PROCESSING OF JAMUN FRUITS

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By

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CERTIFICATE

This is to certify that the thesis entitled "**PROCESSING OF JAMUN FRUITS**" submitted by **ROHINI P. SHINGALAPUR** for the degree of **MASTER OF SCIENCE (HORTICULTURE)** in **POST-HARVEST TECHNOLOGY** of the University of Agricultural Sciences, Dharwad is a record of research work done by her during the period of her study in this university under my guidance and supervision and the thesis has not previously formed the basis for the award of any degree, diploma, associateship, fellowship or other similar titles.

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Affectionately dedicated to

My Beloved Parents

and

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(Professor and Head, Dept. of Fruit Science, KRCCH, Arabhavi)

LIST OF ABBREVIATIONS

1.	Anon.	Anonymous
2.	CFU	Colony forming unit
3.	°B	Degree brix
4.	°C	Degree Celsius
5.	g	Gram
6.	kg	Kilogram
7.	KMS	Potassium metabisulphite
8.	mg	Milligram
9.	ml	Millilitre
10.	min	Minute
11.	OD	Optical density
12.	ppm	Parts per million
13.	TSS	Total soluble solids

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1. INTRODUCTION

The jamun (*Syzygium cumini* L. Skeels) is an important unexploited indigenous fruit of the tropics, belonging to the family myrtaceae. It has recently attained major importance as an arid zone horticultural crop because of its hardy nature and high yielding potential. It is known by several names, such as black plum, black berry and java plum. It is also known in India by a number of local names, such as jamun, rajamun, jambhul, kalajam, phalani and phalinda (Singh *et al*., 1963).

The original home of this fruit is considered to be India and East Indies. It also occurs in Siam, Philippine islands, Sri Lanka, Malaysia, Archipelago, Madagascar and some other countries (Singh *et al*., 1963). It is widely grown in the large parts of India from Indo-Gangetic plains in the north to Tamil Nadu in the south (Singh and Srivastava, 2000). The statistics on acreage and production of this fruit in India are not available as it is seldom planted as an exclusive plantation. Generally, jamun trees are found scattered throughout the tropical and subtropical regions of Indian subcontinent.

The jamun fruits possess considerable medicinal and nutritive properties. The unripe fruit juice is stomachic, carminative and diuretic in nature and has cooling and digestive properties (Kirtikar and Basu, 1975). The juice of unripe fruit is used for preparing vinegar. The bark is useful in control of diarrhoea and dysentery. The green leaves are used for feeding the livestock. Various essential oils (0.18%) are extracted from the dried jamun leaves. The seeds contain about 19 per cent tannins. Powdered seeds are used to treat against diarrhoea, dysentery and for reducing the sugars in the urine. It is also used as lotion for curing ring worm (Dastur, 1952).

There are several types of jamun found in India that differ in colour and size of the fruit. Two types of fruits are commonly observed, *i.e.*, the rajamun, bearing big oblong deep purple or bluish fruits with pink greyish, juicy, sweet pulp with small stone and the khatta, bearing small fruits with acidic pulp (Anon., 1976). The edible pulp forms 70 to 85 per cent of the whole fruit containing 10 to 18 per cent total soluble solids, 0.41 to 2.17 per cent acidity and 83.7 per cent moisture (Daware *et al*., 1985). The edible pulp also contains 0.7 g protein, 0.3 g fat, 0.9 g crude fibre, 14.0 g ash, 15 mg phosphorus, 1.2 mg iron and 18 mg vitamin C per 100 g of pulp.

The mature fruits are living entities even after harvest and contain high amount of moisture. They deteriorate faster during post-harvest handling and storage. Since jamun fruit

is highly perishable, it cannot be stored more than 24 hour at ambient conditions (Ramanjaneya *et al*., 1999). In fact, lot of fruits go waste during season due to non-availability of suitable processing techniques and processing facilities.

Jamun fruits possess good taste and pleasant flavour. The attractive colour of the pulp is due to the presence of anthocyanin pigment and are mostly used for dessert purpose. The fruits are also used for preparation of delicious beverages, jellies, jam, squash, wine, vinegar and pickles (Orchse *et al*., 1961). The ripe jamun fruits are used for making preserves, squashes and jellies. A good jelly and jam can be prepared from ripe jamun fruits (Anon., 1976).

Fruit juices are refreshing and retain characteristic taste and aroma even after few months of their preparation into a beverage compared to several other fruit products. Fruit juices and ready to serve beverages are increasingly gaining popularity throughout the country. Even though fruit juices are most popular, jamun juice and juice based beverages have not yet become popular mainly because of non-availability of suitable processing techniques and processing facilities. Hence, there is a need to develop a low cost technology for preparation and preservation of jamun juice and its beverages.

The pomace, *i.e*., pulp obtained after extraction of juice goes as waste. Hence there is a need to utilise it as a by-product for preparation of value added products like leather.

Jam is a product made by boiling fruit pulp with sufficient sugar to a reasonably thick consistency, firm enough to hold the fruit tissues in position. Other important ingredients for good quality jam are acid and pectin. Jams can be prepared from practically all fruits and vegetables and may be used singly or in suitable combinations (Singh, 1991). Another pulp based product is jelly. A perfect jelly should be transparent, well set but not too stiff and should have the original flavour of fruit. It should possess an attractive colour and should keep its shape and retain a clear cut surface. It should be tender enough to quiver but not to flow (Giridharilal *et al*., 1986). Since the information on preparation of jamun jam and jelly is meagre, there is a need to standardise recipes for jam and jelly preparation.

Since the jamun fruits are highly perishable, they cannot be transported over long distances. Hence there is a need to find out ways and means of processing the fruits into various value added products preferably near the site of production. This will help in reducing the losses during transportation, storage and also help rural employment as most of the jamun trees are found in villages or forest surrounding the villages. Hence, there is a need to develop

a low cost technology for processing jamun fruits into value added products, such as juice based beverages, jam, jelly and utilisation of by-product which have ready acceptability in the market. Therefore, the present investigation was undertaken with the following objectives:

1. To preserve the jamun juice.
2. To standardise the protocol for preparation of jam and jelly.
3. To prepare a new product from jamun pulp / pomace, *i.e.*, leather.

2. REVIEW OF LITERATURE

Jamun is one of the important but under-exploited fruit crops of India. The fruits are mostly used for table purpose. Its medicinal properties are so highly potent in curing various disease that many scientists have focussed attention to discover the nutritional and medicinal secrets of jamun fruits. Scanning of available literature indicates that very scanty research has been done in the area of product development of jamun. Hence the available literature reviewed in this chapter is not only covering the work on value added products of jamun, but also on related fruits grown in India.

2.1 PRESERVATION AND STORAGE OF FRUIT JUICE

Various methods are employed for preservation of juice. Among them, pasteurisation, refrigeration, carbonation and preservation by chemicals are commonly used.

Some of the detrimental factors that effect the preservation and quality of juices and beverages are presence of acids, time of heating / pasteurisation, type of preservative added and the storage temperature (Tressler and Joslyn, 1981).

The role of preservatives has been emphasised by many workers to keep the beverage free from spoilage during storage. The most commonly used chemical preservatives in fruit products are potassium metabisulphite and sodium benzoate. Sodium benzoate is normally preferred for the products which are rich in anthocyanin pigments, such as grape, jamun, phalsa, *etc*., whereas potassium metabisulphite is advocated to the products rich in carotenoid pigments (Goodenough and Atkin, 1981). These two preservatives are reported to be very effective in preventing the spoilage of the product during storage (Giridharilal *et al*., 1986).

Khurdiya and Roy (1985) reported that jamun fruit juice stored at low temperature was found good and acceptable even after a year. High temperature storage and high acid content in beverage were responsible for degradation of their quality.

