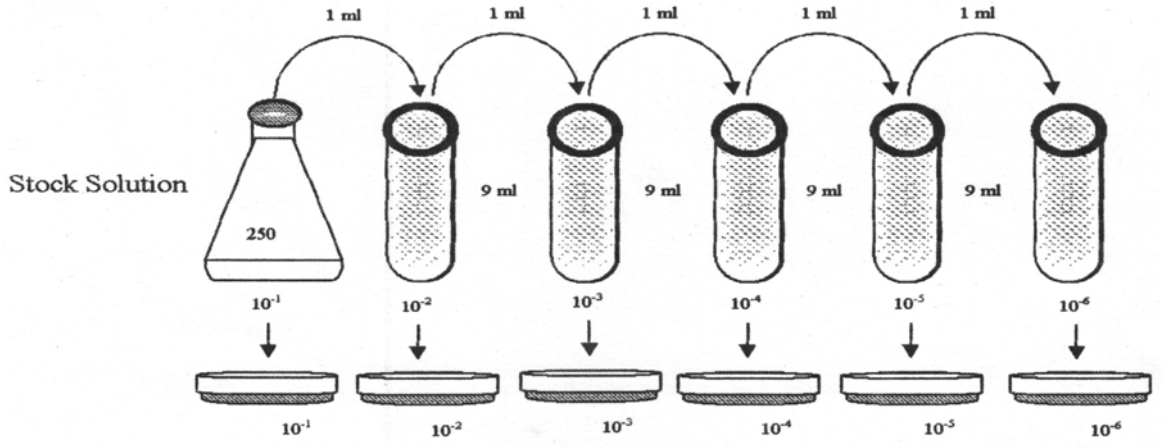
A series of dilution were made as follows using 9 ml blanks

a) The initial $^{1}/_{10}$ dilution (1 ml in 9 ml) was performed

b) This was mixed in a vortex mixer

c) 1 ml from (b) was taken, added to the next tube and mixed well. It was become 10^{-2} time's dilution.

In this way, the dilution was made up to10^{-6} times. The scheme is shown as in fig. 3.1.



Dilution as plated

Fig. 3.1. Simple serial dilution series using with 9 ml blanks along with plating.

3.7.3 Standard plate counts (SPC)

A SPC (or aerobic plate count [APC] is used to determine the level of microbes in the prepared and stored guava products. This data could be used as the indicators of food quality or predictors for the shelf life of the product. Using a sterile pipette, 1 ml of the diluted sample was then taken into each of the sterile empty Petri dishes having nutrient agar media (approximately 10-20 ml) at a temperature of 45°G. Plates were mixed by swirling on a flat surface. Each dilution was plated in triplicate. After solidification of the media the plates were inverted and incubated at 37 °C for 24 hrs. in an incubator.

3.7.4 Counting and recording

After incubation the incubated plates were selected for counting the bacterial colony based on the number and easy of counting of the colony. The plate containing segregated, overlapping and confusing colonies was avoided. The plates containing 30 to 250 bright, cleared and countable colonies were selected.

Number of colony forming unit (cfu)/g or ml. = average cfu/plate x dilution factor.

The viable bacterial count was done through the steps of sample preparation, sample dilution, standard plate counts and counting and recording. The incubation was performed at 37°C for 24 hrs. Methods and technique are followed as described by Ranganna (1991), AOAC (1984), Harrigan (1998) and Nickerson & Sinskey (1977).

3.7.5 Determination of Yeast and mold count

Yeast and mould count of guava juice and jelly were done according to the method as described in the “Recommended Method for the microbiological Examination of Food” (APHA, 2011).

Preparation of media

In this potato Dextrose Agar (PDA) was used to enumerate the yeast and mould count of guava juice. The media was prepared in the laboratory according to the method described in the "Laboratory Manual, Method of Analysis of Milk and Milk Products" (Milk Industry Foundation, 1964). The formula of preparation of PDA media is given below:

Table 3.3: Preparation of media for yeast and mold count

Formula	
Infusion from 200 gm potato	1000 ml
Dextrose, commercial	20 gm
Agar	15 gm
Tartaric Acid, U.S.P. 10% solution sterilized	2.5ml/100ml

Two hundred g of previously peeled and sliced potato was taken in 1000 ml of distilled water and boiled for an hour. After boiling, straining was done through double thickness of a clean cloth. Volume was restored to origin. Then 20 g of commercial dextrose and 25 g agar were added to the potato infusion solution. Later, for complete dissolution the mixture was heated and dispersed into several 200 ml screw cap bottles and sterilized at 121°C (6.795 kg pressure/sq. inch) for 20 minutes. The media was then stored at refrigeration temperature. Before pouring into Petri dishes the media was melted through boiling and around 2.5 ml of 10% tartaric acid was added per 100 ml of media (at 45°C) to reduce the pH value to 3.5 ± 0.1.

Incubation of colony counting

After solidification of agar, the plates were inverted and incubated at 25^0C for 5 days. After incubation, the plates were taken out from the incubator and clines were counted. Yeast colonies were characterized by there smooth, moist and elevated surface, where mold colonies were identified by there profuse growth of hyphae.

Finally, the colony number was multiplied by the dilution and the counts per gram of sample were recorded.

3.8 Sensory evaluation of guava products

The symmetry and the characteristics of guava products (Jam, Jelly and Juice) prepared from different formulations were evaluated for its quality attributes such as colour, flavour and texture and also the overall acceptability through a taste-testing panel. The panelists were selected from the teachers, students and employees of the Department of Food Technology and Rural Industries on the basis on their ability to detect differences and showing consistency in their discrimination. The single stimulus method of testing was followed in the evaluation procedure (Kramer and Twigg, 1962). Each of the prepared guava product was coded as A, B, C & D and presented to each judge along with an evaluation score card (sample of the card is given in Appendix-I.) for evaluation of the quality attributes of the product. The panelists were asked to differentiate the prepared Jam, Jelly and Juice through their degree of choice or acceptability on quality attributes of the product. After tasting the sample, choice or acceptability is given by checking one of the nine possible answers which constituted the scale of choice or acceptability ranging from "like extremely" to "dislike extremely" and were also asked to grade among the samples in respect of colour, flavour, texture and also for overall acceptability. The scoring point was predetermined as - like extremely = 9, like very much =8, like moderately =7, like mildly = 6, Neither like nor dislike = 5, dislike mildly = 4, dislike very much =3, dislike moderately = 2 and dislike extremely = 1. The score cards were collected and a contingency table was made. The preferences or choices of their acceptability on the quality attributes of individual sample were analyzed statistically for any difference among the samples of the products.

CHAPTER IV

RESULTS AND DISCUSSION

4.0 Proximate analysis

Fresh guava, prepared guava juice and jelly were analyzed for its proximate composition. The results are tabulated in a Table 4.1.

Table 4.1: Chemical constituents of guava and guava products

Chemical components per 100 g edible portion	Fresh guava	Guava juice	Guava jelly
Moisture (%)	84.2	97.17	27.17
Total soluble solids (T.S.S)	12.50	21	67
Ash	0.51	0.91	0.69
Reducing sugar (%)	4.45	4.41	29.1
Non-reducing sugar (%)	5.23	17.95	8.23
Total sugar (%)	9.68	22.36	37.33
Ascorbic acid (Vitamin C) (mg/100 ml)	93.2	11.63	9.21
Acidity (%)	1.25	0.56	0.31

The chemical components of fresh guava are more or less similar to that reported by US department of Health Education and Welfare (1972). The department reported that guava contain 80.61 moisture, 0.4% pectin, 4.5% reducing sugar, 3.5% non- reducing sugar, 8.9% total sugar, 0.7% total ash, 1.28% acidity, 19% TSS. The small variation may be due to the inefficient measurement or instrumental error. In component guava in this study may be due to the varietal difference, soil nutrients and composition of the growing area and or inefficient measurement or instrumental error. It is noted here the variety of guava cultivar used in this experiment is unknown.

The higher amount of sugar in prepared juice and jelly is due to the addition of extra sugar and reducing sugar in the formulation.

4.1 Guava juice

Guava juice was prepared with three different types of formulations and evaluated for its chemical formulations and acceptability during 90 days storage period at room temperature. The chemical constituents were determined and summarized in Table 4.1.

