Development and evaluation of jam and chutney from Guava-Jamun blends

By

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CERTIFICATE-I

This is to certify that the thesis entitled, **"Development and evaluation of jam and chutney from Guava-Jamun blends"** submitted for the degree of **Master of Science** in the subject of Food Science and Technology to Chaudhary Charan Singh Haryana Agricultural University, Hisar is a bonafied research work carried out by **Ms. Rashmi Bhardwaj,** Admn. No**. 2011FST122M** under my supervision and guidance, 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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Dated: ***Rashmi Bhardwaj***

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2.	Jamun Fruits
3.	Guava-Jamun jam
4.	Guava -Jamun chutney

ABBREVIATIONS

cv(s).	cultivar(s)
e.g.	*example gratia*; for example
et al.	*et allii*; and others
Fig (s).	Figure (s)
i.e.	*id est*; that is
p., pp.	page, pages
var (s).	Variety (ies)
viz.	*videlicet*; namely

CHAPTER-I

INTRODUCTION

Guava (*Psidium guajava* L.) belongs to family Myrtaceae and is one of the most common fruits grown under tropical and sub-tropical climate. The English name of guava came from the name of a nation "Guajaba". It is fifth important fruit in India with a production of 1.85 million tons from an area of 1.60 lakh hectare. It is known as 'poor man's apple' and is available in plenty at a low price during fruiting seasons. The guava fruits are usually round or oval depending upon the species. The outer skin is usually green before maturity but turns green to yellow when ripe. Guava pulp may be sweet or sour, tasting something between pear and strawberry, off-white to deep pink in colour with variable number of seeds in central pulp.

Guava contains both carotenoids and polyphenols like leucocyanidin, guaijaverin, gallocatechin, the major classes of antioxidant pigments giving them relatively high potential antioxidant value among plant foods. The fruits are rich in dietary fibre, vitamin A, vitamin C, folic acid and minerals mainly potassium, copper and manganese. The fruit is a rich source of vitamin C after barbadose cherry and aonla, and contains about four times higher amount vitamin C than orange. Guava is effective against cancer, bacterial infections, inflammation and pain. It is considered to be as an excellent fruit for salad, jam, jelly, chutney cheese, squash, etc. It can be processed into various value added products to minimize the losses and maintain the cost

The black plum or Indian blackberry, commonly known as Jamun (*Syzygium cumini* L.) is also an important member of family Myrtaceae. Its fruits are oblong, ovoid and crimson black in colour at ripe stage. It is widely grown throughout India and other tropical and sub-tropical countries. Singh *et al.* (1967) reported moisture (84.5 to 86.4%), protein (0.53 to 0.65%), fat (0.10%), calorific value (83 per 100 g), TSS (9 to 11.5%), total sugars (5.8 to 6.9%), acidity (2.1 to 2.5%), pectin (2.3 to 3.7%), vitamin C (30.3 to 40.7 mg/100 g pulp), calcium (0.02%), phosphorus (0.01%) and iron (0.1%) in jamun.

Jamun fruits are used in *Ayurveda* and *Unani* systems of medicine. Its fruits and leaves are used for curing stomach disorder, whereas seed powder and pure juice are used for curing diabetes. Seeds are rich in carbohydrates, proteins and calcium and can be used as a concentrate in animal feed. Fruits are stomachic and diuretic apart from having cooling and digestive properties. These are also used as herbal medicine from ancient age and are reported to be beneficial for diabetic persons (Jadhav *et al.,* 2009). Jamun fruits show antioxidant property which is due to flavonoids and anthocyanins present in it (Banerjee *et al.*, 2005).

Jamun fruits are generally consumed in fresh form. The ripe fruits are highly perishable in nature and available for a very short duration during June-July. The surplus produce can be processed into value added products like jam, jelly, chutney, sauce, cheese and toffee. These value added jamun products can be utilized to increase the food intake and nutritional standards of the population during periods of its low availability.

Blending of pulp/juice from two or more fruits could be an economic requisite to utilize profitably some fruits for processing which may not otherwise have favourable characteristics like colour, flavour, aroma, taste, mouthfeel including overall cost and nutrition for the preparation of the processed products (Kalra *et al*., 1991). Jamun juice, being acidic and astringent in taste, has not been used much and is yet to pick up the impetus for being utilized extensively for processing. Therefore, blending of jamun pulp/juice with guava pulp can supplement their blended products with vitamins (especially vitamin C) and bright sparkling purple colour due to presence of large quantity of anthocyanins in jamun peel and minerals, besides improving their taste, flavour and overall acceptability. Keeping all these above facts in view, the present study was planned with the following objectives:

1. To standardize appropriate combination of Guava-Jamun blends for preparation of jam and chutney
2. To evaluate storage quality of blended products

CHAPTER-II

REVIEW OF LITERATURE

The literature pertaining to study "Development and evaluation of jam and chutney from Guava-Jamun blends" has been reviewed in this chapter under the following headings:

2.1 Physico-chemical characteristics of fresh guava and jamun fruits

2.2 Preparation of fruit products

2.3 Changes in chemical constituents of fruit products during storage

2.4 Changes in organoleptic quality of fruit products during storage

2.1 Physico-chemical characteristics of fresh guava and jamun fruits

Physical and chemical parameters are good indicators for judging maturity stage of fresh fruits. Generally, TSS to acid ratio is an important parameter for assessing the maturity of different fruits.

2.1.1 Physical characteristics of fresh guava and jamun fruits

2.1.1.1 Guava fruit

Ojha *et al.* (1987) found that cv. *Sardar* produced less number of seeds and also had less weight of seeds per kg of fruits than cv. *Allahabad Safeda*. Ramniwas *et al*. (2012) reported maximum fruit weight (182.17 g) and pulp weight (153.75 g) in guava under different irrigation conditions. Mahour *et al.* (2012) found that fruit weight of *Allahabad Safeda* was highest (235 g) followed by *Lucknow-49* (224 g). Pulp (%) was also recorded highest (97.74) in *Allahabad Safeda* which was closely followed by *Chittidar* (97.42) and *Dharidar* (95.4). The *China Red* variety had highest seed percentage, whereas *Allahabad Safeda* contained the lowest seed percentage. Maximum fruit weight was reported in cv. *Spear Acid* (179.4 g), *Mild Flesh* (199.1 g) and *Eskwala* (139.8 g) during rainy, winter and summer seasons, respectively.

2.1.1.2 Jamun fruit

The physical characteristics of jamun fruits in seedling and grafted plant are different. It was observed that fruit length, breadth, TSS, ascorbic acid, total and reducing sugars are present in significantly higher quantities in grafted jamun fruits.

Devi *et al* (2002) reported maximum fruit weight in OG1 (13.67 g) followed by V6 (12.40 g). The minimum weight (3.42 g) was, although, observed in NA1 against mean fruit weight (7.27 g). The maximum fruit length (5.26 cm) was observed in OG1 and minimum (3.31 cm) in NA1. The maximum pulp content (84.55%) was recorded in OG1 followed by V6 (78.49%), while minimum pulp content (58.57%) was recorded in DN2 the mean pulp content (69.52%). Kannan and Thirumaran (2004) reported that ripe jamun fruits had 75 per cent

edible portion with pulp to seed ratio of 3.1:1. Juice/pulp recovery from fruits was 64.4 per cent and pomace content was 23.9 per cent with 11.7 per cent preparation losses.

2.1.2 Chemical characteristics of guava and jamun fruits

2.1.2.1 Guava fruit

Rathore *et al.* (2007) reported that winter season guava fruits had higher contents of chemical constituents over rainy season fruits.

2.1.2.1.1 Total soluble solids

Total soluble solids give a reliable index to judge the proper stage of maturity. Jauhari *et al.* (1970) evaluated TSS in cv. *Allahabad Safeda* (14.27%) and *L-49* (13.52 %). Hegde and Charria (2004) reported maximum TSS (13.83^0B) in winter season guava and minimum (9.31^0B) in rainy season guava. Mahajan *et al.* (2004) reported that TSS of guava fruits cv. *Allahabad Safeda* increased during ripening process up to 4 days and thereafter, it declined. Agrawal (2010) reported that the variety Seedless got maximum TSS (13.25^0B) and it was recorded minimum in Red Fleshed (10.62^0B). Anupa *et al.* (2012) observed maximum TSS (15.38^0B) in *Apple Colour* guava.

2.1.2.1.2 Total and reducing sugars

Elbulk *et al.* (1997) observed that total sugars increased with the fruit growth and development in *Shambati*, *Akistani*, *Shendi* and *Ganib* and maximum level varied from 13.7 to 30.6 mg per 100 ml of juice, while individual contents varied maximally from 5.64 to 7.67, 1.90 to 8.00 and 6.20 to 7.78 mg per 100 ml of juice for fructose, glucose and sucrose, respectively. Bashir *et al.* (2003) reported that maximum values of reducing sugars were 5 and 8 in pulp and 6 and 10 g/l00 g fresh weight in peel of pink and white fleshed guavas, respectively. The peel in both guava types contained more total sugars than pulp. Jain and Dashora. (2010) found non-reducing sugars (2.10%) and total sugars (6.17%) in guava cv. *Sardar*. The sugars present in fruits impart sweetness, which influence the taste and flavour. Anupa *et al.* (2012) found total sugars (7.31 to 7.83%), reducing sugars (3.68 to 3.98%) and non-reducing sugars (3.61 to 3.96%) in *Apple Colour* guavas.

2.1.2.1.3 Acidity

Garg *et al* (1997) found that cv. *Allahabad Safeda* contained 0.45% acidity. Chyau *et al.* (1992) observed acidity as citric acid (0.48%) in mature guava fruits and (0.31%) in ripe guava fruits. Dinesh and Tiwari (2001), although, reported that acidity ranged from 0.1 to 2.05% in different guavas. Biradar *et al.* (2008) compared ten superior progenies of *Taiwan Guava* selections with *Allahabad Safeda,* where *Allahabad Safeda* recorded maximum acidity (0.37%). Sharma *et al.* (2009) reported (0.51 to 0.55%) acidity in guava cv. *Sardar*. Nag *et al.* (2011) observed that acidity decreased during ripening in *Mukundapari*, *Kazipiara*, *Swarupkathi* and local varieties of guava.

2.1.2.1.4 pH

Jain *et al*. (2011) reported pH of the guava pulp to be 3.63. Anupa *et al*. (2012) found pH 5.49 in *Apple Colour* guava.

2.1.2.1.5 Ascorbic acid

Jauhari (1970) evaluated ascorbic acid (217.8 mg per 100 g) in cv. *Allahabad Safeda* and (346.5 mg/100 g) in *L-49*. Garg *et al.* (1997), although, reported that cv. *Allahabad Safeda* contained only 148.5 mg per 100 g ascorbic acid. Bashir *et al.* (2003) recorded ascorbic acid (75 to 85 mg/100 g pulp) in white guava fruits and (55 to 70 mg/100 g pulp) in pink guava fruits. Lim *et al.* (2007) evaluated ascorbic acid content in nine tropical fruits and recorded 144 and 132 mg/100 g ascorbic acid in seeded and seedless guavas, respectively. Jain and Dashora (2010) found ascorbic acid (175.06 mg/100 g pulp) in guava cv. *Sardar*, while Mahour *et al.* (2012) evaluated ascorbic acid (125.0 to 272.1 mg/100 g pulp) in different guava cultivars.

2.1.2.1.6 Pectin

Buluk *et al*. (1995) reported that soluble pectin increased gradually with the fruit development in guava. Dhillon *et al*. (1987) found an increase in pectin content of guava fruits from 0.58 to 0.70% during rainy season and 1.01 to 1.15% during winter season. Mahattanatawee *et al.* (2006) reported pectin to be 1.04 and 0.77 g/100 g fruit in red and white guava, respectively.