Pomegranate juice of satisfactory quality could be prepared by heating the juice to 79.4°C to 82.2°C for 30 minutes, cooling it quickly and allowing it to stand overnight followed by decanting or filtering the juice. The juice could be preserved either by pasteurisation at 79.4°C to 82.2°C for 30 minutes or by adding sodium benzoate at 600 ppm (Salunkhe and Desai, 1986).

Waskar and Deshmukh (1995) stored pomegranate juice in amber coloured and colourless bottles and found that the juice could be stored well and remained acceptable upto

180 days in cold storage (5±1°C). The retention of total anthocyanin content was observed to be minimum at room temperature storage as compared to cold storage.

Patil and Pai (1998) reported that pomegranate juice prepared by enzymatic treatment had excellent quality with high clarity, high yield, good retention of vitamin E and better overall acceptability.

Chobe (1999) reported an increasing trend in TSS, pH, reducing sugar, non-reducing sugar and total sugar during storage of pomegranate juice both at room temperature and low temperature storage conditions, while there was decrease in acidity and ascorbic acid.

Rege and Pai (1999) revealed that colour of the pomegranate juice was fairly stable, except for slight losses during heating at 80°C for 30 minutes.

Heating the litchi juice to 85°C prior to preservation and storage checked the browning to some extent. Low temperature (4-5°C) was better than room temperature (25-35°C) for long term storage (Vijay, 1985).

Colour of phalsa juice during storage was better retained in glass than plastic containers. Stability of colours in phalsa juice was higher at 30°C followed by 20°C and room temperature (31-36°C). The self life of the juice remained acceptable for a period of 100 days at 3°C and for 10 days at room temperature (Khurdiya and Anand, 1981 and Waskar and Khurdiya, 1987).

Ranote *et al*. (1993) noticed an increase in reducing sugar content of Kinnow orange juice during storage of ambient temperature and they found that retention of ascorbic acid was more in canned juice compared to the product stored in bottles or pouches.

Saini and Dharmpal (1997) reported storage stability of Kinnow juice under ambient condition over a period of six months. They observed significant decline in ascorbic acid content but negligible change in TSS, total sugars, pH, ash and viscosity during storage.

The Kinnow juice can be stored only for three hours and seven hours at ambient and refrigerated condition, respectively. At room temperature, keeping quality of kinnow juice could not sustain even upto one week even after addition of KMS at 350 ppm, whereas it could be stored for two weeks at refrigerated condition after addition of 350 ppm potassium metabisulphite (Panesar *et al*., 2000).

Abhay *et al*. (2005) reported that the Kinnow juice was heat treated at 97°C for two and five minutes, respectively, and stored by using preservatives like potassium

metabisulphite (1500 ppm) and sodium benzoate (1000 ppm) separately and in combination. The treated juice was stored for 45 days at room temperature, two minutes heat treated juice preserved with KMS retained original yellow colour of juice. Ascorbic acid content of juice reduced to 6.14 mg per 100 ml juice.

Urmila and Satinder (1983) revealed that there was a loss of ascorbic acid and acidity, whereas the reducing sugars increased during storage of citrus juice. Further, they reported that the use of potassium metabisulphite helped in better retention of colour during storage of citrus juice over sodium benzoate. Similar results were also noted by Ahamad *et al*. (1986).

Khurdiya (1994) studied the effect of method of preservation on the quality of lime juice. The heat processed lime juice possessed lowest acidity (3.79%) which increased with increase in SO_2 concentration. The lime juice preserved with SO_2 and sodium benzoate possessed highest acidity (3.85%) whether heated or unheated. The non-enzymatic browning (NEB) was maximum in juice preserved by heat processing and have decreasing trend with increase in SO_2 concentration.

Sarolia and Mukherjee (2002) studied the effect of different preservation methods on keeping quality of lime juice during storage, *viz*., heating at 85°C, pasteurisation, potassium metabisulphite, sodium benzoate. Among various treatments, the use of KMS 0.1 per cent was found to be effective in preserving the juice for 2½ months. Storage studies showed an increase in sugars, pH, TSS and browning, whereas acidity and ascorbic acid of lime juice decreased.

Masoodi *et al*. (1992) reported that the Perlette grape juice could be stored by addition of different quantity of potassium metabisulphite (350, 450, 550 and 600 ppm) and heating the juice at 88°C for two minutes prior to storage.

Amla juice pasteurised at 85 to 90°C was filled in sterilised bottles, 200 gauge polyethylene pouches and the pouches were blast frozen at -40°C. Both were shelf stable, whereas pasteurised juice filled in high density polyethylene bags with class-II preservative was stable upto six months of storage at 10°C (Vijayanand *et al*., 2003).

Waskar *et al*. (2005) reported that aonla juice could be preserved with 500 ppm sulphur dioxide (1 g KMS/lit.).

The organoleptic scores for colour, taste, flavour and overall acceptability of sapota juice preserved by addition of KMS at 600 ppm was found to be statistically on par with the fresh juice. In case of juice treated with sodium benzoate at 700 ppm, the score for taste,

flavour and overall acceptability were unaffected as compared to that of fresh juice. However, in treatments wherever pasteurisation of juice was done at 60 and 65°C, reduction in scores for colour, taste, flavour and overall acceptability were observed. The TSS, reducing, non-reducing and total sugars of sapota juice were found to increase significantly in treatments of pasteurisation of juice at 60°C and 65°C (Jayalaxmi, 2006).

The nutrient loss was common feature in processed products (Tripathi *et al*., 1989). They also observed that most of the beverages showed an increase in total soluble solids and reduction in total titratable acidity and ascorbic acid, which was proportional to the storage period.

2.2 PREPARATION AND STORAGE OF PULP BASED FRUIT AND VEGETABLE PRODUCTS

Jam is a product made by boiling fruit pulp with sufficient sugar to a reasonably thick consistency, firm enough to hold the fruit tissues in position. Jam should contain 0.5 to 0.6 per cent acid, 68 per cent total soluble solids, invert sugar should not be more than 40 per cent and minimum percentage of the fruit in final product (w/w) should be 45 per cent.

A perfect jelly should be transparent, well set but not too stiff and should have the original flavour of fruit. It should possess an attractive colour and should keep its shape and retain a clear cut surface. It should be tender enough to quiver but not to flow (Giridharilal *et al*., 1986).

Fruits with high content of pectin and organic acids are best suited for jam making. The fruits, such as guava, kumquat, carambola, black berries, kiwi fruit, custard apple, wood apple, apples, citrus peels and papaya are good source of pectin (Swamyrao *et al*., 1989).

Jams can be prepared from practically all fruits and some vegetables and may be used singly or in suitable combinations (Singh, 1991).

Fruit with high content of pectin and organic acids as well suited for jelly making. Guava, sour apple, plum, karonda, wood apple, loquat, papaya and gooseberry are generally used for preparation of jelly (Sanjeevkumar and Srivastava, 2003).

The fruit pulp used for jelly making should have acid content between 0.8 and 1.5 per cent as citric acid for obtaining a satisfactorily good fruit jelly. Higher acidity with low pH of the pulp result in faster inversion of sugars and increases the browning reaction of jelly (Murulikrishan, 1967). He further stated that least degradation of ascorbic acid was noticed

under acidic condition of the pulp and decrease in acidity was found to increase the duration of storage.

The pectin forms better jelly in presence of proper blend of sugar and acid (Baldini *et al*., 1982).

Giridharilal *et al*. (1986) found that the jelly strength increased as the pectin content increased and the jelly strength decreased with decrease in sugar content from 74 to 60 per cent. Weak and tender jellies resulted at lower concentrations.

The sugar required for jelly formation is always proportional to the acidity of the fruit pulp (Lalsingh, 1992).