The pH content of guava juice decreased gradually with the increase of storage days at room temperature (28-30^{o}C). However, the difference of pH was not statistically significant (P>0.01). The pH of guava remained higher at room temperature as on the day of preparation. This may be due to the fermentation of added sugar into alcohol and carbon dioxide during the storage period.

The difference of acidity was also found in different storage period (Table 4.2). The lowest pH at highest storage time support the results. The higher acidity may be due to the further fermentation of alcohol produced from sugar fermentation and may be due to the addition of citric acid into the guava juice. The preservatives of Sodium Benzoate and KMS may contribute acidity by the production of benzoic acid and sulphurous acid in the guava juice.

Table 4.2: Chemical constituents of guava juice during storage time

Chemical components		Storage in days						
		00	15	30	45	60	75	90
Moisture (%)	A	73.42	73.75	74.25	74.51	75.07	75.76	76.23
	B	73.60	73.93	74.43	74.69	75.25	75.94	76.41
	C	73.16	73.43	73.93	74.19	74.75	75.44	7.91
TSS	A	21.0	21.0	21.0	21.0	20.86	20.78	20.65
	B	21.5	21.5	21.5	21.5	21.36	21.27	21.17
	C	21.5	21.5	21.5	21.5	21.45	21.25	21.12
Ash	A	0.26	0.27	0.27	0.28	0.28	0.28	0.29
	B	0.65	0.66	0.66	0.67	0.67	0.67	0.68
	C	0.91	0.92	0.93	0.94	0.94	0.95	0.95
Acidity (%)	A	0.56	0.56	0.56	0.56	0.66	0.61	0.71
	B	0.62	0.62	0.62	0.62	0.62	0.67	0.82
	C	0.08	0.08	0.08	0.08	0.18	0.23	0.38
pH	A	2.94	2.94	2.94	2.94	2.89	2.84	2.74
	B	2.89	2.89	2.89	2.89	2.89	2.79	2.84
	C	2.86	2.86	2.86	2.86	2.81	2.77	2.58
Reducing sugar	A	4.41	4.41	4.41	4.41	4.56	4.62	4.65
	B	4.21	4.21	4.21	4.21	4.25	4.33	4.40
	C	3.94	3.94	3.94	3.94	3.97	3.01	3.04
Non-reducing sugar (%)	A	17.95	17.95	17.95	17.95	18.0	18.1	18.45
	B	17.75	17.75	17.75	17.75	17.8	18.0	18.1
	C	17.9	17.95	18.0	18.05	18.1	18.23	18.47
Total sugar (%)	A	22.36	22.36	22.36	22.36	22.51	22.56	22.62
	B	21.96	21.96	21.96	21.96	21.11	21.16	21.23
	C	20.94	20.94	20.94	20.94	21.09	21.14	21.21

The TSS of juice decreasing very slowly with the increase of storage time. TSS of formulation A, B and C reduced by 0.35, 0.23 and 0.28 percent respectively during three months of storage changed slightly after 45 days storage and the TSS of samples A (KMS 100 ppm) and B (Sodium Benzoate 250 ppm) change slightly after 60 days storage. The change is very negligible and may be due to mechanical and technical error.

The preservatives (KMS and Sodium Benzoate) were used for the preservation of juice. It might be stated that all the samples using the preservatives (Sodium Benzoate 250 ppm and Sodium Benzoate 250 ppm + KMS 100 ppm) were acceptable and maintained good quality during storage. The content of guava juice moisture increased with the increase of storage time. The increase of moisture content may be due to the hydrolysis of sugar into alcohol, carbon dioxide and water (Kabir, 2011).

The variation was observed in reducing sugar and non-reducing sugar at storage conditions. Remarkable increase in reducing and non-reducing sugar was observed after 90^{th} days of storage (Table 4.2). The percent of reducing sugar increased more than non-reducing sugar. The increase in reducing sugar might be due to the hydrolysis of sucrose. Total sugar increased slowly during 90 days storage period. Similar findings also reported by Ewaidah (1992) who observed that the reducing sugar was increased due to hydrolysis of sucrose.

Ash content was remained more or less same throughout the storage period. The amount of preservatives contributes the amount of ash in the formulation.

Vitamin C of the prepared guava juice was determined during the 90-days storage period and the results are shown in Fig. 4.1. The figure showed Vitamin C content decreased with the increase of stores days. Vitamin C content reduced to 20-35% during 3 month of storage. Quantitatively higher content of ascorbic acid/Vita. C was observed in the formulation higher amount guava juice was used. The results are supported by the findings of Achinewhu *et al.* (1994). Also reporter that ascorbic acid decreased with increase of storage time and quantitatively showed that it is reduced about 10-21% during 2 months storage of guava juice in plastic bottles. This may be due to the oxidation of Vitamin C along with other deteriorative factors. It is fact that Vitamin C or ascorbic acid is highly sensitive to oxidation, light and temperature. During the 90-days storage period this component of juice deteriorated rapidly due to above mention facts.

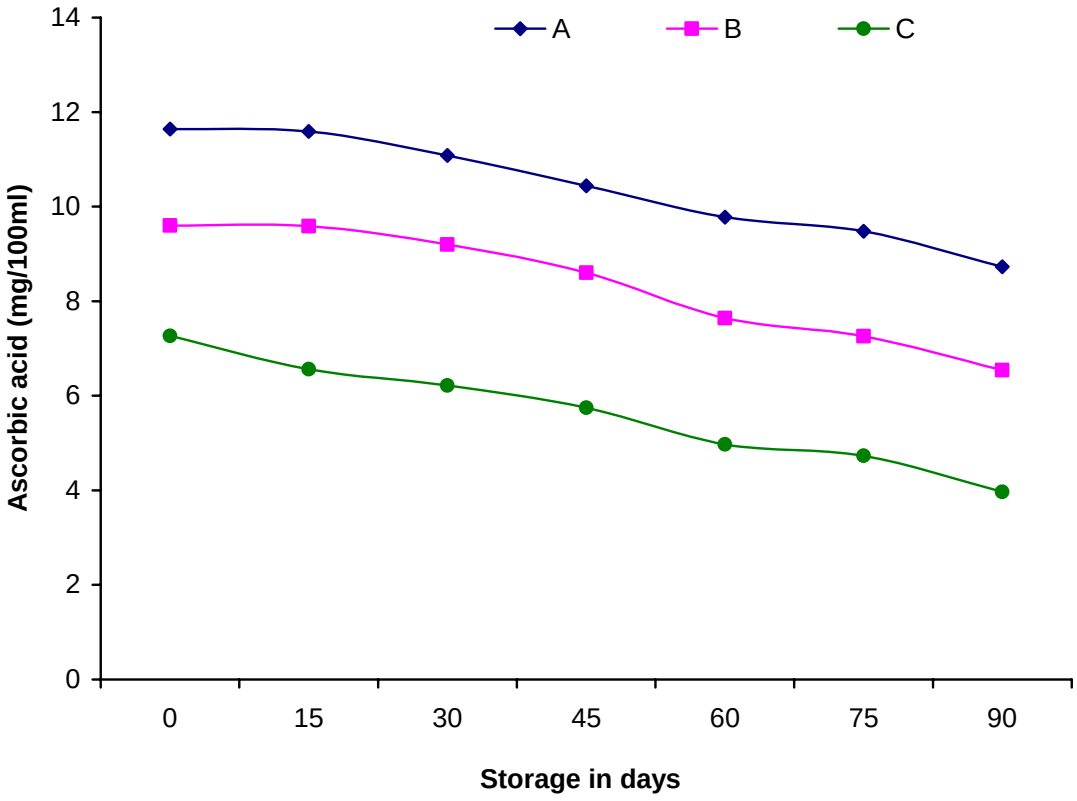


Fig. 4.1. Changes of ascorbic acid (Vitamin-C) during storage of guava juice

4.1.1 Sedimentation of juice

Sedimentation of pulp and undissolved solids start to settle after 30 days. The sediment settled gradually on the bottom of the bottle and at 60 days the sediment become stable there was no emulsifying or thickening agent was used in the juice and hence the insoluble pulps and other celluloses materials form the Sedimentation of the juice. This is the body of the fruit juice and is acceptable in western countries. If it would be shaken before use, then it seemed to be fresh homogenous juice.