2.1.2.1.7 Total phenols

Dhillon *et al*. (1987) reported that total phenols increased during early developmental stages upto 60 days in guava and afterwards, a continuous decrease in total phenols was recorded. Mahattanatawee *et al.* (2006) reported total soluble phenolics to be 2316.7 µg/g puree in red guava and 1589.3 µg/g puree in white guava.

2.1.2.2 Jamun fruit

2.1.2.2.1 Total soluble solids

Total soluble solids, generally, increase with the growth and development of fruits. Mishra and Bajpai (1984) observed an increasing trend in total soluble solids of jamun fruit right from its development to ripening stage. Bhardwaj and Yamdagni (2005) reported TSS to be 11.17% in the grafted jamun fruit pulp. Total soluble solids were reported to be 15.82% in indegenous variety (V2) of Sindh (Shahnawaz and Sheikh, 2011).

2.1.2.2.2 Total and reducing sugars

Bhardwaj and Yamdagni (2005) reported total sugars (10.49%) and reducing sugars (7.19%) in grafted jamun fruit pulp. Chawdhury and Ray (2007) found reducing sugars (14 g per 100 g) in jamun fruits.

2.1.2.2.3 Acidity

Acidity of fruits was recorded higher at the beginning of fruit initiation and it slowly decreased towards maturity. Acidity was reported to be 0.94% in grafted jamun fruit pulp

(Bhardwaj and Yamdagni, 2005). Shahnawaj and Sheikh (2011) found acidity (1.58%) in indigenous jamun fruit.

2.1.2.2.4 pH

Shahnawaz and Sheikh (2011) reported pH of jamun fruit cultivars of Sindh to be 3.87 for improved variety (V1) and 3.77 for indigenous variety (V2). Patil *et al*. (2012) reported 3.2 pH in jamun fruit.

2.1.2.2.5 Ascorbic acid

Ascorbic acid was reported to be 80.35 mg/100 ml in grafted jamun fruit pulp (Bhardwaj and Yamdagni, 2005). Chowdhury and Ray (2007), although, reported 250 mg per 100 g ascorbic acid in jamun fruits.

2.1.2.2.6 Anthocyanins

Kannan and Thirumaran (2004) reported that ripe jamun fruit had 196 mg anthocyanin per 100 ml of juice. Chowdhury and Ray (2007) reported anthocyanins (0.14 g per 100 g) in jamun fruit. Sonia *et al.* (2010) analyzed 168 mg anthocyanin per 100 g of edible jamun pulp.

2.1.2.2.7 Pectin

Singh *et al.* (1967) reported pectin to be 2.3 to 3.7% in jamun fruit.

2.1.2.2.8 Total phenols

Kannan and Thirumaran (2004) reported that ripe jamun fruit had 500 mg phenolic compounds per 100 ml of juice. Benherlal (2010) found 3.9 g total phenols per kg jamun pulp.

2.2 Preparation of fruit products

2.2.1 Blending of fruit pulp

Blending of pulp from two or more different fruits supplements their blended products with attractive colour, improved taste, and flavour and high nutritional value. Nakadi *et al.* (2001) reported that blending of pomegranate juice with mango pulp in 60:40 ratio was adjudged as best combination for the preparation of RTS beverage. Dhaliwal and Hira (2004) blended carrot juice with spinach and pineapple juice to improve the nutritional quality of mixed juices. Orange and tomato juice were blended in ratio of 10:90, 20:80 and 30:70 and stored for six months in glass bottles under ambient conditions. The study indicated that blend with 30 per cent orange juice was found to be highly acceptable (Sivakumar *et al.*, 2006).

Nale *et al.* (2007) prepared mixed fruit toffee from tamarind, mango and papaya pulp blended in various proportions *i.e.,* 100:0 (tamarind pulp), 50:50 (tamarind and mango) and 75:25 (tamarind and papaya). Among different blends, tamarind: mango (50:50) blend was found superior over other combinations. Fruit bar was prepared with mango and papaya pulp blended in two different proportions *i.e.,* 75:25 and 50:50, and enriched it with different levels of whey protein concentrate (WPC-70) like 5, 7 and 10 per cent. Among these different

combinations, mango-papaya pulp in 75:25 ratio with 5 and 7 per cent WPC was highly acceptable (Gayathri and Uthira, 2008).

Anand *et al.* (2009) prepared peach-soy toffees by blending peach pulp and soybean slurry in the ratios of 100:0, 95:5, 90:10, 85:15, 80:20, 75:25 and 70:30, respectively. Among these blends, 85:15 ratio was adjudged as best blend with regard to overall acceptability. RTS fruit beverages with bael and citrus fruit blends were prepared in which bael pulp was blended with juice of seasonal fruits like lime, mandarin orange, sweet orange and pineapple. Two blends of bael and lime (40:60 and 50:50) and one each of bael:mandarin orange (30:70) and bael:sweet orange:pineapple (20:40:40) were prepared and studied. The study adjudged bael:sweet orange:pineapple (20:40:40) blend as the most preferred one (Nagpal and Rajyalakshmi, 2009).

For preparation of mixed fruit slab, aonla and mango pulp could be successfully employed in 1:1 ratio after adjusting its TSS content to 30% (Verma and Chopra, 2010). Singh *et al.* (2010) prepared natural summer fruit beverage from papaya and bael pulp blended in different combinations like 9:1, 7:3 and 6:4, respectively. The product prepared by using combination of 7:3 (papaya and bael) was found most acceptable.

Jain *et al.* (2011) blended guava and papaya pulp and experienced that blending of pulps in different ratios influenced the organoleptic characters as well as the qualitative parameters of blended pulp. Sucharitha *et al.* (2012) developed jam from ber-pineapple blends and observed that among these different samples, 60:40 recorded highest score in terms of colour, taste, flavour and overall acceptability. It was followed by 70:30 by judges from two age groups, whereas lowest score was recorded in 80:20.

2.2.2 Preparation of fruit products

Chauhan *et al.* (1994) developed instant wild pomegranate chutney which reconstituted well in cold water and possessed all characteristics of fresh chutney. The product had a good amount of vitamin C, sugar, ash and fibre. Aggarwal *et al.* (1997) prepared several combinations of guava and grape blended jelly and reported that 40:60 and 60:40 guava-grape juice with 1 per cent pectin resulted in overall good colour, consistency and acceptability of the product. Khurdiya and Sagar (1998) developed mango chutney with good sensory quality attributes from mango pulp and sugar (1:1) after adding spices and other ingredients.

Kumar and Singh (2001) recorded an increase in total soluble solids, acidity and browning, and decrease in organoleptic quality of all aonla products *viz.*, jam, pickle, candy and beverages during eight months storage. Kannan and Thirumaran (2001) reported that jamun products stored in colourless glass bottles were acceptable even after six months storage at ambient conditions, and maximum retention of anthocyanin pigment was found in jamun jam followed by its syrup, squash and ready-to-serve drink. Sharma *et al.* (2009)

developed seabuckthorn-apple blended jam and revealed that jam having apple and seabuckthorn in 65:35 ratio was found the best among different proportions.

Sawant *et al.* (2009) reported that best quality kokum-pineapple blended jam can be prepared with total soluble solids not less than 68.5% and by adding preservatives like sodium benzoate and citric acid. Bhat *et al.* (2010) prepared and studied the physico-chemical and organoleptic properties of curd-pumpkin chutney. Four levels of curd *viz*., 15, 25, 35 and 45 per cent were used and the results indicated that 35% level of curd in the blend was highly acceptable. Kaul *et al.* (2011) prepared strawberry spread by boiling fruit slices with sufficient quantity of sugar to raise total soluble solids to 50, 55 and 60^0 Brix. The spread prepared with 55^0 Brix was found most acceptable during six months storage.

2.3 Changes in chemical constituents of fruit products during storage

2.3.1 TSS

Mishra *et al.* (2011) conducted a storage study on ready-to-eat amla chutney at room and refrigerated temperatures, and reported an increase in TSS from 50.87 to 58.32 and 50.91 after 60 days storage at room and refrigerated temperatures, respectively. Ndabikunze *et al.* (2011) reported that time of storage had no significant influence on TSS in any fruit jams formulations. Fruit jams treated with commercial pectin (CPT), lemon extract (LEP) and *A. digitata* L. powder (APP) maintained the recommended level of TSS above 65%. Nour *et al.* (2011) also reported an increase in TSS of jam prepared from three different varieties of mangoes during 60 days storage. Khan *et al.* (2012) reported an increase in TSS content of strawberry jam from 66.5 to 68.6 during sixty days storage.

2.3.2 Total and reducing sugars (%)

Kannan and Thirumaran (2001) observed a gradual decrease in total sugars (57.7 to 55.9%) and an increase in reducing sugars (30.1 to 36.5%) in jamun jam stored in colourless glass bottles during six months storage at room temperature. The total and reducing sugars increased with the increase in storage period at both ambient (25 to 30^0C) and low temperature (4 to 5^0C) in ber squash (Prasad and Mali, 2003). Prasad and Mali (2006) also studied the bio-chemical changes in ber jam during storage and found no change in total and reducing sugars during three months storage period. Talasila *et al.* (2011) reported that total and reducing sugars in preserved cashew apple juice were stable upto a period of 90 days. After 90 days, the sugar content started declining. Khan *et al.* (2012) observed significant increase in reducing sugars in mango-seabuckthorn blended juice, while non-reducing sugars decreased significantly.

2.3.3 Acidity

Shakir *et al.* (2008) conducted a comparative study on mixed fruit jam of (apple+pear) pulp, blended in ratios 50:50 (T1), 60:40 (T2), 40:60 (T3), and 100% apple (T4) and 100% pear (T5). All the jam samples were stored in sterilized glass jars and evaluated

physico-chemically for ascorbic acid, acidity, pH, total soluble solids, reducing sugars and non-reducing sugars for an interval of 15 days during three months storage period. An increase in acidity from 0.60 to 0.78% was noticed during evaluation. Vidhya and Narain (2010) prepared jam using under exploited fruit, wood apple (*Limonia acidissima*). Acid content of jam decreased by 0.51% at 30 days and 1.55 and 2.5% at 60 and 90 days of storage, respectively.

Mishra *et al.* (2011) developed ready-to-eat amla chutney and stored at two different temperatures *i.e.,* at room temperature and at refrigerated temperature. They found that acidity of chutney at room temperature increased from 1.79 to 2.53 per cent during 60 days storage, while at refrigerated storage, it increased from 1.79 to 1.82 per cent. Nour *et al.* (2011) prepared jam from three different varieties of mango, *Abusamaka*, *Gulb Altour* and *Magloba* and reported that during 60 days of storage, the acidity increased from 0.67, 0.96 and 0.61 to 0.80, 0.99 and 0.64, respectively. Khan *et al.* (2012) developed strawberry jam and evaluated its quality parameters at an interval of 15 days during 60 days storage and reported that acidity of the product increased from 0.68 to 0.86%.

2.3.4 pH

Shakir *et al.* (2008) carried out a comparative study on mixed fruit jam of (apple+pear) pulp, blended in the ratios 50:50 (T1), 60:40 (T2), 40:60 (T3) and 100% apple (T4) and 100% pear (T5). All the jam samples were stored in sterilized glass jars and evaluated physico-chemically. A decrease in pH was observed from 3.64 to 3.22 during three months storage. Ndabikunze *et al.* (2011) produced jams from indigenous fruits obtained from various areas of Tanzania including *Smelly-Berry,* (*Vitex mombassae*) *Wild Loquat* (*Uapaca kirkiana*) and *Marula Plum* (*Sclerocarya birrea*) using lemon extract, commercial pectin and *Baobab* (*Adansonia digitata* L.) powder as sources of pectin and reported that pH of jams formulated was within the required range of 3.0 to 3.5 throughout the storage period. Rababah *et al.* (2011) prepared jam from strawberry and stored at temperatures of 25, 35, 45 and 55^0C. They found that pH decreased from 3.30 to 2.70 during 15 days storage. Khan *et al.* (2012) developed strawberry jam and evaluated its quality parameters at an interval of 15 days for a time period of 60 days, and reported decrease in pH of the product from 3.2 to 2.9 during this period.