Lalsingh (1992) reported that higher the percentage of pectin present in fruit pulp, lower is the requirement to form the jam and the sugar required for jam formation is always proportional to the acidity of fruit pulp.

The optimum pH for a jelly containing one per cent pectin is approximately 3.0, 3.2 and 3.4 for 60, 65 and 70 per cent TSS, respectively. In general, the optimum pH value for jelly is 3.2 (Sanjeevkumar and Srivastava, 2003).

Storage studies on heat processed jamun jam containing 69°Brix total soluble solids revealed that all the sensory qualities were found acceptable even six months after storage (Kannan and Thirumaran, 2004).

Diwakar *et al*. (2003) reported that acceptable quality jamun jam (50% pulp, 70% TSS, 0.4% acidity and 0.5% pectin) could be obtained even after storage period of 100 days.

Kannan and Susheela (2002) reported that even though there was gradual increase in the TSS and total sugar and slight decrease in acidity, the jamun jam stored in colourless glass bottles was acceptable even after six months of storage at ambient condition. The appearance, texture, odour, flavour, taste and overall acceptability were also good.

The ideal sugar / acid composition for the preparation of mango sheet or leather from mango cultivars Baneshan, Bombay Green and Dashehari was found to be 25°Brix and 0.5 per cent acidity. Addition of sugar was found to increase the drying time in all the mango cultivars (Rao and Roy, 1980).

Mango fruit bar prepared from Alphonso pulp by addition of sugar (20%), citric acid (0.2%) and potassium metabisulphite 700 ppm individually or in combination was studied by

Gowda *et al*. (1995). Mango fruit bar prepared by addition of sugar, citric acid and potassium metabisulphite in combination was found to be best in sensory quality.

Sagar and Khurdiya (1998) reported that mango jam prepared from mango pulp and sugar in the ratio of 1 : 1 was observed to have good sensory qualities.

Mango-guava sheet was prepared by blending mango pulp with 5, 10, 15 and 20 per cent guava pulp and maintained the TSS of 25°Brix, acidity 0.5 per cent and sulphur dioxide 1000 ppm (Hemakar *et al*., 2000). The mango pulp with 20 per cent guava pulp gave a better sheet with respect to colour, flavour and texture.

Jam with 45 per cent mixed pulp (bael to mango pulp ratio 1 : 1), 70 per cent TSS and 0.5 per cent acidity recorded the highest organoleptic scores. Acidity and TSS increased slightly after four months of ambient storage, while a gradual increase was observed in non-enzymatic browning during the storage. Jam was found to maintain acceptable quality (organoleptic score > 7) upto six months of storage (Haridwar and Chopra, 2006).

Shah and Bhatia (1983) reported that jelly prepared from blending two apple varieties (Maharaji and American) in the ratio of 1 : 1 resulted in superior quality jelly.

Barwal and Kalia (1997) reported comparative study of jellies prepared from apple fruit, pomace and concentrate. Jelly prepared from fruit extract obtained the highest scores for colour, flavour, taste and overall acceptability than pomace extract and concentrate.

Storage studies on jam and jelly prepared from culled apples revealed that reducing sugars increased and pectin content decreased during storage (Shah and Bhatia, 1983).

Strawberry jam prepared by mixing with apple in the ratio 4 : 1 and addition of sugar in the ratio of 1 : 1 and citric acid @ 0.6 per cent was good in colour, appearance, taste, flavour and acceptable to consumer (Kumar and Manimegalai, 2000).

Joshi *et al*. (1986) reported that mixing up of one part of wood apple pulp with two parts of curd developed best quality jelly.

Wood apple is a rich source of high quality pectin and organic acids (Swamyrao *et al*., 1989). Because of a large proportion of pectin, organic acids and aromatic flavour of pulp, wood apple is good fruit for preparing exceptionally good quality jelly.

The effect of different levels of sugar and skim milk powder on the sensory properties of custard apple toffee was studied by Dhumal *et al*. (1996). Toffees prepared by using 750 g

sugar and 20 g skim milk powder per kilogram apple pulp were superior in terms of sensory properties.

Jam prepared from papaya fruit and rose apple showed no significant changes with respect to TSS, total sugar, reducing sugar, non-reducing sugar and non-enzymatic browning (NEB) after 30 days both at 7°C and 37°C storage temperatures (Daniel *et al*., 2003).

Jam containing TSS varying from 45°Brix to 57°Brix and acidity between 0.88 and 1.15 per cent could be prepared from custard apple fruits (Gowda, 2005).

Singh and Sanjeevkumar (1995) reported that aonla jam with the composition of 45 per cent pulp, 68°Brix total soluble solids and 0.5 per cent acidity was found ideal.

Nath and Sharma (1998) screened five aonla cultivars for preparation of jam. Out of five cultivars, Chakaiya scored highest organoleptic qualities for the jam containing 45 per cent pulp, 0.5 per cent acidity adjusted to 60°Brix TSS.

Anand (1970) recorded less loss of ascorbic acid in the jellies observed in glass containers than in plastic containers. Similar observation was made by Ramanjaneya (1981) in guava jelly prepared from different strengths of pectin content.

Aggarwal *et al*. (1997) reported that jelly prepared from grape : guava blend in the ratio of 40 : 60 with one per cent acidity and pectin each adjusted to 70.5°Brix TSS scored the highest for colour, flavour, consistency and overall acceptability.

Rouse and Moore (1972) reported that the pasteurised chilled jellies made from citrus fruits are found to be superior in retaining flavour compared to jellies stored at 80°F for 24 weeks.

Yousif *et al*. (1990) reported that sensory qualities and chemical evaluation of date jelly containing sugar : extract in 50 : 50 proportion, 0.8 per cent acidity and 1.5 per cent pectin found best over other combinations. He also noticed decrease in water activity and acidity of date jelly with increase in fructose and glucose content during the storage period of six months.

Use of one kg ber pulp of var. Umran without peel, one per cent added pectin, 0.75 per cent acidity and 750 g sugar resulted in smooth textured good jam (Thomas and Kulwal, 2002).

Ber burfi prepared with 75 per cent sugar, 10 per cent vanaspati and skim milk powder, 9.25 per cent citric acid and salt with pista green colour was found to be acceptable

by the panel of judges. During storage of burfi, the moisture content and peroxide value increased which in turn decreased the taste score during storage. However, the burfi was acceptable in terms of colour, flavour, texture and taste without any visual growth throughout the storage period of five weeks (Shobha, 2007).

Study conducted by Bhatnagar *et al*. (1984) on muskmelon (cv. Hara Madhu) jam revealed that a combination of high sugar and low citric acid was better than other combinations and had good keeping quality when stored for six months at room temperature.

Bhatnagar (1991) studied on utilisation of watermelon rind for jam making. Pure jam, though low in citric acid and pectin content, was highly acceptable in organoleptic assessment than combination with pink berries of grape cultivar Beauty Seedless. However, mixed jam had high acid and pectin content with better consistency flavour and colour. He also noticed that decrease in acidity of jam prepared from watermelon rind with increase in the inversion of sugars during storage. he also stated that decrease in acidity was found with increase in the storage period.

Sagar (2003) reported that plum var. Santa Rosa pulp could be used for preparation of plum leather after adjusting to 10 to 30°Brix with sugar @ 300 g sugar per litre of fresh plum pulp and reducing the acidity from 1.5 to 1.3 per cent and containing 1000 ppm potassium metabisulphite. The prepared leather has best sugar / acid blend and retained better colour preparation and storage. This leather could be utilised upto six months of storage in good condition without changing its original colour and flavour.