Table 4.3: Settling behaviour of prepared guava juice

Storage Time (Days)	A			B			C		
	Length* of bottle juice	Length* of clear juice	Length* of sediment	Length* of bottle juice	Length* of clear juice	Length* of sediment	Length* of bottle juice	Length* of clear juice	Length* of sediment
0	16.5	0.0	16.50	16.5	0.0	16.50	16.5	0.0	16.50
15	16.5	0.0	16.50	16.5	0.0	16.50	16.5	0.0	16.50
30	16.5	2.5	14.00	16.5	2.0	14.50	16.5	0.7	15.80
45	16.5	4.0	12.50	16.5	3.5	13.00	16.5	1.5	15.00
60	16.5	5.5	11.00	16.5	4.5	12.00	16.5	1.5	15.00
75	16.5	5.5	11.00	16.5	4.5	12.00	16.5	1.5	15.00
90	16.5	5.5	11.00	16.5	4.5	12.00	16.5	1.5	15.00

*Length measured in cm

4.1.2 Microbial study of guava juice

4.1.2.1 Total viable bacteria in guava juice

This study was performed by standard plate count method. The viable bacteria load was not uniform. The total viable bacteria counts (cfu/ml) were counted. The total number of viable bacteria was determined by multiplying the colony- forming unit (cfu) with dilution number. The total numbers of viable bacteria in different samples have been shown in Fig. 4.2, 4.3, 4.4 and 4.5 Sample A (KMS 100 ppm) showed maximum total viable count and in sample C showed minimum viable count. The bacterial count in C (KMS 100 ppm + Sodium-Benzoate 250 ppm) was less than the samples preserved with different amount of preservatives during the three months of storage. The result indicated that KMS is less effective than sodium benzoate and combined effect of KMS + sodium benzoate.

There is no specific data for initial bacterial load of the guava juice, BSTI has recommended on the hygienic condition of preparing guava juice.

4.1.2.2 Mold and yeast in the guava juice

The number of mold and yeast was found in the guava juice have been shown in Fig. 4.4 and 4.5. The highest number of mold and yeast were found in sample A where 100 ppm KMS were used. The lowest number of mold was found in samples B, and C where 250 ppm sodium benzoate and 100 ppm KMS + 250 ppm sodium benzoate were used respectively. It has been observed that the 250 ppm Sodium Benzoate + 100 ppm KMS were more effective to inhibit the growth of mold and yeast. Sodium Benzoate and KMS are well known antimicrobial chemicals used as preservative to inhibit the growth and activity of microorganisom specially yeast mold and bacteria.

The result of microbiological study correspond to the study of Rangana and Baja (1966), they reported that SO_2 is widely used throughout the world principally in treating food of plant origin. It is used for the preservation of fruit juice to prevent microbiological spoilage. Defroster (1963) reported that microorganism could be killed by heating or irradiation.

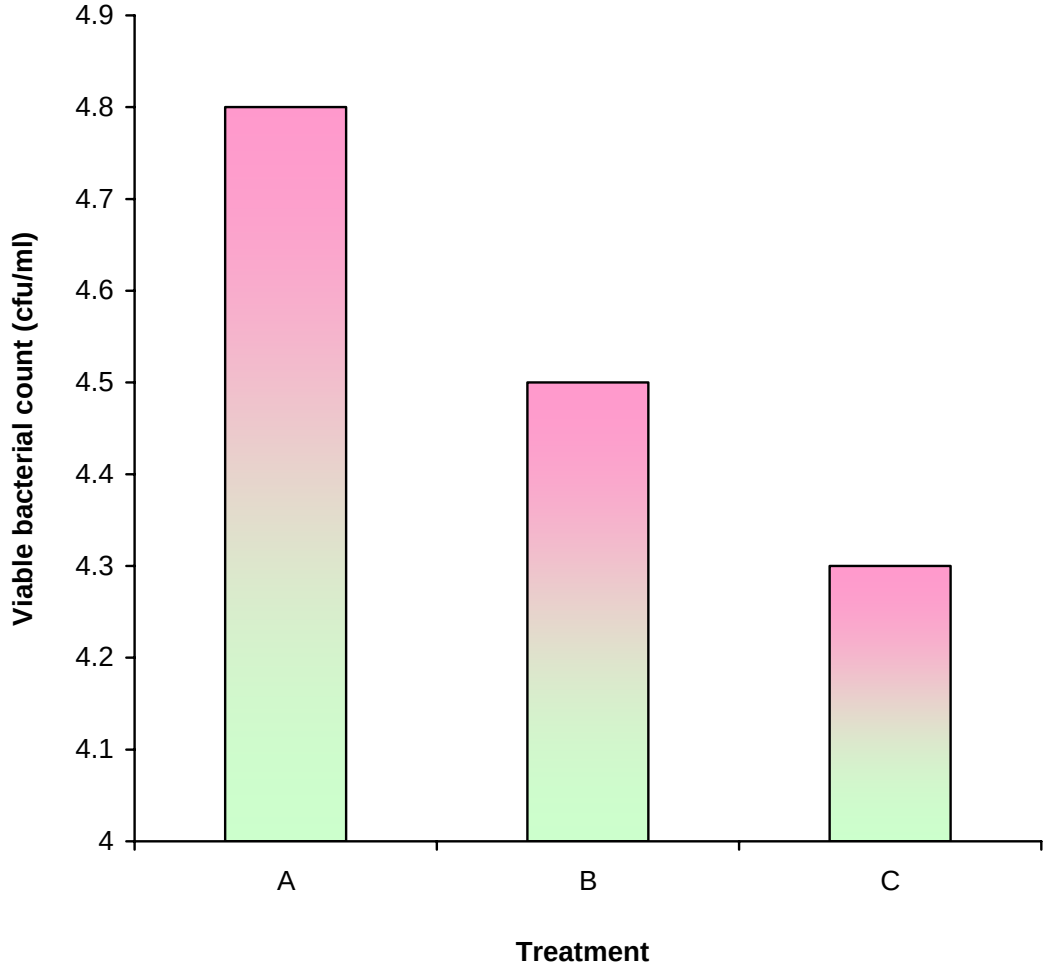


Fig. 4.2. Effect of different treatments on the growth of total number viable count bacterial count (Cfu/ml) of guava juice after 48 hrs of incubation at 32^{o}C