2.3.5 Ascorbic acid

Vidhya and Narain (2010) carried out vitamin C estimation during storage period of wood apple jam and reported vitamin C loss upto the extent of 11.1, 22.2 and 50% after 30, 60 and 90 days, respectively. Talasila *et al.* (2011) developed apple juice and found that vitamin C content of juice was found to be 164 mg/100 ml, which remained stable upto 90 days but finally 12.18 % decrease in vitamin C content of juice was observed at the end of six months storage. Khan *et al.* (2012) observed significant decrease in ascorbic acid in mango-seabuckthorn blended juice during 3 months storage.

2.3.6 Anthocyanins

Kannan and Thirumaran (2001) reported a gradual degradation in anthocyanin pigments of jamun products during six months storage. The maximum retention of anthocyanin pigment was in jamun jam followed by syrup, squash and RTS beverage. Kannan and Thirumaran (2004) recorded rapid degradation in anthocyanin content of jam to the extent of 54.7 mg per cent. Rababah *et al.* (2011) reported a decline in anthocyanin concentration in strawberry jam from 7.10 to 3.73 mg cya-3-glu/100 g when stored for 15 days at 25^0C. A significant decrease in anthocyanins of pomegranate drink was recorded by Thakur *et al.* (2011) during six months storage and more retention of anthocyanins was observed under refrigerated storage conditions than ambient conditions. Loss of anthocyanins in drink might be due to their high susceptibility to auto-oxidative degradation during storage. Amaro *et al.* (2012) reported that significant changes occurred in anthocyanin composition of strawberry jam after 15 and 60 days storage. Jams stored in dark recorded slightly higher levels of retention of anthocyanins.

2.3.7 Total phenols

Talasila *et al.* (2011) recorded significant differences in tannins and phenols in cashew apple juice during three months storage. However, the decrease in tannins was significant from 0.56 to 0.15 % and from 345 to 115 mg gallic acid equivalents/100 ml upto 90 days. Thakur *et al.* (2011) also reported a gradual decrease in phenols content of pomegranate drink during storage and this decrease was slower under refrigerated storage conditions than ambient conditions. Significant decrease in phenols content during storage might be due to their involvement in the formation of polymeric compounds, complexing of phenols with protein and their subsequent precipitations.

2.4 Changes in organoleptic quality of fruit products during storage

Jyothirmayi *et al.* (2006) analyzed that instant raw tamarind chutney powder scored 7.2 even after six months storage period. Vidhya and Narain (2010) reported that the organoleptic evaluation of wood apple jam showed gradual decline in mean score for overall acceptability after 90 days storage. Consistency of product remained the same but its taste declined. Singh and Patil (2011) developed ready-to-mix anardana chutney powder and found

that it retained good texture, attractive colour, appealing flavour and smell, an acceptable taste and refreshing mouthfeel during six months of storage.

Khan *et al.* (2012) reported that organoleptic quality of strawberry jam in terms of colour, taste and overall acceptability decreased from 9.0 to 7.0, 7.1 and 7.0, respectively during sixty days storage. Safdar *et al.* (2012) developed jam from six different mango varieties and sensory evaluation results revealed that *Dusehri* jam recorded highest overall acceptablility among these mango varieties. However, all mango jams remained acceptable even after 150 days storage.

CHAPTER-III

MATERIALS AND METHODS

The present research work entitled, "Development and evaluation of jam and chutney from Guava-Jamun blends" was carried out in Centre of Food Science and Technology, CCSHAU, Hisar during the year 2012-13. The research work was undertaken as per details given below:

3.1 Extraction of pulp

Uniformly ripe guava fruits cv. *Hisar Safeda* and jamun fruits cv. Local were selected for extraction of pulp for making jam and chutney from guava-jamun blends.

3.1.1 Guava pulp

Guava fruits were washed thoroughly with running water and then cut into thin slices with clean stainless steel knife. One kg slices were mixed with 250 ml water and heated at 90^0C to soften fruit slices. The softened fruit slices were then passed through stainless steel sieve to obtain homogeneous pulp without seeds (Fig. 3.1).

Ripe guava fruits

↓

Washing

↓

Cutting thin slices

↓

Adding water

(250 ml/kg slices)

↓

Heating at 90^0C

↓

Passing through sieve

↓

Guava pulp

Fig. 3.1 Flow sheet for extraction of pulp from guava fruits

3.1.2 Jamun pulp

Ripe jamun fruits were washed thoroughly with clean water. In jamun fruits, pulp was extracted manually from the seeds. One kg pulp was mixed with 250 ml of water and mixed in a grinder to obtain fine pulp.

GUAVA FRUITS

Plate 1

JAMUN FRUITS

Plate 2

Ripe jamun fruits
↓
Washing
↓
Separating pulp from seed
(manually)
↓
Adding water
(250 ml/kg slices)
↓
Grinding
↓
Fine Jamun Pulp

Figure 3.2 Flow sheet for extraction of pulp from jamun fruits

3.2 Blending of guava-jamun pulp

The guava pulp was blended with jamun pulp in different ratios (w/w) as given below:

Sr. No.	Guava-Jamun Blends (w/w)
1	100: 0
2	80: 20
3	60: 40
4	40: 60
5	20: 80
6	0: 100

3.3 Preparation of jam from guava-jamun blends

Jam was prepared from the above Guava-Jamun blends as per standard procedure (Fig. 3.3) using 1 kg blended pulp, 750 g sugar, 4 g citric acid and 5 g pectin. The mixture was cooked with constant stirring with a ladle until thick consistency. End point was judged by assessing its TSS. Prepared jam was filled hot in 150 g capacity sterilized glass jars, screw capped properly, cooled in air and stored at room temperature for further studies.

Guava-Jamun blends
↓
Adding sugar
↓
Cooking with constinuous stirring
↓
Adding citric acid and pectin
↓
Cooking till end point
↓

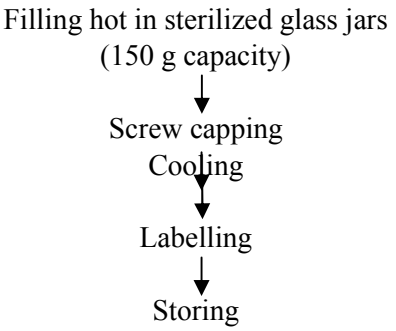

Fig. 3.3 Flow sheet for preparation of guava-jamun jam

3.4 Preparation of chutney from guava-jamun blends

Chutney was prepared from Guava-Jamun blends as per standard procedure (Fig. 3.4) 1 kg pulp, 450 g sugar, 40 g salt, 5 g red chilli powder, 8 g hot spice, 400 g onion paste, 20 g ginger paste, 10 g garlic paste and 5 ml glacial acetic acid. The ingredients (except salt and glacial acetic acid) were mixed thoroughly and cooked continuously with occasional stirring until desired thickness of product was obtained. Salt and glacial acetic acid were added at the end of boiling to prevent browning of the product and it was again cooked for two minutes. Guava-Jamun chutney was filled hot in clean, sterilized 150 g capacity glass jars, screw capped airtight, cooled, labelled and stored at room temperature for recording further observations.

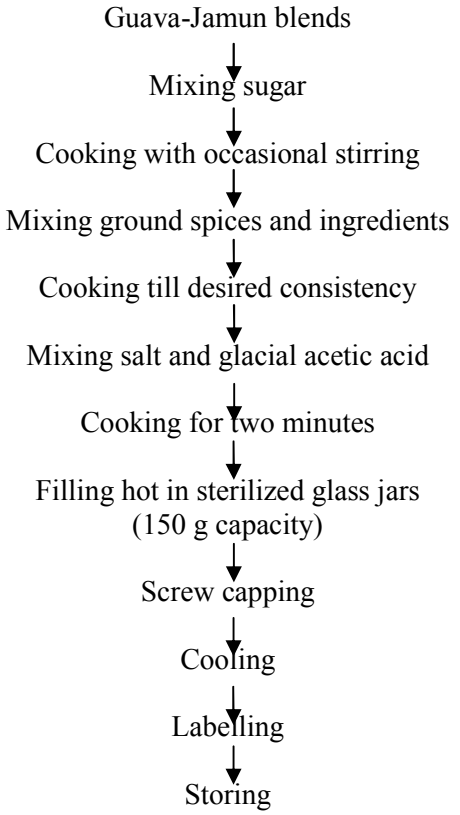

Fig. 3.4 Flow sheet for preparation of guava-jamun chutney

3.5 Physico-chemical analysis

Ripe guava and jamun fruits, and their blended products *viz.*, jam and chutney were analyzed for the following physico-chemical characteristics. Guava-Jamun jam and chutney were also evaluated organoleptically at monthly intervals during three months storage period.

3.5.1 Physical parameters

1. Fruit weight (g)
2. Pulp weight (g)
3. Yield of pulp (%)

3.5.2 Chemical constituents

1. Total soluble solids (%)
2. Total and reducing sugars (%)
3. Acidity (%)
4. pH
5. Ascorbic acid (mg/100 g)
6. Anthocyanins (mg/100 g or ml)
7. Pectin (%)
8. Total phenols (mg/100 g or ml)

3.6 Organoleptic evaluation (9 point hedonic scale)

3.7 Statistical analysis

3.5.1 Physical parameters

Ten fruits were selected randomly and replicated thrice for recording following observations:

3.5.1.1 Fruit weight (g)

Weight of ten fruits was taken on top pan electronic balance and average weight per fruit was calculated and expressed in grams.

3.5.1.2 Pulp weight (g)

Initial weight of randomly selected fruits was recorded on top pan electronic balance. Seeds/stones were separated from the pulp and weighed. Pulp weight was calculated by the following formula:

Pulp weight (g) = [Initial weight of fruit (g) –weight of seeds/stones (g)]

3.5.1.3 Yield of pulp (%)

The yield of pulp was calculated by taking weight of net screened pulp in comparison to weight of fresh fruits and the values were expressed in per cent.

$$\text{Yield of pulp (\%)} = \frac{\text{Weight of pulp}}{\text{Weight of fruits}} \times 100$$

3.5.2 Chemical constituents

3.5.2.1 Total soluble solids (%)

Total soluble solids were estimated at ambient temperature by Abbe's Refractometer (0-95%) or by hand refractometer (0-32%) Erma, Japan and the values were expressed as per cent TSS after correcting at 20^0C temperature.

3.5.2.2 Total and reducing sugars (%)

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

Reagents

1. Potassium ferricyanide solution

Potassium ferricyanide	8.25 g
Anhydrous sodium carbonate	10.6 g
Volume	1 L

2. Potassium iodide solution

Potassium iodide	12.5 g
Zinc sulphate	25.0 g
Sodium chloride	125.0 g
Volume	500 ml

3. 5% Acetic acid solution (v/v)

Glacial acetic acid	50 ml
Volume	1 L

4. Sodium thiosulphate solution (N/100)

Sodium thiosulphate	2.482 g
Volume	1 L

5. Starch solution (indicator)

Soluble starch	1 g
Sodium chloride	20.0 g
Volume	100 ml

Extraction

Ten grams of fresh fruits and five grams of processed products were weighed. About three extractions were taken by adding distilled water and by keeping on water bath. The samples were diluted to appropriate concentration for estimation.