Jagtap *et al*. (2000) reported that whole carrot toffees prepared by using 1000 g sugar per kg whole carrots and carrot pomace toffees prepared by using 2000 g sugar per kg of carrot pomace scored maximum organoleptic score with respect to colour, texture, aroma, sweetness and overall acceptability.

Masoodi *et al*. (2005) reported a storage studies of carrot and tomato as bicolourants in guava jelly. Jelly containing carrot as a colouring source was found slightly better than that containing tomato. The former was also found to be stable with respect to colour during storage.

Vennila and Kingsly (2001) reported that the bar prepared from the combination of sapota-papaya (50 : 50) was found to be acceptable by the consumers even after storing for six months at room temperature. The chemical constituents of the fruit bar did not exhibit high variation during the storage period.

Jayalaxmi (2006) reported that the sapota burfi prepared from fresh pomace with 1 : 1 proportion of pomace to sugar and 0.2 per cent citric acid was found superior with respect to organoleptic quality. The burfi with 1 : 1.5 proportion of pomace sugar with 0.2 per cent citric acid was comparable to that of earlier.

2.3 MICROBIAL ANALYSIS OF JUICE AND PULP BASED PRODUCTS

In contrast to canned foods, jams and jellies have the property of remaining free from spoilage for considerable period in the open containers, *i.e.*, even when there is ample opportunity for recontamination with microorganisms. Jams and jellies depend on preservation by control of moisture content which is achieved partly by evaporation during boiling and partly by addition of a considerable amount of sugar.

Li *et al*. (1989) studied the effect of acidification, low temperature and sorbates on storage of juice and reported an increase in bacterial population during the first two weeks of storage both at 5°C and 25°C; however, the bacterial population in the juice stored at 5°C was lower than that stored at 25°C. The acidification below pH 2.5 and 0.03 per cent sorbic acid was found to influence marked reduction in bacterial population.

Jellies contain higher per cent of sugars which controls microbial growth by reducing the availability of moisture for their development and multiplication (Frazier and Westhoff, 1978 and Fields, 1979).

In jam preparation, the principle spoilage organisms were the yeasts and moulds; so, it is necessary to reduce the water activity to atleast 0.8. This indicates that 60 to 65 per cent sugar content is needed in jam to prevent microbial spoilage (Salunke *et al*., 1983).

Giridharilal *et al*. (1986) opined that hermetically scaled glass jars and cans are best suited for packing of jellies and to prevent mold growth inside the container. They also revealed that improper scaling encourages mold growth inside the container.

Microbial examination of jam prepared from watermelon rind at regular interval of storage showed complete absence of microbial counts which was due to high sugar concentration (Bhatnagar, 1991).

During the study of microbial attributes of mango pulp, Acharya and Shah (1999) reported that standard plate count (SPC) of loose mango pulp samples ranged from 5.98 to 90.8 log CFU per gram.

Laster and Neela (2000) reported that the fresh watermelon juice had more than 100 CFU bacteria population per ml, while mango pulp had less than CFU bacterial population per ml.

The highest population of microorganisms was observed in untreated sapota juice, while the lowest microbial load was observed in the juice pasteurised at 65°C along with KMS at the rate of 600 ppm (Jayalaxmi, 2006).

Microbial load of sapota candies were lower in treatments where the sapota slices were steeped initially at boiling temperature compared to ambient temperature. However, the microbial was minimum and candies were free from spoilage and organoleptically acceptable at six months after storage (Kichu, 2008).

Barmanray *et al*. (1996) reported that guava jelly prepared from different hybrids showed minimum microbial counts (30-80 counts/g) at the storage period of 90 days.

In case of pomegranate juice preserved with chemical preservations and pasteurisation, minimum microbial population was observed in pasteurised juice with 500 ppm sodium benzoate, whereas maximum microbial population was observed in juice preserved by pasteurisation alone (Sowjanya, 2007).

3. MATERIAL AND METHODS

The investigation on processing of jamun fruits was carried out in the Department of Post-harvest Technology, Kittur Rani Channamma College of Horticulture, Arabhavi, Belgaum district, Karnataka during the year 2006-07.

3.1 GEOGRAPHICAL LOCATION AND CLIMATE

Arabhavi is situated in Northern dry zone (zone-3) of Karnataka. It lies at 16°12' N latitude and 75°45' E longitude and at an altitude of 60 m from mean sea level. The annual rainfall at Arabhavi is about 530 mm and it is distributed over a period of seven months from May to November. The mean maximum temperature goes upto 36.4°C (May) and mean minimum temperature drops down to 13.4°C (February). The relative humidity varies between 57.6 per cent (April) and 81.4 per cent (December).

3.2 MATERIAL

Jamun fruits used for the research were collected from two locations. Fruits selected for the first experiments were collected from farmer's field at Gokak. For the second experiment, three promising genotypes, *viz*., KJP-215, KJP-32 and KJP-11 which were identified by the Department of Pomology, Kittur Rani Channamma College of Horticulture, Arabhavi were included. Healthy, uniformly matured fruits were selected, carefully packed in bamboo baskets lined with leaves of jamun trees as a cushioning material to protect them from damages and brought to Arabhavi campus immediately for further experimentation.

3.3 EXPERIMENTAL DETAILS

3.3.1 EXPERIMENT-I

PRESERVATION OF JAMUN JUICE

In this experiment, jamun juice was prepared as per the treatments given below. The design adopted was factorial completely randomised design with three replications. There were seven treatments as Factor-I and five stages of storage as Factor-II.

Factor-I: Treatments

T_1 – Control

T_2 – Pasteurisation of juice at 85°C for 10 minutes + 300 ppm sodium benzoate

T_3 – Pasteurisation of juice at 85°C for 10 minutes + 400 ppm sodium benzoate

T_4 – Pasteurisation of juice at 85°C for 10 minutes + 500 ppm sodium benzoate

T_5 – Juice + 600 ppm sodium benzoate

T_6 – Juice + 800 ppm sodium benzoate

T_7 – Juice + 1000 ppm sodium benzoate

Note: In all treatments including control, juice was heated upto 90°C.

Factor-II: Storage period

S1 – Initial S_2 – 2 MAS S_3 – 4 MAS

S_4 – 6 MAS S_5 – 8 MAS

MAS = Months after storage

Methodology for preparation of jamun juice

Good quality jamun fruits were washed thoroughly with clean tap water, hand crushed, destoned and pulp was heated upto 60°C for two minutes. The juice was extracted by staining through the muslin cloth. Then the juice was heated till it reached 90°C temperature.

In case of treatments T_2, T_3 and T_4, the juice was pasteurised at 85°C for 10 minutes and cooled immediately. Sodium benzoate was added to the pasteurised juice on weight basis according to the treatment details as specified above. In case of T_5, T_6 and T_7, 600, 800 and 1000 ppm sodium benzoate was added, respectively, to the heated juice. In case of T_1, no preservative was added to the juice. The juice treated as per the treatments were filled into clean, sterilised crown bottles of 200 ml capacity, sealed with crown caps using crown corking machine and stored at ambient condition.

3.3.2 EXPERIMENT-II

STANDARDISATION OF RECIPE FOR PREPARATION OF JAMUN JAM AND JELLY

The design adopted for this experiment was factorial completely randomised design with three replications. There were nine treatments as Factor-I and six stages of storage as Factor-II.