A = Juice contained KMS 100 ppm

B = Juice contained sodium Benzoate 250 ppm

C = Juice contained KMS 100 ppm + sodium Benzoate 250 ppm

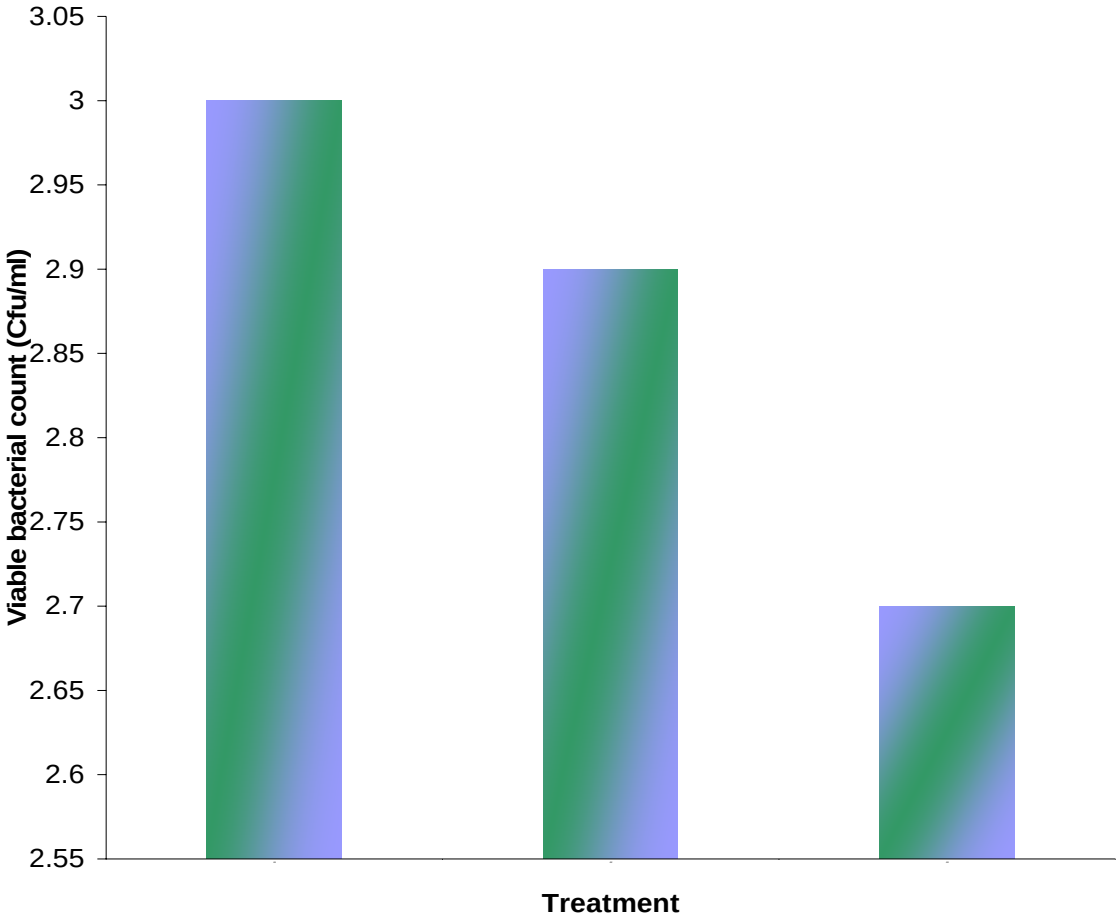


Fig. 4.3. Effect of different treatments on the growth of total number of mold count (Cfu/ml) of guava juice after 72 hrs of incubation at 32°C

A = Juice contained KMS 100 ppm

B = Juice contained sodium Benzoate 250 ppm

C = Juice contained KMS 100 ppm + sodium Benzoate 250 ppm

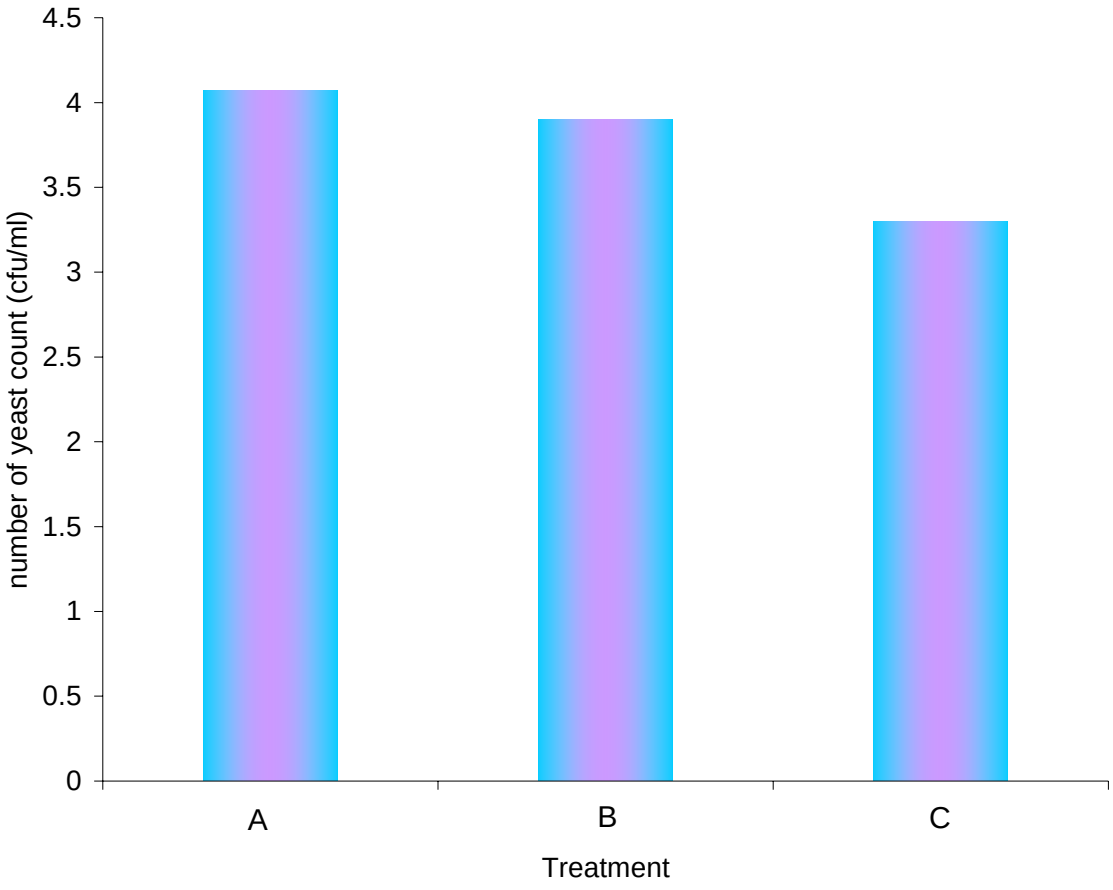


Fig. 4.4. Effect of different treatments on the growth of total number of yeast count (Cfu/ml) of guava juice after 72 hrs of incubation at 32°C

A = Juice contained KMS 100 ppm

B = Juice contained sodium Benzoate 250 ppm

C = Juice contained KMS 100 ppm + sodium Benzoate 250 ppm

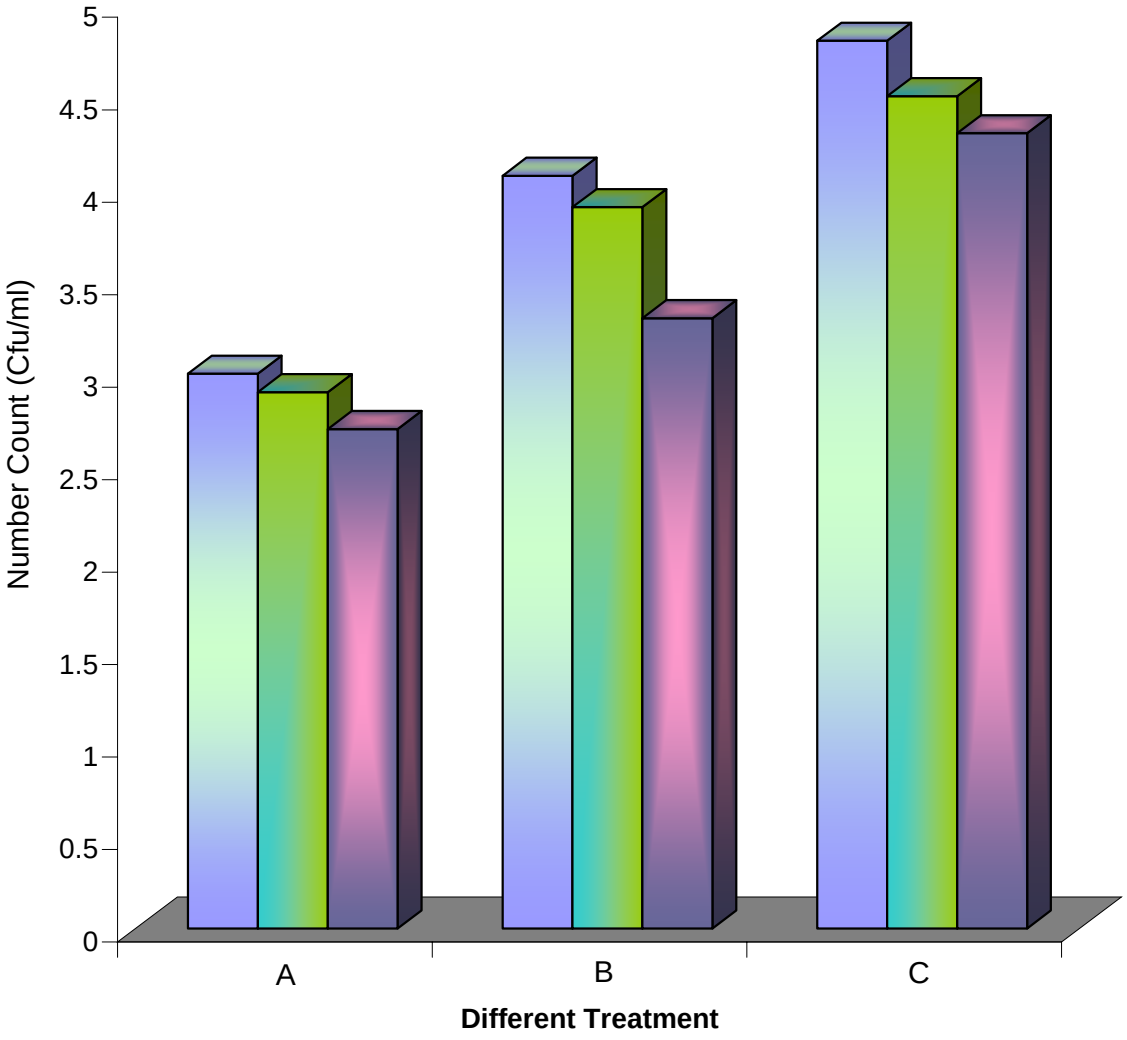


Fig. 4.5. Comparison of mold, yeast and total viable bacterial count (Cfu/ml) of guava juice for the effect of different treatments