Estimation

(a) Reducing sugars (%)

Five ml of potassium ferricyanide solution was added to five ml of extract in a test tube (1 wide × 7 long). The tubes were covered and kept for 15 minutes in a boiling water bath. The tubes were then cooled under tap water, and 5 ml of potassium iodide solution and 3 ml of acetic acid solution were added to it. The liberated iodine was titrated with sodium

thiosulphate (0.01 N) using starch as an indicator. The end point was disappearance of blue colour and appearance of milky white color. A blank with 5 ml of distilled water was also run simultaneously. The results were calculated by the following formula and expressed in g of sugar per 100 g sample.

$$\text{Reducing sugar (g)} = \frac{\text{Dilution factor x } (T.V_{blank} - T.V_{sample}) \times 0.338}{\text{Volume of aliquot x } 1000} \times 100$$

(b) Total sugars (%)

To 25 ml of sugar extract, 4 ml of concentrated hydrochloric acid was added and kept for 15 minutes at 68^0C in water bath. The acidity was neutralized by adding a little anhydrous sodium carbonate till the effervescence stopped. After this, the volume was made to 100 ml and total sugars were then determined as per the procedure described in reducing sugars.

3.5.2.3 Acidity (%)

Total acids were extracted in water and were estimated by titration against 0.1N sodium hydroxide (Ranganna, 2003). Five grams of macerated sample of fresh fruits was weighed and after adding distilled water (1:5 w/v); it was kept on boiling water bath for one hour. It was filtered, cooled and its volume was made upto 100 ml and suitable aliquot was titrated against 0.1N NaOH using a few drops of 1 per cent phenolphthalein solution as an indicator. From the volume of alkali used, acidity was calculated and results were expressed as g citric acid per 100 g sample.

$$\text{Acidity (\%)} = \frac{\text{Titre vol. (ml)} \times \text{Normality of alkali} \times \text{Eq. wt. of acid} \times \text{Vol. made (ml)} \times 100}{\text{Vol. of aliquot (ml)} \times \text{Wt. or volume of sample (g or ml)} \times 1000}$$

Eq. wt. of citric acid = 64.04

3.5.2.4 pH

pH of product was recorded by pH meter (Model: CL 54 Digital Toshniwal Instruments Mfg. Pvt. Ltd., India).

3.5.2.5 Ascorbic acid (mg/100 g)

The ascorbic acid was determined as per the method given by A.O.A.C. (1990).

Reagents

1. Metaphosphoric acid solution (3%)

Metaphosphoric acid	15 g
Glacial acetic acid	40 ml
Volume	500 ml

2. 2, 6-dichlorophenol indophenol dye

2, 6-dichlorophenol indophenol dye	50 mg

Sodium bicarbonate	42 mg
Volume	200 ml

Preparation of standard ascorbic acid

Fifty mg of ascorbic acid was weighed and made to 50 ml with metaphosphoric acid reagent. One ml of standard ascorbic acid solution was used to standardize the dye with the appearance of a light pink colour as the end point and dye factor was calculated as:

$$\text{Dye factor} = \frac{\text{ml of ascorbic acid}}{\text{ml of dye used}}$$

Extraction

Ascorbic acid was extracted from the fruit blends by macerating 5 g of sample with 3 per cent metaphosphoric acid. The extract was filtered and an appropriate volume was made.

Estimation

A suitable aliquot was titrated against 2,6-dichlorophenol indophenol dye till the appearance of pink colour. The results were expressed in terms of mg ascorbic acid per 100 g by the following formula.

$$\text{mg of ascorbic acid/100 g} = \frac{\text{Titre} \times \text{Dye factor} \times \text{Volume made up}}{\text{Vol. of aliquot} \times \text{Wt. or volume of sample}} \times 100$$

3.5.2.6 Anthocyanins (mg/100 g or ml)

Reagents

1. Ethanolic HCl

95% ethanol- 1.5 N HCl (85:15)

Extraction

Ten grams sample was blended with 15 ml of ethanolic HCl and stored overnight in a refrigerator at 4^0C. Next day, the extract was filtered using Whatman No. 1 filter paper and its volume made to 50 ml with ethanolic HCl with repeated washing of the residue on the filter paper.

Estimation

For estimation, 3 ml of sample was taken, diluted with ethanolic HCl to yield optical density measurements within the optimum range of the instrument. Stored in dark for 2 hours and absorbance was taken at 535 nm. The total anthocyanins content was estimated by using the formula given below:

$$\text{Total OD per 100g (A)} = \frac{\text{Absorbance at 535 nm} \times \text{Volume made up of the extract used for colour measurement} \times \text{Total Volume}}{\text{ml of extract used} \times \text{Wt. of sample taken}} \times 100$$

$$\text{Total anthocyanins content in mg/100 g} = \frac{\text{A}}{\text{Extinction coefficient of anthocyanin pigment}}$$

Extinction coefficient for anthocyanin pigment in jamun is 98.2

3.5.2.7 Pectin (%)

Total pectin as calcium pectate in fresh fruits was estimated by the method of Ranganna (2003).

Reagents

1. 1N Acetic acid

Glacial acetic acid	30 ml
Volume	500 ml

2. 1N Calcium chloride

Anhydrous calcium chloride	27.5 g
Volume	500 ml

3. 1N Sodium hydroxide

Sodium hydroxide	20 g
Volume	500 ml

4. 1% Silver nitrate

Silver nitrate	1 g
Volume	100 ml

Extraction

For estimation of pectin, 25 g of fresh fruits macerated samples were taken in a flask. To this, 200 ml distilled water was added and kept on a hot plate for an hour. The water lost during boiling was replaced simultaneously. The flask was then cooled and the volume was made to 250 ml. The contents of flask were filtered through Whatman filter paper No. 4.

Estimation

To 50 ml portion of filtrate, 50 ml of distilled water and 5 ml of 1N NaOH was added and kept overnight. Next day, 25 ml of 1N acetic acid solution was added to it and after 5 minutes, 12.5 ml of 1N calcium chloride solution was added with stirring. After allowing it to stand it for an hour, it was boiled for one minute and filtered through oven dried, previously weighed Whatman filter paper No. 4. The precipitates were washed with distilled water until these were free from chloride (test with 1% silver nitrate solution). The precipitates were then dried at 100^0C overnight, cooled in desiccator and weighed. The amount of pectin was expressed as per cent calcium pectate.

$$\text{Calcium pectate (\%)} = \frac{\text{Weight of calcium pectate} \times \text{Volume of content}}{\text{Vol. of filtrate} \times \text{Weight of sample taken for estimation}} \times 100$$

3.5.2.8. Total phenols (mg/100 g)

Phenols were estimated by the method of A.O.A.C. (1990).

Reagents

1.	**Folin ciocalteau reagents (2N)**	1:1
2.	**Sodium carbonate**	35 g
	Volume	1 L
3.	**Tannic acid**	100 mg
	Volume	1 L

Preparation of standard curve

Aliquots (0 to 10 ml) of standard tannic acid solution were pipetted into 100 ml volumetric flask and 75 ml of distilled water was added, after this, 5 ml folin ciocalteau reagent and 10 ml of sodium carbonate solution was added. Its volume was made to 100 ml with water, mixed well and the absorbance was taken after 30 minutes at 760 nm and standard curve was prepared.

Determination

Five grams of fruit pulp and blended products were macerated and boiled for 30 minutes with 400 ml distilled water, transferred to 500 ml volumetric flask and the volume was made upto the mark. Took 5 ml (sample + water) diluted extract and pipetted 0.5 ml of folin ciocalteau reagent. After 3 to 4 minutes, one ml of sodium carbonate solution was added and its volume was made to 10 ml with distilled water. It was mixed well and the absorbance was determined after 30 minutes at 760 nm.

3.6. Organoleptic evaluation (9 point hedonic scale)

Guava-Jamun jam and chutney were subjected to sensory evaluation soon after preparation and after 1, 2 and 3 months storage period by a panel of judges following the hedonic rating scale (see appendix) as described by Ranganna (2003). The products were evaluated for colour and appearance, texture, taste, flavour, mouthfeel and overall acceptability. The overall acceptability of guava-jamun jam and chutney was based on mean scores obtained from all the sensory characters. The characters with mean scores of 6 or above out of 9 were considered acceptable.

3.7. Statistical analysis

The data in the present investigation were subjected to analysis of variance (ANOVA) techniques and analyzed according to completely randomized design. The critical difference value at 5 per cent level was used for making comparison among different treatments during three months storage period.

CHAPTER-IV

EXPERIMENTAL RESULTS

The present investigation entitled "**Development and evaluation of jam and chutney from Guava-Jamun blends**" was carried out to standardize appropriate combination of guava-jamun blends for preparation of jam and chutney, and also to evaluate storage quality of blended products The experimental results emanating from the present study have been presented in this chapter under the following sub headings:

4.1 Physico-chemical characteristics of guava and jamun fruits

4.2 Changes in chemical constituents and organoleptic quality of guava-jamun jam and chutney during storage

4.3 Cost of production of guava-jamun jam and chutney

4.1 Physico-chemical characteristics of fresh guava and jamun fruits

The fresh guava and jamun fruits were evaluated for various physico-chemical characteristics and the results recorded have been presented in Table 1. Data show that average guava and jamun fruit weight, pulp weight and yield of pulp were (124.7 and 5.27 g), (833.9 and 674.7 g/kg fruit) and (83.39 and 67.47%), respectively. Chemical constituents of guava and jamun fruits such as total soluble solids (TSS), total sugars, reducing sugars, acidity and pH were analyzed to be (9.07 and 8.47%), (7.30 and 5.92%), (2.62 and 4.57%), (0.57 and 1.15%) and (3.71 and 3.38), whereas ascorbic acid, anthocyanin, pectin and total phenols were found to be (85.80 and 18.20 mg/100 g), (N.D. and 134.92 mg/100 g), (1.11 and 0.86%) and (117.06 and 220.90 mg/100 g), respectively.

Table 1. Physico-chemical characteristics of fresh Guava and Jamun fruits

Sr. No.	Parameters	Guava*	Jamun*
1.	Fruit weight (g)	124.67±8.62	5.27±0.15
2.	Pulp weight (g/kg fruit)	833.9±8.79	674.7±11.12
3.	Yield of pulp (%)	83.39±0.89	67.47±1.11
4.	TSS (%)	9.07±0.12	8.47±0.11
5.	Total sugars (%)	7.30±0.08	5.92±0.08
6.	Reducing sugars (%)	2.62±0.12	4.57±0.20
7.	Acidity (%)	0.57±0.07	1.15±0.06
8.	pH	3.71±0.06	3.38±0.17
9.	Ascorbic Acid (mg/100g)	85.80±3.68	18.20±2.60
10.	Anthocyanin (mg/100g)	N.D.**	134.92±3.14
11.	Pectin (%)	1.11±0.85	0.86± 0.15
12.	Total phenols (mg/100g)	117.06±0.05	220.90± 0.08

*The values are mean ± S.D. of three replicates except fruit weight, pulp weight and yield of pulp which are mean ± S.D. of ten replicates

**Not in detectable amount

4.2 Changes in chemical constituents and organoleptic quality of guava-jamun jam and chutney during storage

4.2.1 Jam

4.2.1.1 Total soluble solids (%)

The data in Table 2 reveal that there was significant effect of different treatments on total soluble solids of guava-jamun jam. Total soluble solids of blended jam also increased significantly (68.0 to 68.6%) during three months storage period. However, interaction between treatment and storage period was found non-significant. Total soluble solids were recorded maximum (68.6%) in jam (100 guava:0 jamun) and minimum (68.1%) in jam (0 guava:100 jamun).