Factor-I: Treatments

T_1 – KJP-215 - Recipe-1 T_4 – KJP-32 - Recipe-1 T_7 – KJP-11 - Recipe-1

T_2 – KJP-215 - Recipe-2 T_5 – KJP-32 - Recipe-2 T_8 – KJP-11 - Recipe-2

T_3 – KJP-215 - Recipe-3 T_6 – KJP-32 - Recipe-3 T_9 – KJP-11 - Recipe-3

Factor-II: Storage period

S_1 – Initial S_2 – 1 MAS S_3 – 2 MAS

S_4 – 3 MAS S_5 – 4 MAS S_6 – 5 MAS

MAS = Months after storage

Methodology for jamun jam and jelly preparation

Three selected genotypes, namely KJP-215, KJP-32 and KJP-11 with variable physico-chemical characteristics (Appendix-I) were used for preparation of jam and jelly. For the preparation of jamun jam, uniform size, good quality fruits were selected, washed thoroughly and destoned. Pulp was homogenised and jam was prepared as per the recipies given below:

Ingredients	Recipe 1	Recipe 2	Recipe 3
Pulp	1 kg	1 kg	1 kg
Sugar	675 g	750 g	850 g
Citric acid	2 g	3 g	4 g
Pectin	25 mg	25 mg	25 mg

The required quantity of pulp and sugar, as per the recipe, were taken in a stainless steel vessel with copper bottom and heated over a gas stove with continuous stirring. Citric acid and pectin was added when the mixture started boiling. Heating was continued until the required consistency was achieved, *i.e.*, till the boiling mass reached 68 to 70 per cent total soluble solids (TSS). The end point was determined by sheet or thread test. The product was filled into clean and sterilised jam bottles and sealed.

For the preparation of jamun jelly, uniform size, good quality fruits were selected, washed thoroughly and destoned. The pulp was boiled with a known quantity of water (500 ml / kg of pulp) and citric acid as mentioned in the recipes given below:

Ingredients	Recipe 1	Recipe 2	Recipe 3
Water (per kg pulp weight)	500 ml	500 ml	500 ml
Citric acid (per kg pulp weight)	-	0.5 g	1.0 g
Pectin (per kg pulp weight)	3 g	4 g	5 g

At the end of boiling for a period of 20 to 25 minutes, the extract was strained and pectin was added as per the recipes and pectin test was carried out by alcohol test method. Based on the pectin strength, sugar was added at the ratio of 1 : 0.75 (pectin extract weight to sugar weight) for medium pectin and 1 : 1 for high pectin content. The mixture was boiled and scum was removed regularly in order to avoid formation of cloudy jelly. The end point was judged using cold plate test (Giridharilal *et al*., 1986). Cooled jelly was filled into pre-sterilised jam bottles and sealed.

3.3.3 EXPERIMENT-III

STANDARDISATION OF PROTOCOL FOR PREPARATION OF JAMUN LEATHER

The design adopted for the experiment was factorial completely randomised design with three replications. There were nine treatments as Factor-I with seven stages of storage as Factor-II.

Leather was prepared from fresh jamun pomace (pulp left after extraction of juice) with the following recipes.

Factor-I: Treatments

T_1 – Fresh pomace + 30% sugar + 1% citric acid + heating at 60°C + drying

T_2 – Fresh pomace + 35% sugar + 1.5% citric acid + heating at 60°C + drying

T_3 – Fresh pomace + 40% sugar + 2% citric acid + heating at 60°C + drying

T_4 – Fresh pomace + 30% sugar + 1% citric acid + microoven heating + drying

T_5 – Fresh pomace + 35% sugar + 1.5% citric acid + microoven heating + drying

T_6 – Fresh pomace + 40% sugar + 2% citric acid + microoven heating + drying

T_7 – Fresh pomace + 30% sugar + 1% citric acid + drying

T_8 – Fresh pomace + 35% sugar + 1.5% citric acid + drying

T_9 – Fresh pomace + 40% sugar + 2% citric acid + drying

Factor-II: Storage period

S_1 – Initial	S_2 – 1 MAS	S_3 – 2 MAS	S_4 – 3 MAS
S_5 – 4 MAS	S_6 – 5 MAS	S7 – 6 MAS	

MAS = Months after storage

Preparation of jamun leather

Two hundred gram fresh pomace was taken and sugar and citric acid were added on weight basis as per treatments. 75 ml of water was added to the mixture and blended in an electrical grinder. In treatments T_1, T_2 and T_3, the mixture was heated in a stainless steel vessel upto a temperature of 60°C. The heated mixture was spread on a stainless steel plate and pressed to make a uniform thickness. In case of T_4, T_5 and T_6, the mixture was spread in a stainless steel plate to a uniform thickness, pressed and kept in a micro-over at 60°C for four minutes. In case of T_7, T_8 and T_9, the blended mixture was spread uniformly on a stainless steel plate without heating. The mixture spread on the plates in all the treatments was cut into pieces of 5 x 5 cm by a stainless steel knife after the heat treatment as per treatment details. The plates containing the pieces, attached to the surface of plate, were kept in an electric tray drier maintained at a temperature of 60°C for 8 to 10 hours till a moisture content of 11 to 12 per cent was reached. The pieces were removed from the plate and then packed in 200 gauge polyethylene bags, sealed and stored in air tight container.

3.4 OBSERVATIONS RECORDED

The following physico-chemical parameters were recorded immediately after preparation and at different stages of storage.

3.4.1 Total soluble solids (%)

The total soluble solids (TSS) of jamun products were measured by using an 'Erma' make hand refractometer and expressed as per cent after necessary corrections.

3.4.2 Titratable acidity (%)

A known volume (5 ml) of juice sample was taken and diluted to 100 ml with distilled water. This was mixed well and five ml of aliquot was taken and titrated against standard NaOH (0.1 N) using phenolphthalein indicator. For jam / jelly / leather, a known weight of sample (5 g) was taken and macerated in distilled water, filtered through muslin cloth and the volume was made upto 100 ml with distilled water. From this, five ml of aliquot was taken and titrated against standard NaOH (0.1 N) using phenolphthalein indicator. The appearance of light pink colour indicated the end point. The value was expressed in terms of citric acid as per cent acidity of jamun products (Anon., 1984).

$$\text{Per cent of acid} = \frac{\text{Titre value} \times \text{Normality of NaOH} \times \text{Volume made up} \times \text{Equivalent weight of acid}}{\text{Volume of sample taken for estimation} \times \text{Weight or volume of sample taken}} \times 1000$$

3.4.3 Ascorbic acid (mg/100 g)

Ascorbic acid content was estimated by using 2,6-dichlorophenol indophenol dye titrimetrically as per the modified procedure of AOAC (Anon., 1984). Five ml of juice was taken and diluted to a known volume (100 ml) with four per cent oxalic acid. This was filtered through muslin cloth to get a clear juice. One ml of aliquot was titrated against 2,6-dichlorophenol indophenol. The results were expressed as milligram of ascorbic acid per 100 g of fruit juice.

3.4.4 Sugars

The sugar content of the juice / jam / jelly / leather of jamun obtained from representative samples under each treatment were estimated and expressed as per cent on weight basis in case of jam / jelly / leather and on volume basis in case of juice.

3.4.4.1 Reducing sugar (%)

Reducing sugar in samples was estimated as per the dinitro salicylic acid method (Miller, 1972). The values obtained were expressed as per cent.

3.4.4.2 Total sugars (%)

The total sugar present in the products were estimated by the same method as in case of reducing sugar after inversion of the non-reducing sugar using dilute hydrochloric acid (Anon., 1984). The values obtained were expressed as percentage.

3.4.4.3 Non-reducing sugar (%)

The percentage of non-reducing sugar was obtained by subtracting the values of reducing sugar from that of total sugar and multiplying the same with 0.95 (Somogyi, 1952).