A = Juice contained KMS 100 ppm

B = Juice contained sodium Benzoate 250 ppm

C = Juice contained KMS 100 ppm + sodium Benzoate 250 ppm

4.2 Guava jelly

The prepared guava jelly was analyzed for its different chemical components and the results are shown in Table 4.4. The adjusted components i.e. T.S.S., acidity and sugar remains more or less same throughout 90-days storage time.

Table 4.4: Chemical constituents of guava jelly during storage time

Chemical components		Storage in days						
		00	15	30	45	60	75	90
Moisture (%)	A	27.21	27.21	27.21	27.21	27.54	28.04	28.30
	B	23.14	23.14	23.14	23.14	23.47	23.55	23.97
	C	26.12	26.12	26.12	26.12	26.33	26.45	26.95
TSS	A	64.00	63.90	63.80	63.65	63.45	63.37	63.23
	B	67.00	66.95	66.81	66.56	66.40	66.25	66.15
	C	64.00	63.65	66.43	66.35	66.23	66.19	66.10
Acidity (%)	A	0.20	0.20	0.20	0.20	0.25	0.3	0.37
	B	0.31	0.31	0.31	0.31	0.36	0.38	0.44
	C	0.16	0.16	0.16	0.16	0.21	0.24	0.25
pH	A	2.75	2.75	2.75	2.75	2.71	2.65	2.60
	B	2.82	2.82	2.82	2.82	2.75	2.69	2.65
	C	2.87	2.87	2.87	2.87	2.81	2.76	2.71
Reducing sugar	A	26.40	26.40	26.40	26.40	26.45	26.50	26.55
	B	29.10	29.10	29.10	29.10	29.15	29.25	29.30
	C	27.50	27.50	27.50	27.50	27.55	27.57	27.65
Non-reducing sugar (%)	A	10.35	10.35	10.35	10.35	10.40	10.45	10.50
	B	8.23	8.23	8.23	8.23	8.28	8.33	8.38
	C	23.0	23.0	23.0	23.0	23.15	23.20	23.25
Total sugar (%)	A	36.75	36.75	36.75	36.75	36.80	36.85	36.90
	B	31.63	31.63	31.63	31.63	31.69	31.75	31.85
	C	47.30	47.30	47.30	47.30	47.35	47.40	47.45

The storage of jelly in glass container up to 3 months showed similar change of Vitamin C as juice.

Vitamin C or ascorbic acid of stored guava jelly was determined and the results are presented in Fig. 4.6. The figure showed that Vit. C decreased with the increases of storage days. Highest Vit. C was found on the day of preparation of guava jelly having higher amount of original guava juice. The results could be analyzed in same manner as was interpreted in case of guava juice.

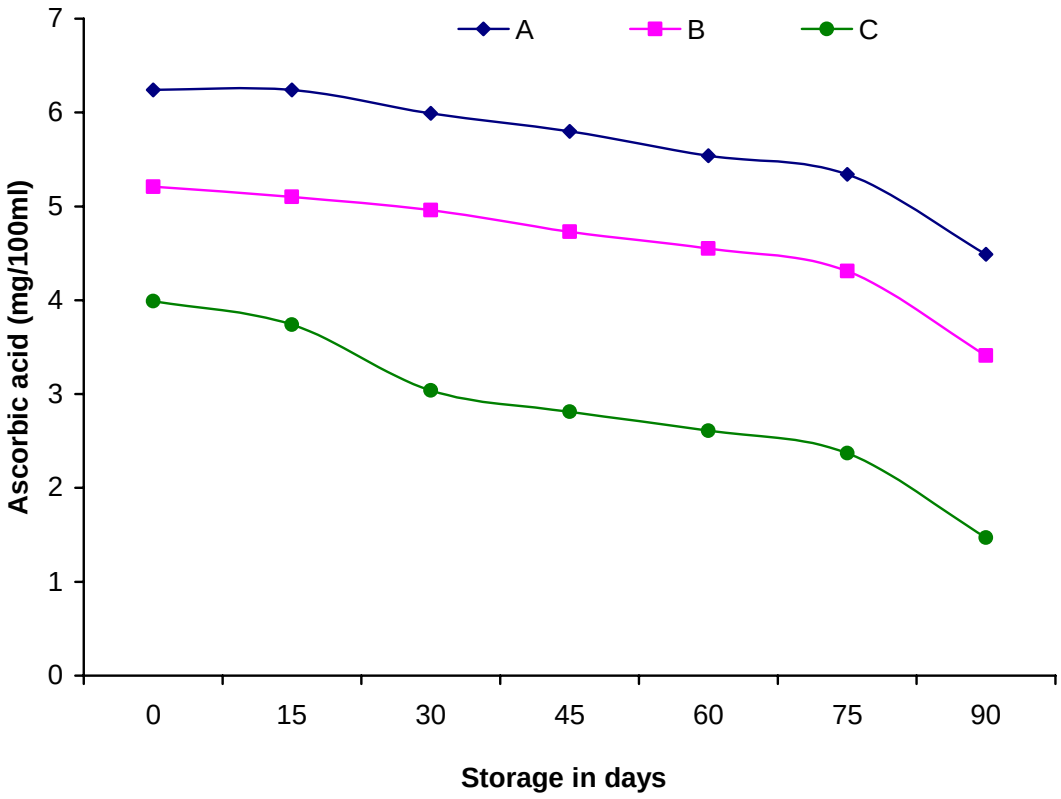


Fig. 4.6. Changes of ascorbic acid (Vitamin-C) during storage of guava jelly

4.3 Sensory evaluation of guava juice and jelly after 3 months of storage

The guava juices were preserved with different amount of preservatives. After three months of storage juices and jellies were evaluated for its acceptability and spoilage organoleptically by a 10 member taste testing panel. The responses and comments of test panelists on juice are tabulated and analyzed statistically for its variance during the storage period. The calculated variance ratio F_C and tabulated variance ratio F_T are arranged in a Table 4.5 and 4.6. The table shows that the calculated F_C value is always less than that of tabulated F_T values in case of panelists. This indicated that there is no variation among the panelists or judges. The calculated F_C value is greater than that of tabulated F_T value in case of Formulation. This means that there is a significant difference in formulation. The extent of variation among the formulation in respect of colour, flavour and acceptability is calculated following the DMRT test. The results are shown in Table 4.7 and 4.8.

The table showed that the formulation B has secured the highest score in respect of colour, flavour and taste and overall acceptability in case of guava juice but in guava jelly formulation C has got highest score in respect of flavour taste and acceptability. Hence, the formulation B for guava juice and formulation C for guava jelly may be recommended.