Table 2. Effect of various treatments on total soluble solids (%) of guava-jamun jam during storage

Treatments (Guava:Jamun)	Storage period (months)				Mean
	0	1	2	3	
100:0	68.0	68.7	68.8	69.0	**68.6**
80:20	68.0	68.5	68.6	68.8	**68.5**
60:40	68.0	68.4	68.4	68.6	**68.4**
40:60	68.0	68.2	68.3	68.5	**68.3**
20:80	68.0	68.1	68.2	68.3	**68.2**
0:100	68.0	68.1	68.2	68.2	**68.1**
Mean	**68.0**	**68.3**	**68.4**	**68.6**	
C.D. at 5%	**Treatment =0.08, Storage =0.09, Treatment × Storage =NS**				

4.2.1.2 Total sugars (%)

The data in Table 3 reveal that there was significant effect of different treatments on total sugars of guava-jamun jam. Total sugars of blended jam also increased significantly (51.5 to 52.9%) during three months storage period. However, interaction between treatment and storage period was found non-significant. Total sugars were recorded maximum (53.0%) in jam (100 guava:0 jamun) and minimum (51.5%) in jam (0 guava:100 jamun).

4.2.1.3 Reducing sugars (%)

The data in Table 4 show that there was significant effect of different treatments on reducing sugars of guava-jamun jam and there was also a significant increase (33.1 to 35.7) in reducing sugars of guava-jamun jam with the advancement in storage period. Interaction between treatments and storage period was, however, found non-significant. Reducing sugars were recorded maximum (36.1%) in jam (0 guava:100 jamun) and minimum (32.8%) in jam (100 guava: 0 jamun).

100G:0J 80G:20J 60G:40J 40G:60J 20G:80J 0G:100J

GUAVA – JAMUN JAM

Plate 3

100G:0J 80G:20J 60G:40J 40G:60J 20G:80J 0G:100J

GUAVA – JAMUN CHUTNEY

Plate 4

G = Guava
J = Jammun

Table 3. Effect of various treatments on total sugars (%) of guava-jamun jam during storage

Treatments (Guava:Jamun)	Storage period (months)				Mean
	0	1	2	3	
100:0	51.9	52.8	53.4	54.0	**53.0**
80:20	51.7	52.6	53.0	53.7	**52.8**
60:40	51.6	52.4	52.6	52.8	**52.4**
40:60	51.3	51.7	52.3	52.6	**52.0**
20:80	51.2	51.6	52.0	52.3	**51.8**
0:100	51.1	51.4	51.6	52.0	**51.5**
Mean	**51.5**	**52.1**	**52.5**	**52.9**	
C.D. at 5%	**Treatment = 0.17, Storage = 0.36, Treatment × Storage = NS**				

Table 4. Effect of various treatments on reducing sugars (%) of guava-jamun jam during storage

Treatments (Guava:Jamun)	Storage period (months)				Mean
	0	1	2	3	
100:0	31.4	32.1	33.5	34.6	**32.8**
80:20	31.8	32.5	33.9	34.7	**33.2**
60:40	32.7	33.1	34.2	35.7	**33.9**
40:60	33.3	33.9	34.9	35.9	**34.5**
20:80	34.4	35.2	35.5	36.3	**35.4**
0:100	34.9	35.5	36.7	37.1	**36.1**
Mean	**33.1**	**33.7**	**34.8**	**35.7**	
C.D. at 5%	**Treatment = 0.30, Storage = 0.52, Treatment × Storage = NS**				

4.2.1.4 Acidity (%)

It is clear from the data in Table 5 that there was significant effect of different treatments on acidity of guava-jamun jam and there was also a significant decrease (1.07 to 0.94%) in acidity of guava-jamun jam with the advancement in storage duration. However, interaction between treatments and storage period was found non-significant. Acidity was recorded maximum (1.22%) in jam (0 guava:100 jamun) and minimum (0.82%) in jam (100 guava:0 jamun).

Table 5. Effect of various treatments on acidity (%) of guava-jamun jam during storage

Treatments (Guava:Jamun)	Storage period (months)				Mean
	0	1	2	3	
100:0	0.88	0.84	0.79	0.75	**0.82**
80:20	0.93	0.91	0.84	0.81	**0.87**
60:40	1.02	0.98	0.95	0.90	**0.96**
40:60	1.10	1.05	1.00	0.95	**1.02**
20:80	1.23	1.19	1.14	1.09	**1.16**
0:100	1.29	1.24	1.19	1.15	**1.22**
Mean	**1.07**	**1.04**	**0.99**	**0.94**	
C.D. at 5%	**Treatment = 0.01, Storage = 0.01, Treatment × Storage = NS**				

4.2.1.5 pH

The data in Table 6 show that there was significant effect of different treatments on pH of guava-jamun jam and there was also a significant increase (3.16 to 3.33) in pH of guava-jamun jam with the advancement in storage period. Interaction between treatments and storage period was, however, found non-significant. pH value was recorded maximum (3.33) in jam (100 guava:0 jamun) and minimum (3.13) in jam (0 guava:100 jamun).

Table 6. Effect of various treatments on pH of guava-jamun jam during storage

Treatments (Guava:Jamun)	Storage period (months)				Mean
	0	1	2	3	
100:0	3.24	3.27	3.32	3.49	**3.33**
80:20	3.23	3.29	3.34	3.41	**3.31**
60:40	3.19	3.24	3.27	3.32	**3.25**
40:60	3.12	3.21	3.27	3.28	**3.23**
20:80	3.12	3.18	3.23	3.27	**3.20**
0:100	3.06	3.13	3.17	3.18	**3.13**
Mean	**3.16**	**3.22**	**3.27**	**3.33**	
C.D. at 5%	**Treatment = 0.01, Storage = 0.01, Treatment × Storage = NS**				

4.2.1.6 Ascorbic acid (mg/100 g)

The data in Table 7 reveal that there was significant effect of different treatments on ascorbic acid of guava-jamun jam. Ascorbic acid of blended jam decreased significantly (17.9 to 10.7 mg/100 g) during three months storage period. The interaction between treatments and storage period was also found significant. The maximum ascorbic acid value was recorded

(25.4 mg/100 g) in jam (100 guava:0 jamun) and minimum (4.5 mg/100 g) in jam (0 guava:100 jamun).

Table 7. Effect of various treatments on ascorbic acid (mg/100 g) of guava-jamun jam during storage

Treatments (Guava:Jamun)	Storage period (montha)				Mean
	0	1	2	3	
100:0	28.6	26.6	24.9	21.3	**25.4**
80:20	25.1	21.7	18.2	16.5	**20.4**
60:40	19.9	17.3	14.7	12.1	**16.0**
40:60	15.5	13.9	11.3	8.7	**12.5**
80:20	11.3	8.7	6.1	3.5	**7.4**
0:100	6.9	5.3	3.5	2.0	**4.5**
Mean	**17.9**	**15.6**	**13.1**	**10.7**	
C.D. at 5%	**Treatment = 1.09, Storage =1.34 , Treatment × Storage = 2.69**				

4.2.1.7 Anthocyanins (mg/100 g)

The data in Table 8 show that there was significant effect of different treatments on anthocyanin of guava-jamun jam. Anthocyanin of blended jam decreased significantly (40.3 to 34.4 mg/100 g) during three months storage period. The interaction between treatments and storage period was also found significant. The maximum anthocyanins were recorded (77.9 mg/100 g) in jam (0 guava:100 jamun) and minimum (0 mg/100 g) in jam (100 guava:0 jamun).

Table 8. Effect of various treatments on anthocyanins (mg/100 g) of guava-jamun jam during storage

Treatments (Guava:Jamun)	Storage period (months)				Mean
	0	1	2	3	
100:0	0	0	0	0	**0**
80:20	15.5	13.5	10.5	7.7	**11.8**
60:40	36.6	34.1	32.6	30.2	**33.4**
40:60	49.7	48.0	45.6	42.5	**46.5**
80:20	59.9	57.1	54.0	52.3	**55.8**
0:100	80.3	79.6	77.9	73.9	**77.9**
Mean	**40.3**	**38.7**	**36.7**	**34.4**	
C.D. at 5%	**Treatment = 0.9, Storage = 1.05, Treatment × Storage = 2.09**				

4.2.1.8 Total phenols (mg/100 g)

It is evident from the data in Table 9 that there was significant effect of different treatments on total phenols of guava-jamun jam. The interaction between the treatments and storage period was also found significant. Total phenols were recorded maximum (117.7 mg/100 g) in jam (0 guava: 100 jamun) and minimum (57.7 mg/100 g) in jam (100 guava:0 jamun). Total phenols of blended jam decreased significantly (90.6 to 82.5 mg/100 g) during three months storage.

Table 9. Effect of various treatments on total phenols (mg/100 g) of guava-jamun jam during storage

Treatments (Guava:Jamun)	Storage period (months)				Mean
	0	1	2	3	
100:0	61.4	59.3	57.0	53.1	**57.7**
80:20	74.3	72.1	69.1	66.6	**70.6**
60:40	82.5	80.3	76.1	74.1	**78.3**
40:60	95.3	92.3	88.9	86.9	**90.9**
20:80	108.3	106.0	103.0	101.3	**104.7**
0:100	121.7	119.7	116.3	113.0	**117.7**
Mean	**90.6**	**88.3**	**85.1**	**82.5**	
C.D. at 5%	**Treatment = 0.77, Storage = 0.94, Treatment × Storage = 1.89**				

4.2.1.9 Colour and appearance

It is clear from the data (Table 10) that there was no significant effect of different treatments on colour and appearance of guava-jamun jam. The scores for colour and appearance in blended jam, however, decreased significantly (8.6 to 7.9) during three months storage. Interaction between treatments and storage period was also found non-significant. Maximum score (8.3) for colour and appearance was recorded in jam (60 guava:40 jamun, 40 guava:60 jamun and 80 guava:20 jamun) and minimum score (7.8) was recorded in jam (100 guava :0 jamun).

4.2.1.10 Texture

The data (Table 11) reveal that there was significant effect of different treatments and storage period on texture of guava-jamun jam. However, the interaction between treatments and storage period was found non-significant. The scores for texture decreased significantly from 8.3 to 6.8 during three months storage period. Texture score was recorded maximum (8.0) in jam (40 guava:60 jamun) and minimum (6.8) in jam (0 guava:100 jamun).

Table 10. Effect of various treatments on colour and appearance of guava-jamun jam during storage

Treatments (Guava:Jamun)	Storage period (months)				Mean
	0	1	2	3	
100:0	8.3	7.7	7.7	7.3	**7.8**
80:20	8.3	8.0	7.7	7.7	**7.9**
60:40	8.7	8.3	8.0	8.0	**8.3**
40:60	8.7	8.3	8.0	8.0	**8.3**
80:20	8.7	8.3	8.0	8.0	**8.3**
0:100	8.7	8.2	8.0	7.8	**8.2**
Mean	**8.6**	**8.1**	**7.9**	**7.9**	
C.D. at 5%	**Treatment = NS, Storage =0.37, Treatment × Storage = NS**				

Table 11. Effect of various treatments on texture of guava-jamun jam during storage

Treatments (Guava:Jamun)	Storage period (months)				Mean
	0	1	2	3	
100:0	8.3	7.0	7.0	6.3	**7.2**
80:20	8.7	7.3	7.3	7.0	**7.6**
60:40	8.7	7.7	7.3	7.3	**7.8**
40:60	8.7	8.0	7.7	7.7	**8.0**
20:80	8.3	6.7	6.7	6.0	**6.9**
0:100	7.7	6.7	6.7	6.3	**6.8**
Mean	**8.3**	**7.2**	**7.2**	**6.8**	
C.D. at 5%	**Treatment = 0.52, Storage = 0.64, Treatment × Storage = NS**				

4.2.1.11 Taste

The data in Table 12 reveal there was no significant effect of different treatments on taste of guava-jamun jam. The scores for taste decreased significantly (8.6 to 7.7) during three months storage period. Interaction between treatments and storage period was found non-significant. Taste acceptability was recorded maximum (8.4) in jam (40 guava:60 jamun) and minimum (8.0) in jam (100 guava:0 jamun, 80 guava:20 jamun and 0 guava:100 jamun).