3.4.5 Anthocyanin (mg/100 ml)

Ten ml of filtered juice was diluted to 100 ml with 0.1 N HCl and allowed to equilibrate in the dark for one hour and filtered. In case of jam / jelly / leather, five grams of sample was mashed and soaked in 100 ml with 0.1 N HCl and allowed to equilibrate in the dark for one hour and filtered. The absorbance of the filtrate was recorded at 520 nm in UV-spectrophotometer (Genova make) using 0.1 N HCl as blank (Srivastava and Sanjeevkumar, 1998).

$$\text{Total OD / 100 ml} = \frac{\text{OD x volume made up}}{\text{ml of sample taken}} \text{ x } 100$$

$$\text{Total anthocyanin (mg/100 ml)} = \frac{\text{Total OD per 100 ml}}{87.3}$$

3.4.6 Phenols (mg/100 ml)

The representative samples of juice / jam / jelly / leather under each treatment were homogenised and preserved in 80 per cent alcohol in a refrigerator. Phenols were estimated as per the Folin Ciocalteau Reagent (FCR) method (Bray and Thorpe, 1954) and expressed as mg per 100 ml.

3.4.7 Moisture content (%)

The moisture content of leather was determined using Ohans Halogen moisture analyser and expressed as percentage.

3.4.8 Organoleptic evaluation

The organoleptic evaluation of the jamun products was carried out by a panel of 10 semi-trained judges consisting of teachers and post-graduate students of Kittur Rani Channamma College of Horticulture, Arabhavi. The samples of juice / jam / jelly / leather in each treatment were directly served to the panellists for organoleptic evaluation. The characters like colour and appearance, texture, taste, flavour and overall acceptability were judged on a five point Hedonic scale by following the score card given below:

Hedonic scale	Scores				
	Colour and appearance	Texture*	Taste	Flavour	Overall acceptability
Highly acceptable	5	5	5	5	5
Acceptable	4	4	4	4	4
Fairly acceptable	3	3	3	3	3
Poorly acceptable	2	2	2	2	2
Not acceptable	1	1	1	1	1

* Texture was excluded in juice.

3.4.9 Microbial analysis

The microbial count was taken from juice / jam / jelly / leather at different stages of storage as described by Harrigan and McCance (1966).

3.4.9.1 Preparation of sample

Samples were prepared by taking 10 ml of representative sample from three replications in each treatment. Each sample was mixed with 90 ml sterilised distilled water blank in a conical flask and serial dilution technique was carried out to estimate the bacterial, fungal and yeast load in the jamun products. The dilutions 10^{-3} and 10^{-4} were used for fungi and yeast counting and 10^{-5} and 10^{-6} were used for bacterial counting. One ml of aliquot of respective dilution was transferred to petri plates in duplicate and sterilised molten RBA, NA and Wichram media were poured to isolate fungi, bacteria and yeast, respectively. After solidification, the plates were incubated at 37±1°C for three to five days and colony counts were recorded, tabulated and expressed in CFU per ml or g of sample.

3.5 STATISTICAL ANALYSIS

The data on the physico-chemical parameters and organoleptic characters recorded were subjected to factorial completely randomised design analysis. Interpretation of the data was carried out in accordance with Panse and Sukhatme (1985). The level of significance used in ‘F’ and ‘t’ test was p=0.01. Critical difference values were calculated wherever ‘F’ test was significant.

4. EXPERIMENTAL RESULTS

The results of the investigation on the processing of jamun fruits conducted at the Department of Post-harvest Technology, Kittur Rani Channamma College of Horticulture, Arabhavi during 2006-07 are presented in the following pages.

4.1 EXPERIMENT-I

PRESERVATION OF JAMUN JUICE

4.1.1 Colour and appearance (scores out of 5.0)

The data on organoleptic evaluation pertaining to the colour and appearance as influenced by treatments, storage period and their interaction effects are presented in Table 1 and depicted in Fig. 1.

The results on colour and appearance indicated significant differences among the treatments, storage period and the interaction between them. Significantly highest mean score for colour and appearance irrespective of storage period was observed in T_6 (4.19) which was on par with T_5 (4.18), whereas significantly least score was observed in T_7 (3.72). During storage, the mean score for colour and appearance Irrespective of treatments, reduced from an initial value of 4.42 to 3.36 at eight months after storage (MAS). Among the interactions, the highest score was observed in T_1 to T_6 (4.50 each) at initial period, whereas the least score was observed in T_7 (3.07) at 8 MAS.

4.1.2 Taste (scores out of 5.0)

The data pertaining to the taste of jamun juice as influenced by treatments, storage period and their interaction effects are presented in Table 2 and depicted in Fig. 1. The perusal of data indicates that there were significant differences among the treatments and also between the different storage periods.

The mean score for taste of the treatments irrespective of storage period varied between 3.10 and 4.51. The treatment T_5 (4.51) recorded significantly highest score followed by T_6 (4.27), whereas significantly least score was recorded in T_7 (3.10). Irrespective of the treatments, score for taste of jamun fresh juice were found significant at different stages of storage. The scores decreased gradually with advancement in storage period. The scores were found to decrease linearly from 4.18 at initial stage to 3.56 at 8 MAS.

The interaction effects between the treatments and storage period were also significant. The highest scores for taste was recorded in T_5 (4.75) at initial stage, whereas least score was observed in T_7 (2.85) at 8 MAS.

4.1.3 Flavour (scores out of 5.0)

The data pertaining to the flavour of jamun juice as influenced by treatments, storage period and their interaction effects are presented in Table 3 and depicted in Fig. 1.

Flavour of jamun juice varied significantly with treatments, storage period and the interaction them. Significantly highest score for flavour irrespective of storage period was observed in T_5 (3.85), whereas the least score was in T_4 (3.64). During storage, the mean score for flavour irrespective of treatment reduced from an initial value of 4.08 to 3.35 at 8 MAS. Among the interactions, the highest score was observed in T_5 (4.14) at initial period, whereas the least score was observed in T_4 (3.17) at 8 MAS.

4.1.4 Overall acceptability (scores out of 5.0)

The data on sensory evaluation of jamun juice with respect to overall acceptability as influenced by treatments, storage period and their interaction effects are presented in Table 4 and depicted in Fig. 1. The results indicated that the treatments, storage period and the interaction effect between treatments and storage period had significant effect on scores of overall acceptability.

Irrespective of storage period, maximum mean score for overall acceptability (4.28) was recorded in T_5, whereas minimum score was recorded in T_7 (3.38). The mean score for overall acceptability irrespective of treatment decreased from initial score of 4.26 to 3.30 during storage period of 8 MAS. The interaction effects between the treatments and storage period were highly significant. The highest score was observed in T_5 (4.75) at initial period, whereas the least score was observed in T_7 (2.95) at 8 MAS.

4.1.5 Total soluble solids (%)

The data on changes in total soluble solids (TSS) with respect to different treatments, storage period and their interaction effects are presented in Table 5 and depicted in Fig. 2.

The results on TSS indicated significant differences among the treatments, storage period and the interaction between them. The mean maximum TSS was observed in T_4 (13.85), while the least TSS was observed in T_5 (12.44). Irrespective of treatments, the mean TSS of jamun juice increased significantly from 13.03 per cent to a final value of 13.45 per

cent at 8 MAS. The interaction effect between treatments and storage period was also significant. Among the different treatments at different storage period, the highest TSS was recorded in T_4 (14.06%) at 8 MAS, while the lowest of 12.25 per cent was recorded in T_5 at initial stage.

4.1.6 Titratable acidity (%)

The data on changes in titratable acidity as influenced by different treatments and storage period are presented in Table 6 and depicted in Fig. 2.

The results on titratable acidity indicated significant differences among the treatments, storage period and the interaction between them. The mean maximum titratable acidity was observed in T_7 (0.93%), while the least titratable acidity was recorded in T_2 (0.76%). Irrespective of treatments, the mean titratable acidity of jamun juice was significantly high (0.93%) at initial stage of storage and least (0.74%) at 8 MAS. Also, there was linear decrease in acidity with the advancement of storage period. The interaction effect between treatments and storage period was also significant. Among the different treatments at different storage period, the highest titratable acidity (1.00%) was recorded in T_7 at initial stage and least (0.63%) in T_2 at 8 MAS.