Table 4.5: Variance ratio of formulations and panelists on the different quality parameters of guava juice

Storage days	Source of variance	Quality parameters											
		Colour			Flavour			Taste			Acceptability		
		Variance ratio			Variance ratio			Variance ratio			Variance ratio		
		F_c	F_T		F_c	F_T		F_c	F_T		F_c	F_T	
			P≤0.05	P≤0.01		P≤0.05	P≤0.01		P≤0.05	P≤0.01		P≤0.05	P≤0.01
0	Panelists	1.60	2.46	3.60	2.00	2.46	3.60	1.78	2.46	3.60	2.00	2.46	3.60
	Formulations	15.00	3.55	6.01	6.00	3.55	6.01	4.33	3.55	6.01	3.58	3.55	6.01
15	Panelists	1.60	2.46	3.60	2.00	2.46	3.60	1.78	2.46	3.60	2.00	2.46	3.60
	Formulations	15.00	3.55	6.01	6.00	3.55	6.01	4.33	3.55	6.01	3.58	3.55	6.01
30	Panelists	1.55	2.46	3.60	2.00	2.46	3.60	1.78	2.46	3.60	2.00	2.46	3.60
	Formulations	14.00	3.55	6.01	6.00	3.55	6.01	4.33	3.55	6.01	3.58	3.55	6.01
45	Panelists	1.55	2.46	3.60	2.00	2.46	3.60	1.78	2.46	3.60	2.00	2.46	3.60
	Formulations	14.00	3.55	6.01	6.00	3.55	6.01	4.33	3.55	6.01	3.58	3.55	6.01
60	Panelists	1.55	2.46	3.60	1.55	2.46	3.60	1.65	2.46	3.60	2..35	2.46	3.60
	Formulations	14.00	3.55	6.01	5.55	3.55	6.01	4.15	3.55	6.01	3.00	3.55	6.01
75	Panelists	1.50	2.46	3.60	2.23	2.46	3.60	1.60	2.46	3.60	2.45	2.46	3.60
	Formulations	13.00	3.55	6.01	5.50	3.55	6.01	4.05	3.55	6.01	3.00	3.55	6.01
90	Panelists	1.45	2.46	3.60	2.00	2.46	3.60	1.55	2.46	3.60	2.30	2.46	3.60
	Formulations	13.00	3.55	6.01	5.00	3.55	6.01	4.00	3.55	6.01	2.95	3.55	6.01

Table 4.6: Variance ratio of formulations and panelists on the different quality parameters of guava jelly

Storage days	Source of variance	Quality parameters											
		Colour			Flavour			Texture			Acceptability		
		Variance ratio			Variance ratio			Variance ratio			Variance ratio		
		F_c	F_T		F_c	F_T		F_c	F_T		F_c	F_T	
			P≤0.05	P≤0.01		P≤0.05	P≤0.01		P≤0.05	P≤0.01		P≤0.05	P≤0.01
0	Panelists	1.34	2.46	3.60	1.34	2.46	3.60	1.95	2.46	3.60	1.43	2.46	3.60
	Formulations	9.51	3.55	6.01	9.05	3.55	6.01	27.35	3.55	6.01	29.02	3.55	6.01
15	Panelists	1.34	2.46	3.60	1.34	2.46	3.60	1.95	2.46	3.60	1.43	2.46	3.60
	Formulations	9.51	3.55	6.01	9.05	3.55	6.01	27.35	3.55	6.01	29.02	3.55	6.01
30	Panelists	1.29	2.46	3.60	1.30	2.46	3.60	1.90	2.46	3.60	1.37	2.46	3.60
	Formulations	8.50	3.55	6.01	8.00	3.55	6.01	26.00	3.55	6.01	28.00	3.55	6.01
45	Panelists	1.29	2.46	3.60	1.30	2.46	3.60	1.90	2.46	3.60	1.37	2.46	3.60
	Formulations	8.50	3.55	6.01	8.00	3.55	6.01	26.00	3.55	6.01	28.00	3.55	6.01
60	Panelists	1.29	2.46	3.60	1.30	2.46	3.60	1.90	2.46	3.60	1.33	2.46	3.60
	Formulations	8.50	3.55	6.01	8.00	3.55	6.01	26.00	3.55	6.01	27.50	3.55	6.01
75	Panelists	1.24	2.46	3.60	1.25	2.46	3.60	1.85	2.46	3.60	1.28	2.46	3.60
	Formulations	7.50	3.55	6.01	7.00	3.55	6.01	25.00	3.55	6.01	26.50	3.55	6.01
90	Panelists	1.19	2.46	3.60	1.20	2.46	3.60	1.80	2.46	3.60	1.23	2.46	3.60
	Formulations	7.50	3.55	6.01	7.00	3.55	6.01	25.00	3.55	6.01	26.50	3.55	6.01

Table 4.7: Mean sensory score of guava juice for different samples

Juice type/ sample	Colour	Flavour	Taste	Overall acceptability
A	6.6^{b}	7.2^{b}	7.4^{b}	6.8^{b}
B	7.6^{a}	7.6^{a}	7.8^{a}	7.5^{a}
C	7.6^{a}	7.2^{b}	7.7^{a}	7.2^{ab}
LSD	0.4427	0.2803	0.2971	0.5511

Means with same superscript with a column are not significantly different at P<0.01

A = Juice contained KMS 100 ppm

B = Juice contained sodium Benzoate 250 ppm

C = Juice contained KMS 100 ppm + sodium Benzoate 250 ppm

Table 4.8: Mean sensory score of guava Jelly for different samples

Jelly type/ sample	Colour	Flavour	Texture	Overall acceptability
A	6.6^{b}	6.6^{c}	6.1^{b}	6.2^{cd}
B	6.0^{b}	6.2^{c}	5.3^{c}	5.7^{d}
C	6.5^{b}	6.9^{bc}	6.1^{b}	6.4^{c}
LSD	0.7424	o.7485	0.6793	0.5265

Means with same superscript with a column are not significantly different at P<0.05

A = 270 gm juice + 165 gm glucose + 165 gm sugar

B = 270 gm juice + 220 gm glucose + 110 gm sugar

C = 270 gm juice + 82.50 gm glucose + 287.5 gm sugar

CHAPTER V

SUMMARY AND CONCLUSION

The study was performed in the laboratories of the Department of Food Technology and Rural Industries (FTRI), Bangladesh Agricultural University, Mymensingh, during July-December, 2011. The objectives of the present study were to observe storage qualities of guava juices and jelly preparation using guava juice. Various preservatives were used in juices for storage. Microbiological status and sensory evaluation of guava juices and jellies were evaluated. Mature guava was collected from the Local Market and prepared juice and jelly with three formulations and stored at room temperature (29-33^{0}C). Observations were made on physical and chemical properties as well as on microbiological growth and actives.

The various treatments significantly affected the physico-chemical properties of juice. The highest sediment was found in sample B (Sodium Benzoate 250 ppm) and the lowest was in sample A (KMS 100 ppm). The TSS remained similar for all of the treatment except sample A (KMS 100 ppm). Vitamin C reduced 20-30% up to three month storage. Acidity remained not same in all of these sample. Acidity increase of the sample after two month storage. pH was recorded and it was decreased gradually in sample B (Sodium Benzoate 250 ppm) and sample C (KMS 100 ppm + Sodium Benzoate 250 ppm).

The quality of jellies was evaluated at one month interval. The better quality of jelly was found same for sample C (270 gm juice + 82.50 gm glucose + 287.5 gm sugar). In sample C citric acid was used instead of lemon juice.

The chemical composition of guava juices were moisture 73.42%, total solids 26.3%, total soluble Solids 23%, ash 91%, acidity 0.56%, reducing sugar 4.41%, non- reducing sugar 17.95%, total sugar 22.36%, ascorbic acid (Vitamin C) 11.64 mg/ 100 ml.

The composition of guava jellies were moisture 27.17%, vitamin C 9.21 mg/ 100ml, acidity 6.31%, total soluble solids 67%, pH 3.2%, reducing sugar 29.10%, non-reducing sugar 8.23%, Total sugar 31.63%.

At room temperature external fruit colour and fruit freshness were rapidly changed than in refrigerator temperature. At room temperature the fruit was decay free up to 11^{th} day of storage and then decay started on eyes and gradually to shale fruit. It was observed that pH was always lower in refrigerator then in room temperature. The amount of pH was insignificant between two storage conditions. There was no difference in TSS between two storage conditions. The difference in ash content was unto 8^{th} days of storage conditions and it showed difference at the 8^{th} days of storage between two storage conditions. The difference of reducing sugar and non-reducing sugar was noticed between two storage conditions. But it changed slightly. Reducing and non-reducing sugar was always higher at room temperature than in refrigerator. Total sugar was increased slightly during storage.