Table 12. Effect of various treatments on taste of guava-jamun jam during storage

Treatments (Guava:Jamun)	Storage period (months)				Mean
	0	1	2	3	
100:0	8.3	8.0	8.0	7.7	**8.0**
80:20	8.7	8.0	8.0	7.3	**8.0**
60:40	8.7	8.0	8.0	8.0	**8.2**
40:60	8.7	8.7	8.3	8.0	**8.4**
20:80	8.7	8.3	8.0	7.7	**8.2**
0:100	8.3	8.0	8.0	7.7	**8.0**
Mean	**8.6**	**8.2**	**8.1**	**7.7**	
C.D. at 5%	**Treatment = NS, Storage = 0.37, Treatment × Storage = NS**				

4.2.1.12. Flavour

The data in Table 13 reveal that there was significant effect of different treatments and storage period on flavor of guava-jamun jam. However, the interaction between treatments and storage period was found non-significant. The scores for flavour however, decreased significantly from 8.4 to 7.8 during three months storage period. Flavour score was recorded maximum (8.4) in jam (40 guava:60 jamun) and minimum (7.9) in jam (100 guava:0 jamun) and (0 guava:100 jamun).

Table 13. Effect of various treatments on flavor of guava-jamun jam during storage

Treatments (Guava:Jamun)	Storage period (months)				Mean
	0	1	2	3	
100:0	8.1	8.0	7.9	7.7	**7.9**
80:20	8.5	8.3	8.0	7.6	**8.1**
60:40	8.4	8.3	8.1	7.8	**8.2**
40:60	8.7	8.4	8.3	8.1	**8.4**
20:80	8.6	8.3	8.1	7.9	**8.2**
0:100	8.1	8.0	8.0	7.8	**7.9**
Mean	**8.4**	**8.2**	**8.1**	**7.8**	
C.D. at 5%	**Treatment = NS, Storage = 0.32, Treatment × Storage = NS**				

4.2.1.13 Mouthfeel

The data in Table 14 reveal that the scores for mouthfeel in guava-jamun jam decreased significantly from 8.4 to 7.5 during three months storage. There was, however, no significant effect of different treatments on mouthfeel in guava-jamun jam. Interaction between treatments and storage period was also found non-significant. Mouth feel scores

were recorded maximum (8.1) in jam (60 guava:40 jamun) and minimum (7.7) in jam (100 guava:0 jamun).

Table 14. Effect of various treatments on mouthfeel of guava-jamun jam during storage

Treatments (Guava:Jamun)	Storage period (months)				Mean
	0	1	2	3	
100:0	8.3	7.7	7.7	7.3	**7.7**
80:20	8.6	7.7	7.7	7.7	**7.9**
60:40	8.7	8.0	8.0	7.7	**8.1**
40:60	8.3	8.0	8.0	7.7	**8.0**
20:80	8.3	8.3	7.7	7.3	**7.9**
0:100	8.3	8.0	7.7	7.3	**7.8**
Mean	**8.4**	**7.9**	**7.8**	**7.5**	
C.D. at 5%	**Treatment = NS, Storage = 0.48, Treatment × Storage = NS**				

4.2.1.14 Overall acceptability

The data (Table 15) show that there was significant effect of different treatments and storage period on overall acceptability of guava-jamun jam. Overall acceptability of guava-jamun jam decreased significantly from 8.5 to 7.6 with the advancement in storage period. The interaction between treatments and storage period was, however, found non-significant. Overall acceptability of jam was recorded maximum (8.2) in blend (40 guava:60 jamun) and minimum (7.7) in blend (100 guava:0 jamun).

Table 15. Effect of various treatments on overall acceptability of guava-jamun jam during storage

Treatments (Guava:Jamun)	Storage period (months)				Mean
	0	1	2	3	
100:0	8.3	7.7	7.6	7.3	**7.7**
80:20	8.6	7.9	7.7	7.5	**7.9**
60:40	8.7	8.1	7.9	7.8	**8.1**
40:60	8.6	8.3	8.1	7.9	**8.2**
20:80	8.5	7.9	7.7	7.4	**7.9**
0:100	8.2	7.9	7.7	7.4	**7.8**
Mean	**8.5**	**7.9**	**7.8**	**7.6**	
C.D. at 5%	**Treatment = 0.27, Storage = 0.33, Treatment × Storage = NS**				

4.2.2 Chutney

4.2.2.1 Total soluble solids (%)

The data in Table 16 reveal that there was significant effect of different treatments on total soluble solids of guava-jamun chutney. There was also significant effect of storage period on total soluble solids of guava-jamun chutney. However, interaction between treatment and storage period was found non significant. Total soluble solids were recorded maximum (53.5%) in chutney (100 guava:0 jamun) and minimum (53.0%) in chutney (0 guava:100 jamun). Total soluble solids increased significantly from 53.0 to 53.4% in guava-jamun chutney during three months storage period.

Table 16. Effect of various treatments on total soluble solids (%) of guava-jamun chutney during storage

Treatments (Guava:Jamun)	Storage period (months)				Mean
	0	1	2	3	
100:0	53.0	53.6	53.6	53.7	**53.5**
80:20	53.0	53.3	53.5	53.6	**53.4**
60:40	53.0	53.3	53.3	53.5	**53.3**
40:60	53.0	53.2	53.3	53.4	**53.2**
20:80	53.0	53.1	53.1	53.3	**53.1**
0:100	53.0	53.0	53.1	53.1	**53.0**
Mean	**53.0**	**53.2**	**53.3**	**53.4**	
C.D. at 5%	**Treatment = 0.07, Storage = 0.08, Treatment × Storage = NS**				

4.2.2.2 Total sugars (%)

The data (Table 17) show that there was significant effect of different treatments on total sugars of guava-jamun chutney. Total sugars of blended chutney also increased significantly during three months storage period. Interaction between treatments and storage period was, however, found non-significant. Total sugars of guava-jamun chutney increased significantly from 39.7 to 41.6 per cent during three months storage period. Total sugars were recorded maximum (42.1%) in chutney (100 guava:0 jamun) and minimum (39.3%) in chutney (0 guava:100 jamun).

Table 17. Effect of various treatments on total sugars (%) of guava-jamun chutney during storage

Treatments (Guava:Jamun)	Storage period (months)				Mean
	0	1	2	3	
100:0	41.1	42.2	42.5	42.7	**42.1**
80:20	41.0	41.5	41.8	42.2	**41.6**
60:40	40.3	41.2	41.4	41.8	**41.2**
40:60	39.6	41.0	41.1	41.4	**40.8**
20:80	38.6	40.3	41.0	41.1	**40.2**
0:100	37.5	39.6	39.9	40.3	**39.3**
Mean	**39.7**	**40.9**	**41.3**	**41.6**	
C.D. at 5%	**Treatment = 0.37, Storage = 0.24, Treatment × Storage = NS**				

4.2.2.3 Reducing sugars (%)

The data in Table 18 reveal that there was significant effect of different treatments on reducing sugars of guava-jamun chutney and there was also a significant increase in reducing sugars of guava-jamun chutney with the advancement in storage period. The interaction between treatments and storage period was, however, found non-significant. Reducing sugars of guava-jamun chutney increased significantly from 23.3 to 26.1 per cent during three months storage period. Reducing sugars were recorded maximum (26.9%) in chutney (0 guava:100 jamun) and minimum (22.9%) in chutney (100 guava:0 jamun).

Table 18. Effect of various treatments on reducing sugars (%) of guava-jamun chutney during storage

Treatments (Guava:Jamun)	Storage period (months)				Mean
	0	1	2	3	
100:0	21.9	22.4	23.0	24.5	**22.9**
80:20	22.4	22.7	23.2	24.9	**23.3**
60:40	23.1	23.1	23.4	25.2	**23.7**
40:60	23.4	23.8	25.6	26.3	**24.8**
20:80	24.5	25.6	26.7	27.1	**25.9**
0:100	25.2	26.3	27.4	28.8	**26.9**
Mean	**23.3**	**23.9**	**24.9**	**26.1**	
C.D. at 5%	**Treatment = 0.46, Storage = 0.56, Treatment × Storage = NS**				

4.2.2.4 Acidity (%)

The data (Table 19) show that there was significant effect of different treatments on acidity percentage of guava-jamun chutney. There was a significant decrease in acidity of guava-jamun chutney with the advancement in storage duration. However, interaction between treatments and storage period was not found significant. Acidity was recorded maximum (0.77%) in chutney (0 guava:100 jamun) and minimum (0.34%) in chutney (100 guava:0 jamun). Acidity of guava-jamun chutney decreased significantly from 0.61 to 0.50 per cent during three months storage period.

Table 19. Effect of various treatments on acidity (%) of guava-jamun chutney during storage

Treatments (Guava:Jamun)	Storage period (months)				Mean
	0	1	2	3	
100:0	0.40	0.37	0.32	0.28	**0.34**
80:20	0.49	0.45	0.41	0.38	**0.43**
60:40	0.58	0.52	0.49	0.45	**0.51**
40:60	0.65	0.61	0.58	0.54	**0.59**
20:80	0.74	0.71	0.67	0.63	**0.69**
0:100	0.82	0.80	0.76	0.71	**0.77**
Mean	**0.61**	**0.58**	**0.54**	**0.50**	
C.D. at 5%	**Treatment = 0.01, Storage = 0.01, Treatment × Storage = NS**				

4.2.2.5 pH

The data in Table 20 reveal that there was significant effect of different treatments on pH of guava-jamun chutney and there was also a significant increase in pH of guava-jamun chutney with the advancement in storage period. Interaction between treatments and storage period was, however, found non-significant. pH of guava-jamun chutney increased significantly from 3.3 to 3.6 during three months storage period. It was recorded maximum (3.7) in chutney (100 guava:0 jamun) and minimum (3.1) in chutney (0 guava:100 jamun).

4.2.2.6 Ascorbic acid (mg/100 g)

It is evident from the data in Table 21 that there was significant effect of different treatments on ascorbic acid of guava-jamun chutney. Ascorbic acid of blended chutney decreased significantly (16.8 to 8.3 mg/100 g) during three months storage period. The interaction between treatments and storage period was also found significant. The maximum ascorbic acid content was recorded (22.5 mg/100 g) in chutney (100 guava:0 jamun) and minimum (3.6 mg/100 g) in chutney (0 guava:100 jamun).

Table 20. Effect of various treatments on pH of guava-jamun chutney during storage

Treatments (Guava:Jamun)	Storage period (months)				Mean
	0	1	2	3	
100:0	3.6	3.6	3.7	3.7	**3.7**
80:20	3.5	3.5	3.5	3.6	**3.5**
60:40	3.3	3.4	3.4	3.5	**3.4**
40:60	3.2	3.3	3.4	3.4	**3.3**
20:80	3.2	3.2	3.3	3.4	**3.2**
0:100	3.1	3.1	3.2	3.2	**3.1**
Mean	**3.3**	**3.4**	**3.5**	**3.6**	
C.D. at 5%	**Treatment = 0.06, Storage = 0.07, Treatment × Storage = NS**				

Table 21. Effect of various treatments on ascorbic acid (mg/100 g) of guava-jamun chutney during storage

Treatments (Guava:Jamun)	Storage period(months)				Mean
	0	1	2	3	
100:0	26.9	24.2	21.6	17.3	**22.5**
80:20	24.2	19.1	14.7	11.3	**17.3**
60:40	19.1	16.5	13.0	10.4	**14.8**
40:60	14.7	11.3	8.7	6.1	**10.2**
20:80	9.5	8.7	6.1	3.5	**6.9**
0:100	6.1	5.0	2.7	1.2	**3.6**
Mean	**16.8**	**14.1**	**11.1**	**8.3**	
C.D. at 5%	**Treatment = 1.03, Storage = 1.27, Treatment × Storage = 2.38**				

4.2.2.7 Anthocyanins (mg/100 g)

The data in Table 22 show that there was significant effect of different treatments on anthocyanins of guava-jamun chutney. Anthocyanin of blended chutney decreased significantly (35.7 to 27.6 mg/100 g) during three months storage period. The interaction between treatments and storage period was also found significant. The maximum anthocyanins were recorded (66.4 mg/100 g) in chutney (0 guava:100 jamun) and minimum (1.9 mg/100 g) in chutney (100 guava: 0 jamun).