4.1.7 Ascorbic acid (mg/100 ml)

The data pertaining to retention of ascorbic acid of juice as influenced by treatments and storage period are presented in Table 7 and depicted in Fig. 2.

The data on retention of ascorbic acid content were found to vary significantly with respect to treatments, stages of storage period and the interaction between treatments and storage period. Treatment T_7 retained highest ascorbic acid content of 17.26 mg per 100 ml of juice, whereas the lowest value was retained in T_2 (16.32 mg/100 g of juice). Irrespective of treatments, the mean ascorbic acid content of jamun juice decreased significantly from an initial value of 17.24 to 15.93 per 100 ml juice at 8 MAS. Among the interaction effects, the highest ascorbic acid content was retained in T_7 (17.75 mg/100 ml of juice) at initial stage and least (15.57 mg/100 ml of juice) in T_2 at 8 MAS.

4.1.8 Anthocyanin (mg/100 ml)

The data on changes in anthocyanin (mg/100 ml) with respect to different treatments, storage period and their interaction effects are presented in Table 8 and depicted in Fig. 2.

The results on anthocyanin content indicated significant differences among the treatments, storage period and the interaction between treatments and storage period. The mean maximum anthocyanin content among the different treatments irrespective of storage period was observed in T_6 (51.65 mg/100 ml), while the least anthocyanin content was recorded in treatment T_7 (51.40 mg/100 ml). Irrespective of treatments, the mean anthocyanin content of jamun juice was significantly high (52.36 mg/100 ml) at initial stage of storage, which decreased to a least value of 50.64 mg per 100 ml at 8 MAS. Among the different treatments at different storage period, the highest anthocyanin content (52.49 mg/100 ml) was recorded in T_6 at initial stage and the least (50.50 mg/100 ml) in T_7 at 8 MAS.

4.1.9 Total phenols (mg/100 ml)

The data regarding phenol content (mg/100 ml) of juice in different treatments stored upto eight months are presented in Table 9 and depicted in Fig. 2. The data indicated that there were significant differences among the treatments, storage period and interaction between them. The mean maximum phenol content was observed in T_7 (355.52 mg/100 ml), while the least phenol content was observed in T_4 (354.47 mg/100 ml). Irrespective of treatments, the mean phenol content of jamun juice was significantly high (355.69 mg/100 ml) at initial stage of storage which decreased to a least value of 353.73 mg per 100 ml at 8 MAS. Among the different treatments at different storage period, the highest phenol content (356.29 mg/100 ml) was recorded in T_7 at initial stage and least in T_4 (353.16 mg/100 ml) at 8 MAS.

4.1.10 Total sugars (%)

The data on total sugar content of juice as influenced by treatments and storage period are presented in Table 10 and depicted in Fig. 2.

The results on total sugars indicated significant differences between the treatments, storage period and the interaction between them. The mean total sugar content of the treatments irrespective of storage period was maximum in T_4 (8.86%), whereas the least value was observed in T_5 (8.28%). Irrespective of treatments, the total sugar content increased from an initial value of 8.35 to 8.83 per cent at 8 MAS. Among interaction effects, the highest total sugar content was recorded in T_4 (9.17%) at 8 MAS, whereas the lowest was in T_5 (8.10%) at initial stage of storage.

4.1.11 Microbial load (CFU/ml)

The perusal of data presented in Table 11 indicates the microbial load of juice as influenced by treatments and storage period. Least bacterial population at the beginning (2.28

x 10^5 CFU/ml) and at eight months after storage (3.89 x 10^5 CFU/ml) was found in treatment T_4 followed by T_3 (2.35 x 10^5 CFU/ml and 3.95 x 10^5 CFU/ml, respectively), whereas the highest bacterial population at the beginning (3.15 x 10^5 CFU/ml) and at eight months after storage (4.50 x 10^5 CFU/ml) were observed in T_1.

The least fungal population at the beginning (1.18 x 10^3 CFU/ml) and at 8 MAS (3.02 x 10^3 CFU/ml) was found in treatment T_7 followed by T_3 (1.23 x 10^3 CFU/ml and 3.09 x 10^3 CFU/ml, respectively), whereas highest fungal population at the beginning (1.85 x 10^3 CFU/ml) and at 8 MAS (3.85 x 10^3 CFU/ml) was observed under T_1.

Similarly, minimum yeast population at the beginning (3.20 x 10^3 CFU/ml) and at 8 MAS (4.07 x 10^3 CFU/ml) was found in treatment T_4 followed by T_3 (3.27 x 10^3 CFU/ml and 4.13 x 10^3 CFU/ml, respectively), whereas the highest yeast population at the beginning (3.80 x 10^3 CFU/ml) and at 8 MAS (5.00 x 10^3 CFU/ml) was observed under T_1.

4.2 EXPERIMENT-II

STANDARDISATION OF RECIPE FOR PREPARATION OF JAMUN JAM AND JELLY

4.2.1 Colour and appearance of jamun jam (score out of 5.0)

The data on organoleptic evaluation pertaining to the colour and appearance as influenced by treatments, storage period and their interaction effects are presented in Table 12 and depicted in Fig. 3.

The results on colour and appearance of jamun jam indicated significant differences among the treatments, storage period and the interaction between them. Significantly highest mean score for colour and appearance irrespective of storage period was observed in T_1 (4.35), whereas least score was observed in T_8 (3.71). During storage, the mean scores for colour and appearance irrespective of treatment reduced from an initial value of 4.23 to 3.76 at 5 MAS. Among the interactions, the highest score was observed in T_1 (4.55) at initial period, whereas the least score was observed in T_8 (3.50) at 5 MAS.

4.2.2 Taste of jamun jam (score out of 5.0)

The data pertaining to the taste of jamun jam as influenced by treatments, storage period and their interaction effects are presented in Table 13 and depicted in Fig. 3. The perusal of data indicates that there were significant differences among the treatments and also between the different storage period.

The mean score for taste of the treatments irrespective of storage period varied between 3.29 and 4.18. The treatment T_1 (4.19) recorded significantly highest score followed by T_6 (4.09), whereas least score was recorded in T_9 (3.29). Irrespective of treatments, score for taste of jamun jam were found to be significant at different stages of storage. The scores decreased gradually with advancement in storage period. A linear decrease of score from 3.96 at initial stage to 3.59 at 5 MAS was noticed.

The interaction effects between the treatments and storage period were also significant. The highest scores for taste was recorded in T_1 (4.39) at initial stage, whereas least score was observed in T_9 (3.10) at 5 MAS.

4.2.3 Texture of jamun jam (score out of 5.0)

The data pertaining to the texture of jamun jam as influenced by treatments, storage period and their interaction effects are presented in Table 14 and depicted in Fig. 3.

The results on texture indicated significant difference among the treatments, storage period and the interaction between them. Significantly highest mean score for texture irrespective of storage period was observed in T_7 (4.26), whereas least score was observed in T_8 (3.45). During storage, the mean score for texture, irrespective of treatment reduced from 4.11 of initial value to 3.64 at 5 MAS. Among the interactions, the highest score was observed in T_7 (4.45) at initial period, whereas the least score was observed in T_8 (3.24) at 5 MAS.

4.2.4 Flavour of jamun jam (score out of 5.0)

The data pertaining to the flavour of jamun jam as influenced by treatments, storage period and their interaction effects are presented in Table 15 and depicted in Fig. 3.