A statistical analysis on response of taste panel on the sensory attributes of juices revealed that colour, flavour, and overall acceptability of the different treated juices were significantly ($P<0.05$) affected. The colour of the juices supplemented with the samples used Sodium Benzoate 250 ppm (B) and KMS 100 ppm + Sodium Benzoate 250 ppm (C) were equally acceptable. The samples supplemented with KMS 100 ppm (A) and KMS 100 ppm + Sodium Benzoate 250 ppm (C) were equally acceptable for flavour. Samples used with Sodium Benzoate 250 ppm (B) was more acceptable than with the compared of other samples. Overall acceptability of sample B (Sodium Benzoate 250 ppm) was observed by the taste panel.

Viable bacterial count (Cfu/ml) was found higher in fresh juice (A) than other treatments. It was observed that the bacterial count increased 3 to 10 times during storage of three months. Minimum number of bacteria was found in sample C (KMS 100 ppm + Sodium-Benzoate 250 ppm) and B (250ppm sodium Benzoate) but maximum was in sample A (100 ppm KMS).

Minimum number of mold was content in samples C (KMS 100 ppm + Sodium-Benzoate 250 ppm) and B (Sodium-Benzoate 250 ppm). Minimum number of yeast was found in samples B and C. It has been observed that 100 ppm KMS + 250 ppm Sodium Benzoate were more effective against mold and yeast growth.

(1) Using of preservatives such as 250 ppm of Sodium Benzoate and 100 ppm KMS +250 ppm of Sodium Benzoate was more effective against microbial growth to prevent spoilage of stored guava juice.

(2) This study indicates a bright prospect of processing of jelly from guava juice for benefit of the growers, processors and the consumers in Bangladesh. It may also be mentioned that by exporting the best quality jelly of international standard may earn foreign exchange that may have positive contributions in the national economy of Bangladesh. However, further study is necessary for research with other ingredients for preparation of jelly.

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APPENDICES

Appendix I: Rating score for colour of guava juice

Number of taster	Treatment			Total
	A	B	C	
1	7	9	8	23
2	6	7	8	22
3	4	7	7	20
4	7	8	7	22
5	6	7	8	21
6	8	7	7	21
7	7	8	9	23
8	6	9	7	23
9	8	8	8	22
10	7	6	7	21
Total	66	76	76	218
Mean	6.6	7.6	7.6	7.26

Hedonic scale used: 9= Like extremely; 8= Like very much; 7 Like moderately; 6= Like slightly; 5= Neither like nor dislike; slightly; 3= Dislike very much; 2 =dislike extremely

Appendix II: Analysis of variance for colour guava juice

Sl. No.	Source of Variance	Degree of freedom (n-1)	Sun of square SS	Variance S^2 or mean S square M.S.	Calculated value F_c	Probability
1.	Taster	9	3.2	0.356	1.6000	0.1892
2.	Products	2	6.667	3.333	15.0000	0.0001**
3.	Error	18	4.000	0.222		
4.	Total	29	13.867			

Grand mean = 7.26
Grand sum = 218.00
Total count = 30
Co-efficient of variation = 6.49%

Juice	**Color Mean**
A	6.60
B	7.60
C	7.60

Appendix III: Duncan's Multiple Range Test (DMRT) value for colure of guava juice LSD 0.4427; < 0.05

Sample type	Original order of means	Sample type	Ranked order of means
A	6.60 [b]	A	7.60 [a]
B	7.60 [a]	B	7.60 [a]
C	7.60 [a]	C	6.60 [b]

Appendix IV: Rating score for flavour of guava juice

Number of taster	Treatment			Total
	A	B	C	
1	8	9	6	22
2	7	8	8	22
3	7	8	8	21
4	8	8	8	21
5	8	8	7	22
6	4	5	4	22
7	7	9	8	21
8	7	6	8	21
9	8	8	8	24
10	8	7	7	24
Total	72	76	72	220
Mean	7.2	7.6	7.2	7.33

Hedonic scale used: 9= Like extremely; 8= Like very much; 7 Like moderately; 6= Like slightly; 5= Neither like nor dislike; slightly; 3= Dislike very much; 2 =dislike extremely

Appendix V: Analysis of variance for flavour guava juice

Sl. No.	Source of Variance	Degree of freedom (n-1)	Sun of square SS	Variance S^2 or mean S square M.S.	Calculated value F_c	Probability
1.	Taster	9	4.000	0.444	2.00	0.0018
2.	Products	2	1.067	3.533	6.00	0.0101**
3.	Error	18	1.600	0.089		
4.	Total	29	6.667			

Grand mean = 7.33
Grand sum = 220.00
Total count = 30
Co-efficient of variation = 4.07%

Juice	**Flavour Mean**
A	7.20
B	7.60
C	7.20

Appendix VI: Duncan's Multiple Range Test (DMRT) value for flavor of guava juice LSD 0.2803; < 0.050

Sample type	Original order of means	Sample type	Ranked order of means
A	7.20 [b]	A	7.60 [a]
B	7.60 [a]	B	7.20 [b]
C	7.20 [b]	C	7.20 [b]

Appendix VII: Rating score for taste of guava juice

Number of taster	Treatment			Total
	A	B	C	
1	9	8	9	24
2	7	8	9	24
3	8	8	8	23
4	8	8	8	23
5	7	7	6	21
6	6	7	6	21
7	7	8	8	23
8	6	8	7	22
9	8	8	8	24
10	8	8	8	24
Total	72	76	72	229
Mean	7.2	7.6	7.2	7.63

Hedonic scale used: 9= Like extremely; 8= Like very much; 7 Like moderately; 6= Like slightly; 5= Neither like nor dislike; slightly; 3= Dislike very much;2 =dislike extremely

Appendix VIII: Analysis of variance for Taste guava juice

Sl. No.	Source of Variance	Degree of freedom (n-1)	Sun of square SS	Variance S^2 or mean S square M.S.	Calculated value F_c	Probability
1.	Taster	9	4.300	0.478	1.78	0.0023
2.	Products	2	0.867	0.433	4.3333	0.0291**
3.	Error	18	1.800	0.100		
4.	Total	29	6.967			

Grand mean = 7.63
Grand sum = 229.00
Total count = 30
Co-efficient of variation = 4.14%

Juice	**Taste Mean**
A	7.40
B	7.80
C	7.70

Appendix IX: Duncan's Multiple Range Test (DMRT) value for Taste of guava juice LSD 0.6793; < 0.050

Sample type	Original order of means	Sample type	Ranked order of means
A	7.40 [b]	A	7.80 [a]
B	7.80 [a]	B	7.70 [a]
C	7.70 [a]	C	7.40 [b]

Appendix X: Rating score for overall acceptability of guava juice

Number of taster	Treatment			Total
	A	B	C	
1	8	9	8	25
2	7	8	9	24
3	6	8	7	21
4	7	8	7	22
5	7	7	7	21
6	6	6	5	17
7	7	8	8	23
8	6	7	7	20
9	7	8	7	22
10	7	6	7	20
Total	68	75	72	215
Mean	6.8	7.5	7.2	7.16

Hedonic scale used: 9= Like extremely; 8= Like very much; 7 Like moderately; 6= Like slightly; 5= Neither like nor dislike; slightly; 3= Dislike very much;2 =dislike extremely

Appendix XI: Analysis of variance for overall acceptability guava juice

Sl. No.	Source of Variance	Degree of freedom (n-1)	Sun of square SS	Variance S^2 or mean S square M.S.	Calculated value F_c	Probability
1.	Taster	9	15.500	1.722	2.00	0.0018
2.	Products	2	2.467	1.233	3.5806	0.0491*
3.	Error	18	6.200	0.344		
4.	Total	29	24.167			

Grand mean = 7.167
Grand sum = 215.00
Total count = 30
Co-efficient of variation = 8.19%

Juice	**Overall acceptability Mean**
A	6.80
B	7.50
C	7.20

Appendix XII: Duncan's Multiple Range Test (DMRT) value for overall acceptability of guava juice LSD 0.5511; < 0.05

Sample type	Original order of means	Sample type	Ranked order of means
A	6.80 [b]	A	7.50
B	7.50 [a]	B	7.20
C	7.20 [ab]	C	6.80