Table 22. Effect of various treatments on anthocyanins (mg/100 g) of guava-jamun chutney during storage

Treatments (Guava:Jamun)	Storage period (months)				Mean
	0	1	2	3	
100:0	2.5	2.1	1.6	1.2	**1.9**
80:20	13.4	11.8	9.5	7.8	**10.6**
60:40	30.1	27.6	22.4	20.6	**25.2**
40:60	41.6	37.7	34.1	31.4	**36.2**
20:80	53.6	50.8	48.7	45.6	**49.7**
0:100	73.4	70.3	63.9	58.9	**66.4**
Mean	**35.7**	**33.2**	**30.0**	**27.6**	
C.D. at 5%	**Treatment = 0.42, Storage = 0.52, Treatment × Storage = 1.04**				

4.2.2.8 Total phenols (mg/100 g)

It is clear from the data in Table 23 that there was significant effect of different treatments and storage period on total phenols of guava-jamun chutney. The interaction between treatments and storage period was also found significant. Total phenols were recorded maximum (154.1 mg/100 g) in chutney (0 guava:100 jamun) and minimum (80.1 mg/100 g) in chutney (100 guava:0 jamun). Total phenols of blended chutney decreased significantly from 118.1 to 110.8 mg/100 g during three months storage.

Table 23. Effect of various treatments on total phenols (mg/100 g) of guava-jamun chutney during storage

Treatments (Guava:Jamun)	Storage period (months)				Mean
	0	1	2	3	
100:0	83.7	81.4	78.7	76.7	**80.1**
80:20	96.7	94.3	91.1	88.4	**92.6**
60:40	103.3	101.3	98.2	95.1	**99.5**
40:60	127.0	125.0	122.7	120.0	**123.7**
20:80	141.0	139.0	137.3	134.0	**137.8**
0:100	157.0	155.5	153.0	150.7	**154.1**
Mean	**118.1**	**116.1**	**113.5**	**110.8**	
C.D. at 5%	**Treatment = 0.72, Storage = 0.88, Treatment × Storage = 1.76**				

4.2.2.9 Colour and appearance

It is evident from data in Table 24 that there was significant effect of different treatments and storage period on colour and appearance of guava-jamun chutney. The interaction between treatments and storage period was, however, found non-significant. Maximum score (8.3) for colour and appearance was recorded in chutney (60 guava:40 jamun), while minimum score (7.6) was recorded in chutney (0 guava:100 jamun). The scores for colour and appearance in blended chutney decreased significantly (8.6 to 7.4) during three months storage.

Table 24. Effect of various treatments on colour and appearance of guava-jamun chutney during storage

Treatments (Guava:Jamun)	Storage period				Mean
	0	1	2	3	
100:0	8.3	8.0	7.7	7.3	**7.8**
80:20	8.7	8.3	8.0	7.7	**8.2**
60:40	8.7	8.3	8.3	8.0	**8.3**
40:60	8.7	8.0	7.7	7.3	**7.9**
20:80	8.7	8.0	7.3	7.0	**7.8**
0:100	8.3	7.7	7.3	7.0	**7.6**
Mean	**8.6**	**8.1**	**7.7**	**7.4**	
C.D. at 5%	**Treatment = 0.40, Storage = 0.50, Treatment × Storage = NS**				

4.2.2.10 Texture

The data in Table 25 reveal there was significant effect of different treatments and storage period on texture of guava-jamun chutney. The scores for texture decreased significantly from 9.0 to 7.6 during three months storage period. The interaction between treatments and storage period was, however, found non-significant. Texture acceptability was recorded maximum (8.6) in chutney (60 guava:40 jamun) and minimum (7.9) in chutney (20 guava:80 jamun and 0 guava: 100 jamun).

4.2.2.11 Taste

The data (Table 26) show that there was no significant effect of different treatments on taste of guava-jamun chutney. However, there was significant effect of storage period on taste of guava-jamun chutney. Interaction between treatments and storage period was also found non-significant. The scores for taste decreased significantly from 8.8 to 7.5 during three months storage period. The taste acceptability was recorded maximum (8.3) in chutney (80 guava:20 jamun and 60 guava:40 jamun) and minimum (7.7) in chutney (0 guava:100 jamun).

Table 25. Effect of various treatments on texture of guava-jamun chutney during storage

Treatments (Guava:Jamun)	Storage period (months)				Mean
	0	1	2	3	
100:0	9.0	8.7	8.3	8.0	**8.5**
80:20	9.0	8.7	8.3	8.0	**8.5**
60:40	9.0	8.7	8.7	8.0	**8.6**
40:60	9.0	8.0	7.7	7.3	**8.0**
20:80	9.0	8.0	7.7	7.0	**7.9**
0:100	9.0	8.0	7.3	7.3	**7.9**
Mean	**9.0**	**8.3**	**8.0**	**7.6**	
C.D. at 5%	**Treatment =0.35, Storage =0.43, Treatment × Storage = NS**				

4.2.2.12. Flavour

The data in Table 27 reveal that there was no significant effect of different treatments on flavour in guava-jamun chutney. There was, however, significant effect of storage period on flavour scores in guava-jamun chutney. Flavor scores in guava-jamun chutney decreased significantly (8.7 to 7.5) during three months storage period. The interaction effect of treatments and storage period was however, found non-significant. Flavour scores were recorded maximum (8.4) in chutney (60 guava:40 jamun) and minimum (7.6) in chutney (0 guava:100 jamun).

Table 26. Effect of various treatments on taste of guava-jamun chutney during storage

Treatments (Guava:Jamun)	Storage period (months)				Mean
	0	1	2	3	
100:0	8.3	7.7	7.7	7.3	**7.8**
80:20	9.0	8.3	8.0	7.7	**8.3**
60:40	9.0	8.3	8.0	8.0	**8.3**
40:60	9.0	8.0	7.7	7.7	**8.1**
20:80	9.0	7.7	7.7	7.3	**7.9**
0:100	8.7	7.7	7.3	7.0	**7.7**
Mean	**8.8**	**7.9**	**7.7**	**7.5**	
C.D. at 5%	**Treatment = NS, Storage =0.43, Treatment × Storage = NS**				

Table 27. Effect of various treatments on flavour of guava-jamun chutney during storage

Treatments (Guava:Jamun)	Storage period (months)				Mean
	0	1	2	3	
100:0	8.1	7.9	7.3	7.3	**7.7**
80:20	8.6	8.3	8.1	7.7	**8.2**
60:40	8.9	8.4	8.2	7.9	**8.4**
40:60	9.0	8.0	7.8	7.7	**8.1**
20:80	8.9	8.1	8.0	7.1	**8.0**
0:100	8.2	7.6	7.3	7.1	**7.6**
Mean	**8.7**	**8.1**	**7.8**	**7.5**	
C.D. at 5%	**Treatment = NS, Storage = 0.38, Treatment × Storage = NS**				

4.2.2.13 Mouthfeel

The data in Table 28 show that there was significant effect of different treatments on mouthfeel in guava-jamun chutney. There was no significant effect of storage period on mouthfeel scores in guava-jamun chutney. Although, mouthfeel scores in guava-jamun chutney decreased (8.6 to 7.3) during three months storage period. The interaction effect of treatments and storage period was also found non-significant. Mouthfeel scores were recorded maximum (8.2) in chutney (60 guava:40 jamun) and minimum (7.5) in chutney (0 guava:100 jamun).

Table 28. Effect of various treatments on mouthfeel of guava-jamun chutney during storage

Treatments (Guava:Jamun)	Storage period (months)				Mean
	0	1	2	3	
100:0	8.0	7.7	7.3	7.3	**7.6**
80:20	8.7	8.3	8.0	7.3	**8.1**
60:40	8.7	8.3	8.0	7.7	**8.2**
40:60	9.0	7.7	7.7	7.7	**8.0**
20:80	8.7	7.3	7.3	7.0	**7.6**
0:100	8.3	7.3	7.3	7.0	**7.5**
Mean	**8.6**	**7.8**	**7.6**	**7.3**	
C.D. at 5%	**Treatment = 0.46, Storage = NS, Treatment × Storage = NS**				

4.2.2.14. Overall acceptability

The data in Table 29 show that there was significant effect of different treatments and storage period on overall acceptability of guava-jamun chutney. The interaction between

treatments and storage period was, however, found non-significant. The overall acceptability of guava-jamun chutney decreased significantly (8.7 to 7.5) during three months storage period. Overall acceptability of chutney was recorded maximum (8.4) in blend (60 guava:40 jamun) and minimum (7.7) in blend (0 guava:100 jamun).

Table 29. Effect of various treatments on overall acceptability of guava-jamun chutney during storage

Treatments (Guava:Jamun)	Storage period (months)				Mean
	0	1	2	3	
100:0	8.3	8.0	7.7	7.4	**7.9**
80:20	8.8	8.4	8.1	7.7	**8.3**
60:40	8.9	8.4	8.2	7.9	**8.4**
40:60	8.9	7.9	7.7	7.5	**8.0**
20:80	8.9	7.8	7.5	7.1	**7.8**
0:100	8.5	7.7	7.3	7.1	**7.7**
Mean	**8.7**	**8.0**	**7.8**	**7.5**	
C.D. at 5%	**Treatment = 0.15, Storage = 0.18, Treatment × Storage = NS**				

4.3 Cost of production of guava-jamun jam and chutney

It is clear from the data in Table 30 that cost of production of guava-jamun jam and chutney increased with the increase in proportion of jamun pulp in guava-jamun blends. Cost of production of guava-jamun jam was recorded maximum (Rs. 152/kg) in blend (0 guava:100 jamun) and minimum (Rs. 79/kg) in blend (100 guava:0 jamun). Likewise, cost of production of guava-jamun chutney was recorded maximum (Rs. 144/kg) in blend (0 guava:100 jamun) and minimum (Rs. 68/kg) in blend (100 guava:0 jamun).

Table 30. Effect of various treatments on cost of production (Rs./kg) of guava-jamun jam and chutney

Treatments (Guava:Jamun)	Cost of production* (Rs./kg)	
	Jam	**Chutney**
100:0	79	68
80:20	93	82
60:40	106	98
40:60	120	113
20:80	136	128
0:100	152	144

*Production cost does not include labour and fuel cost
(cost of guava= Rs. 30/kg and cost of jamun = Rs. 90/kg)

CHAPTER-V

DISCUSSION

The present investigation was carried out on the topic entitled "Development and evaluation of jam and chutney from Guava-Jamun blends". The results on physico-chemical composition of guava and jamun fruits, and changes in chemical constituents and organoleptic quality of guava-jamun jam and chutney during three months storage have been discussed under the following headings:

5.1 Physico-chemical composition of fresh guava and jamun fruits

The fresh guava and jamun fruits were analyzed for various physico-chemical characteristics. Average fruit weight (124.7 and 5.27 g), pulp weight (833.9 g and 674.7 g/kg fruit), yield of pulp (83.39 and 67.47%), total soluble solids (9.07 and 8.47%), total sugars (7.30 and 5.92%), reducing sugars (2.62 and 4.57%), acidity (0.57 and 1.15%), pH (3.71 and 3.38), ascorbic acid (85.80 and 18.20 mg/100 g), anthocyanin (Nil and 134.92 mg/100 g), pectin (1.11 and 0.86%) and total phenols (117.06 and 220.90 mg/100 g) were recorded for guava and jamun fruits, respectively. Similar results were reported by Dhillon *et al*. (1987) in guava pulp, Bashir *et al*. (2003) in guava, Kannan and Thirumaran (2004) in jamun pulp, Bhardwaj and Yamdagni (2005) in jamun, Sharma *et al*. (2009) in guava, Jain *et al.* (2011) in guava, Patil *et al*. (2012) in jamun, Mahour *et al*. (2012) in guava and Anupa *et al*. (2012) in guava pulp.

5.2 Changes in chemical constituents of guava-jamun jam and chutney during storage

5.2.1 Total soluble solids

The perusal of the data presented in Table 2 and Table 16 showed an increasing trend in total soluble solids of guava-jamun jam and chutney during three months storage. This increase might possibly be due to conversion of polysaccharides into simple soluble substances. These results are in accordance with those of Muhammad *et al.* (2008) in apple jam, Hussain and Shakir (2010) in apricot and apple jam, Mishra *et al.* (2011) in ready-to-eat amla chutney and Bhuiyan (2012) in fresh hog plum chutney.

5.2.2 Total and reducing sugars

5.2.2.1 Total sugars

There was a gradual and significant increase in total sugars of guava-jamun jam and chutney with the advancement in storage period. The increase in total sugars might be due to inversion of sugars as reported by Roy and Singh (1979). They conducted studies on bael slab and toffee, and concluded that increase in total sugars might be due to hydrolysis of

polysaccharides like pectin and starch into simple sugars. Similar observations were recorded by Mishra *et al.* (2011) in ready-to-eat amla chutney.

5.2.2.2 Reducing sugars

Reducing sugars of fruit products generally increase during storage. This increase in reducing sugars might be due to acid hydrolysis of sucrose (Labuza *et al.,* 1970; Rao and Roy, 1980). There was significant increase in reducing sugars of both guava-jamun jam and chutney with the increase in storage period. The increase in reducing sugars during storage might be due to inversion of non-reducing into reducing sugars and hydrolysis of polysaccharides. Similar results were reported by Muhammad *et al.* (2008) in apple jam. Mishra *et al.* (2011) also found significant increase in reducing sugars in ready-to-eat amla chutney. Similar results were also confirmed by Nour *et al.* (2011) in mango jam and Khan *et al.* (2012) in strawberry jam.

5.2.3 Acidity and pH

A significant decrease in acidity and a significant increase in pH of guava-jamun jam and chutney were observed during three months storage period. Rababah *et al.* (2011) also reported similar results in strawberry jam.

5.2.4 Ascorbic acid

Ascorbic acid content decreased significantly in guava-jamun jam and chutney during three months storage period. Since it is sensitive to heat, oxygen and light, and therefore, vitamin C content of developed products might be low due to the fact that it readily got oxidized. Similar reduction in ascorbic acid was recorded by Muhammad *et al.* (2008) in apple jam, Hussain and Shakir (2010) in apricot and apple jam, Souad *et al.* (2012) in watermelon waste jam and Bhuiyan (2012) in fresh hog plum chutney.

5.2.5 Anthocyanins

Anthocyanins are responsible for bluish black or deep purple colour of jamun fruit and its processed products. Anthocyanin contents of jamun jam and chutney decreased significantly during three months storage period. Anthocyanins are phenolic compounds which are highly volatile and are easily oxidised. Anthocyanins might also have decreased due to their condensation into brown pigments during storage. Similar results were reported by Kannan and Thirumaran (2001) in jamun products, Kopjar *et al.* (2009) in strawberry jam, Poiana *et al.* (2011) in strawberry, sweet and sour cherry jam, and Amaro *et al*. (2012) in strawberry jam.

5.2.6 Total phenols

A significant loss in total phenols of both the blended products was recorded during three months storage. The phenolic compounds are highly volatile and are easily oxidized to give brown products of high molecular weight. The decrease in total phenols during storage might be due to their condensation into brown pigments (Fennema, 1976). Similar results

were also reported by Roy and Singh (1979) in bael products, Kannan and Thirumaran (2001) in jamun products (RTS drink, squash, syrup and jam), Kaushik *et al.* (2002) in bael preserve, Kopjar *et al*. (2009) in strawberry jam and Poiana *et al.* (2011) in strawberry, sweet and sour cherry jam.

5.3 Changes in organoleptic quality of guava-jamun jam and chutney during storage

A significant decrease in colour and appearance, texture, taste, flavour, mouthfeel and overall acceptability of guava-jamun jam and chutney was recorded during three months storage period. However, organoleptic score of both the blended fruit products remained above the acceptable level even after three months storage. This decrease in organoleptic quality might be due to changes in chemical constituents or certain enzymatic and non-enzymatic changes in the products.

Kumar (1990) also reported that organoleptic scores of papaya jam and candy decreased gradually with the increase in storage period and the products were found acceptable up to nine months. Domale *et al.* (2008) also reported a gradual decrease in organoleptic score of aonla products during storage at ambient temperature. Vidhya and Narain (2010) reported that organoleptic evaluation of wood apple jam showed gradual decline in mean score for overall acceptability after 90 days storage.

Similarly, Khan *et al.* (2012) reported a decline in organoleptic quality of strawberry jam in terms of colour, taste and overall acceptability, and their scores decreased from 9.0 to 7.0, 7.1 and 7.0, respectively during sixty days storage. Safdar *et al.* (2012) also reported decrease in overall acceptability of mango jam prepared from different varieties. However, all mango jams remained acceptable even after 150 days storage.

CHAPTER-VI

SUMMARY AND CONCLUSION

The present investigation entitled, "Development and evaluation of jam and chutney from Guava-Jamun blends" was carried out in Centre of Food Science and Technology, CCSHAU, Hisar during 2012-2013. The objectives of investigation were to standardize appropriate combination of guava-jamun blends for preparation of jam and chutney, and also to evaluate storage quality of blended products. The salient findings of the investigation are summarized as under:

- Guava and jamun fruits had average fruit weight (124.7 g and 5.27 g) and pulp weight (833.9 g and 674.7 g/kg fruit), respectively.
- Yield of pulp was more in guava fruit (83.39%) than jamun fruit (67.47%).
- Total soluble solids (TSS), total sugars, pH, ascorbic acid and pectin were recorded more in guava fruit than jamun fruit.
- Contrary to it, reducing sugars, acidity, and total phenols were found more in jamun fruit than guava fruit.
- Total soluble solids, total and reducing sugars (%) increased significantly in guava-jamun jam and chutney during three months storage period.
- pH of guava-jamun jam and chutney also increased significantly during three months storage period.
- Anthocyanins and total phenols of guava-jamun jam and chutney decreased significantly during storage period.
- Acidity and ascorbic acid in both the blended products decreased significantly during storage period.
- Overall acceptability of jam and chutney increased by blending guava pulp with jamun pulp in comparison to guava or jamun pulp used alone for the preparation of products.
- Jam prepared with 1 kg blended pulp (40 guava:60 jamun), 750 g sugar, 4 g citric acid and 5 g pectin was found most acceptable (8.2).
- Chutney prepared with 1 kg blended pulp (60 guava:40 jamun), 450 g sugar, 400 g onion paste, 40 g salt, 20 g ginger paste, 10 g garlic paste, 8 g hot spice mix, 5 g red chilli powder and 5 ml glacial acetic acid was found most acceptable (8.4).
- Guava-Jamun jam and chutney were found acceptable even after three months storage period, however, a significant decrease in overall acceptability of both the products was noticed during three months storage period.

- In guava-jamun jam, cost of production was maximum (Rs.152/kg) in blend (0 guava:100 jamun) and minimum (Rs.79/kg) in blend (100 guava:0 jamun).
- In guava-jamun chutney also, cost of production was maximum (Rs. 144/kg) in blend (0 guava:100 jamun) and minimum (Rs. 68/kg) in blend (100 guava:0 jamun).

CONCLUSION

It has been concluded from the present investigation that overall acceptability of guava-jamun jam and chutney increased by blending guava pulp with jamun pulp in comparison to guava or jamun pulp used alone for the preparation of products. The comparative evaluation of guava-jamun blends revealed that jam prepared with 40 guava:60 jamun pulp ratio was highly acceptable followed by 60 guava:40 jamun and 80 guava:20 jamun pulp ratios, while chutney prepared with 60 guava:40 jamun pulp ratio was highly acceptable followed by 80 guava:20 jamun and 40 guava:60 jamun pulp ratios. Acceptability of both the blended products decreased significantly with the increase in storage duration, however, organoleptic scores of both the products remained above the acceptable level in all the blends even after three months storage period. Total soluble solids, total sugars, reducing sugars and pH increased significantly, while acidity, ascorbic acid, anthocyanins and total phenols decreased significantly in guava-jamun jam and chutney during three months storage period. Ascorbic acid increased with the increase in proportion of guava pulp, while anthocyanins and total phenols increased with the increase in proportion of jamun pulp in guava-jamun jam and chutney. In guava-jamun jam and chutney, cost of production was maximum with 0 guava:100 jamun pulp ratio and minimum with 100 guava:0 jamun pulp ratio.

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APPENDIX

CENTRE OF FOOD SCIENCE AND TECHNOLOGY

(HEDONIC RATING SCALE)

Name: Date:

Product: Time:

Instructions: Taste the given samples and check how much you like or dislike each one. Use the appropriate scale to show your attitude by assigning points that best describe your feelings about the samples. An honest expression of your personal feeling will help us. Evaluate on the basis of the following scale.

Score Preference	**Code**
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

S.No.	**Colour and appearance**	**Texture**	**Taste**	**Flavour**	**Mouthfeel**	**Overall acceptability**	**Remarks**

Signature

ABSTRACT

Title of Research Project	:	**Development and evaluation of jam and chutney from Guava-Jamun blends**
Full Name of the Degree Holder	:	**RASHMI BHARDWAJ**
Admission No.	:	2011FST122M
Title of the Degree	:	**Master of Science**
Name of Discipline	:	Food Science and Technology
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Year of Award of Degree	:	2013
Major Subject	:	Food Science and Technology
Total Number of Pages in Thesis	:	43 + iv +I
Number of Words in Abstract	:	251

Key words: Guava, jamun, blends, jam, chutney, organoleptic, quality, overall acceptability, storage

The present research work entitled "Development and evaluation of jam and chutney from Guava-Jamun blends" was carried out with the objectives to standardize appropriate combination of guava-jamun blends for preparation of jam and chutney, and also to evaluate the storage quality of blended products. Guava and jamun fruits were analyzed for different physico-chemical parameters. Data show that guava and jamun fruits had average fruit weight (124.7 and 5.27 g) and pulp weight (883.9 and 674.7 g/kg fruit), respectively. Chemical constituents of guava and jamun fruits such as TSS, total sugars and reducing sugars were found to be (9.07 and 8.47%), (7.30 and 5.92%) and (2.62 and 4.57%), whereas acidity, pH, ascorbic acid, anthocyanins, pectin and total phenols were analyzed to be (0.57 and 1.15%), (3.71 and 3.38), (85.80 and 18.20 mg/100 g), (N.D. and 134.9 mg/100 g), (1.11 and 0.86%) and (117.06 and 220.9 mg/100 g), respectively. Chemical constituents of blended products were analyzed just after processing and at monthly intervals during three months storage period. Total soluble solids, total sugars, reducing sugars and pH increased significantly, while acidity, ascorbic acid, anthocyanins and total phenols decreased significantly in guava-jamun jam and chutney during three months storage. Jam prepared with (40 guava:60 jamun) and chutney prepared with (60 guava:40 jamun) blends were found highly acceptable. Acceptability of guava-jamun jam and chutney decreased significantly with the increase in storage period. Cost of production of guava-jamun jam and chutney was recorded maximum in 0 guava:100 jamun blend and minimum in 100 guava:0 jamun blend.

MAJOR ADVISOR **SIGNATURE OF DEGREE HOLDER**

HEAD OF THE DEPARTMENT
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RASHMI BHARDWAJ