Appendix XIII: Rating score for colour of guava jelly

Taster	Treatment			Total
	A	B	C	
1	7	7	7	38
2	6	6	6	33
3	6	5	7	35
4	6	5	6	32
5	8	7	7	36
6	6	5	6	32
7	6	5	7	33
8	7	6	5	34
9	7	7	8	36
10	7	7	6	37
Total	66	60	65	346
Mean	6.6	6.0	6.5	6.92

Hedonic scale used: 9= Like extremely; 8= Like very much; 7 Like moderately; 6= Like slightly; 5= Neither like nor dislike; slightly; 3= Dislike very much;2 =dislike extremely

Appendix XIV: Analysis of variance for colour guava jelly

Sl. No.	Source of Variance	Degree of freedom (n-1)	Sun of square SS	Variance S^2 or mean S square M.S.	Calculated value F_c	Probability
1.	Taster	9	8.080	0.898	1.3400	0.2515
2.	Products	2	25.480	6.370	9.5075	0.0000**
3.	Error	18	24.120	0.670		
4.	Total	29	57.680			

Grand mean = 6.92
Grand sum = 346.00
Total count = 3050
Co-efficient of variation = 11.83%

Jelly	**Colour Mean**
A	6.60
B	6.60
C	6.50

Appendix XV: Duncan's Multiple Range Test (DMRT) value for colure of guava jelly LSD 0.7424; < 0.050

Sample type	Original order of means	Sample type	Ranked order of means
A	6.60 ^{c}	A	6.60 ^{b}
B	6.20 ^{c}	B	6.50 ^{b}
C	6.90 ^{bc}	C	6.60 ^{b}

Appendix XVI: Rating score for flavour of guava jelly

Taster	Treatment			Total
	A	B	C	
1	7	6	6	36
2	7	6	6	35
3	6	5	7	35
4	6	6	6	31
5	7	7	7	35
6	5	5	7	32
7	6	5	7	33
8	6	6	6	35
9	8	7	8	40
10	8	9	9	42
Total	66	62	69	354
Mean	6.6	6.5	6.9	7.08

Hedonic scale used: 9= Like extremely; 8= Like very much; 7 Like moderately; 6= Like slightly; 5= Neither like nor dislike; slightly; 3= Dislike very much;2 =dislike extremely

Appendix XVII: Analysis of variance for flavour guava jelly

Sl. No.	Source of Variance	Degree of freedom (n-1)	Sun of square SS	Variance S^2 or mean S square M.S.	Calculated value F_c	Probability
1.	Taster	9	20.480	2.276	1.34	0.0046
2.	Products	2	24.680	6.170	9.0587	0.0000**
3.	Error	18	24.520	0.681		
4.	Total	29	69.680			

Grand mean = 7.080
Grand sum = 354.00
Total count = 50
Co-efficient of variation = 11.66%

Jelly	**Flavour Mean**
A	6.10
B	5.30
C	6.10

Appendix XVIII : Duncan's Multiple Range Test (DMRT) value for flavour of guava Jelly LSD 0.7485; < 0.050

Sample type	Original order of means	Sample type	Ranked order of means
A	6.60 ^{c}	A	6.90 ^{bc}
B	6.20 ^{c}	B	6.60 ^{c}
C	6.90 ^{bc}	C	6.20 ^{c}

Appendix XIX: Rating score for texture of guava jelly

Taster	Treatment			Total
	A	B	C	
1	7	6	7	37
2	6	6	7	34
3	6	5	7	35
4	5	5	5	30
5	5	4	3	28
6	6	5	6	32
7	6	5	7	33
8	7	6	5	34
9	6	6	8	37
10	7	5	6	35
Total	61	53	61	335
Mean	6.1	5.3	6.1	6.70

Hedonic scale used: 9= Like extremely; 8= Like very much; 7 Like moderately; 6= Like slightly; 5= Neither like nor dislike; slightly; 3= Dislike very much;2 =dislike extremely

Appendix XX: Analysis of variance for texture guava jelly

Sl. No.	Source of Variance	Degree of freedom (n-1)	Sun of square SS	Variance S^2 or mean S square M.S.	Calculated value F_c	Probability
1.	Taster	9	14.900	1.656	1.95	0.0099
2.	Products	2	61.400	15.350	27.3564	0.0000**
3.	Error	18	20.200	0.561		
4.	Total	29	96.500			

Grand mean = 6.70
Grand sum = 335.00
Total count = 50
Co-efficient of variation = 11.18%

Jelly	**Texture Mean**
A	6.10
B	5.30
C	6.10

Appendix XXI : Duncan's Multiple Range Test (DMRT) value for texture of guava Jelly LSD 0.6793; < 0.050

Sample type	Original order of means	Sample type	Ranked order of means
A	6.10 ^{b}	A	6.10 ^{b}
B	5.30 ^{c}	B	6.10 ^{b}
C	6.10 ^{b}	C	5.30 ^{c}

Appendix XXII: Rating score for overall acceptability of guava jelly

Taster	Treatment			Total
	A	B	C	
1	7	6	7	36
2	6	6	6	33
3	6	5	7	35
4	5	5	5	30
5	7	6	6	34
6	6	5	6	32
7	6	5	7	33
8	6	6	6	34
9	6	6	8	35
10	7	7	6	37
Total	62	57	64	339
Mean	6.2	5.7	6.4	6.78

Hedonic scale used: 9= Like extremely; 8= Like very much; 7 Like moderately; 6= Like slightly; 5= Neither like nor dislike; slightly; 3= Dislike very much;2 =dislike extremely

Appendix XXIII: Analysis of variance for overall acceptability guava jelly

Sl. No.	Source of Variance	Degree of freedom (n-1)	Sun of square SS	Variance S^2 or mean S square M.S.	Calculated value F_c	Probability
1.	Taster	9	7.380	0.820	1.43	
2.	Products	2	49.080	9.770	29.0198	0.0000**
3.	Error	18	20.120	0.337		
4.	Total	29	58.580			

Grand mean = 6.780
Grand sum = 339.00
Total count = 50
Co-efficient of variation = 8.56%

Jelly	Overall acceptability Mean
A	6.20
B	5.70
C	6.40

Appendix XXIV: Duncan's Multiple Range Test (DMRT) value for overall acceptability of guava Jelly LSD 0.5265; < 0.050

Sample type	Original order of means	Sample type	Ranked order of means
A	6.20 ^{cd}	A	6.40 ^{c}
B	7.700 ^{d}	B	6.20 ^{cd}
C	6.40 ^{c}	C	5.70 ^{d}

Appendix XXV: Total number of viable bacterial count (log cfu/ml) affect incubation 48 hr at 32°C

Sample	Bacteria count
A	4.8
B	4.5
C	4.3

Appendix XXVI: Total count of mold and yeast count (log cfu/ml) affect incubation 72 hr at 32°C

Sample	Mould	Yeast
A	3	4.07
B	2.9	3.9
C	2.7	3.3

Photo 1. Appearance of Kazi guava at different stages of maturity.

Photo 2. Cross section of jelly guavas at maturate stages.

Photo 3. Cross section of Kazi guavas at different stages.

Photo 4. Cross section of Kazi guavas at maturate stages.

Photo 5. Cross section of jelly guavas at ripen stages.

Photo 6. Cross section of jelly guavas at ripen stages.

Photo 7. Appearance of Jelly guava at different stages.

Photo 8. Appearance of jelly guavas at maturate stages.

Appendix XXVII: Tasting of guava juice (Hedonic Rating Test)

Name of Taster ..... Date: .....

Please taste these samples and check how much you like or dislike each one on four sensory attributes such as colour, flavour, taste and overall acceptability. Use he appropriate scale to show your attitude by checking at the point that best describes your feeling about the sample please give a reason for this attribute. Remember you are the only one who can tell what you like. An honest expression of your personal feeling will help us.

For Colour/Flavour/Taste/Overall Acceptability

Hedonic	Colour			Flavour			Taste			Acceptability		
	A	B	C	A	B	C	A	B	C	A	B	C
Like extremely												
Like very much												
Like moderately												
Like slightly												
Neither like nor dislike												
Dislike slightly												
Dislike moderately												
Dislike very much												
Dislike extremely												