The data on flavour of jamun jam varied significantly with treatments, storage period and the interaction between treatments and storage period. Significantly highest score for flavour irrespective of storage period was observed in T_1 (4.30), whereas least score was observed in T_9 (3.54). During storage, the mean score for flavour Irrespective of treatments, reduced from an initial value of 4.17 to 3.64 at 5 MAS. Among the interactions, the highest score was observed in T_1 (4.53) at initial period, whereas the least score was observed in T_9 (3.30) at 5 MAS.

4.2.5 Overall acceptability of jamun jam (score out of 5.0)

The data pertaining to the overall acceptability of jamun jam as influenced by treatments, storage period and their interaction effects are presented in Table 16 and depicted

in Fig. 3. The results indicated that the treatments, storage period and the interaction effect between them had significant effect on scores of overall acceptability.

Irrespective of storage period, maximum mean score for overall acceptability (4.45) was recorded in T_1, whereas minimum score was recorded in T_8 (3.39). Maximum preference with respect to overall acceptability for genotype KJP-215 was recorded in recipe 1 followed by recipe 3 and minimum score was recorded in recipe 2. For KJP-32, the highest scores for overall acceptability was found in recipe 3 followed by recipe 2 and the lowest in recipe 1. Similarly, best overall acceptability score for KJP-11 was recorded in recipe 1 followed by recipe 3 and the least was in the recipe 2.

Irrespective of treatments, score for overall acceptability of jamun jam were found significant at different stages of storage. The scores decreased gradually with advancement in storage period. During storage period of five months, the scores decreased from 4.23 to 3.65. Among the interactions, the highest score was observed in T_1 (4.71) at initial period, whereas the least score was observed in T_8 (3.04) at 5 MAS.

4.2.6 Titratable acidity (%) of jamun jam

The data on changes in titratable acidity (%) with respect to different treatments and storage period are presented in Table 17 and depicted in Fig. 4.

The results on titratable acidity indicated significant differences among the treatments, storage period and the interaction between them. The mean maximum titratable acidity was observed in T_9 (0.90%), while the least titratable acidity was recorded in T_1 (0.71%). Irrespective of treatments, the acidity of jam decreased gradually with advancement in storage period. There was a linear decrease in titratable acidity from 0.91 per cent at initial stage to 0.61 per cent at 5 MAS. Among the interaction effects, highest score for titratable acidity was recorded in T_9 (1.05%) at initial stage, whereas least score was observed in T_1 (0.50%) at 5 MAS.

4.2.7 Total soluble solids (%)

The data on changes in total soluble solids (TSS, %) with respect to different treatments, storage period and their interaction effects are presented in Table 18 and depicted in Fig. 4.

The results on TSS indicated significant differences among the treatments, storage period and the interaction between them. The mean maximum TSS was observed in T_3

(70.11%), while the least TSS was observed in T_4 (68.75%). Irrespective of treatments, the mean TSS of jamun jam increased significantly from 69.31 per cent to a final value of 70.10 per cent at 5 MAS. The interaction effect between treatments and storage period was also significant. Among the different treatments at different storage period, the highest TSS was recorded in T_3 (70.46%) at 5 MAS, while the lowest of 68.53 per cent was recorded in T_4 at initial stage.

4.2.8 Anthocyanin (mg/100 g) of jamun jam

The data on changes in anthocyanin content with respect to different treatments and storage period are presented in Table 19 and depicted in Fig. 4.

The result on anthocyanin content indicated significant differences among the treatments, storage period and the interaction between them. The mean maximum anthocyanin content was observed in T_7 (60.03 mg/100 g), whereas least score was observed in T_1 (49.51 mg/100 g). During storage, the mean anthocyanin content, irrespective of treatment reduced from an initial value of 54.10 mg per 100 g to 53.01 mg per 100 g at 5 MAS. Among the interactions, the highest anthocyanin content was observed in T_7 (60.18 mg/100 g) at initial period, whereas the least score was observed in T_1 (48.63 mg/100 g) at 5 MAS.

4.2.9 Reducing sugar (%) of jamun jam

The data pertaining to the reducing sugar content of jamun jam as influenced by treatments and storage period are presented in Table 20 and depicted in Fig. 4.

The data on reducing sugar content indicates significant differences among the treatments, storage period and the interaction between them. The mean maximum reducing sugar content was observed in T_1 (26.46%), while the least reducing sugar was recorded in T_6 (24.67%). Irrespective of treatments, the mean reducing sugar of jamun jam increased significantly from 25.50 per cent to final value of 25.88 per cent at 5 MAS. Among the interaction effects, the highest reducing sugar was recorded in T_1 (26.64%) at 5 MAS, while the lowest of 24.52 per cent was recorded in T_6 at initial period.

4.2.10 Non-reducing sugar (%) of jamun jam

The data with respect to non-reducing sugar content of the jamun jam in different treatments stored upto five months are presented in Table 21.

The data on non-reducing sugar content were found to be significant with respect to treatments, stages of storage period and the interaction between treatments and storage period.

Irrespective of storage period, T_6 (32.30%) recorded highest non-reducing sugar content, whereas the lowest value was observed in T_1 (29.00%). Irrespective of treatments, the mean non-reducing sugar content of jamun jam increased significantly from an initial value of 30.33 to 30.69 per cent at 5 MAS. Among the interaction effects, the highest non-reducing sugar content was observed in T_6 (32.55%) at 5 MAS, whereas the lowest was observed in T_1 (28.88%) at initial stage of storage.

4.2.11 Total sugars (%) of jamun jam

The data on total sugar content of jamun jam as influenced by treatments and storage period are presented in Table 22 and depicted in Fig. 4.

The results on total sugar content (%) revealed that there were significant differences between the treatments, storage period and the interaction between them. The mean total sugar content of the treatments irrespective of storage period was highest in T_6 (58.67%), whereas the least value was observed in T_4 (56.70%). Irrespective of treatments, the total sugar content increased from an initial value of 57.43 to 58.18 per cent at 5 MAS. Among the interaction effects, the highest total sugar content was recorded in T_6 (59.12%) at 5 MAS, whereas the lowest was in T_4 (56.40%) at initial stage of storage.

4.2.12 Microbial load on jamun jam (CFU/g)

The perusal of data presented in Table 23 indicates the microbial load of jam as influenced by treatments and storage period. The least bacterial population at the beginning (0.47×10^5 CFU/g) and at five months after storage (1.49×10^5 CFU/g) was found in treatment T_3 followed by T_6 (0.50×10^5 CFU/g and 1.52×10^5 CFU/g, respectively), whereas the highest bacterial population at the beginning (0.75×10^5 CFU/g) and at five months after storage (1.82×10^5 CFU/g) was observed in T_4.

The least fungal population at the beginning (0.43×10^3 CFU/g) and at 5 MAS (1.42×10^3 CFU/g) was found in treatment T_3 followed by T_6 (0.46×10^3 CFU/g and 1.48×10^3 CFU/g, respectively), whereas the highest fungal population at the beginning (0.71×10^3 CFU/g) and at 5 MAS (1.77×10^3 CFU/g) was observed under T_4.

Similarly, minimum yeast population at the beginning (0.68×10^3 CFU/g) and at 5 MAS (1.69×10^3 CFU/g) was found in treatment T_3 followed by T_6 (0.72×10^3 CFU/g and 1.73×10^3 CFU/g, respectively), whereas the highest yeast population at the beginning (0.99×10^3 CFU/g) and 5 MAS (2.06×10^3 CFU/g) was observed under T_4.

4.2.13 Colour and appearance of jamun jelly (scores out of 5.0)

The data on organoleptic evaluation pertaining to colour and appearance as influenced by treatments, storage period and their interaction effects are presented in Table 24 and depicted in Fig. 5.

The results on colour and appearance indicated significant differences among the treatments, storage period and the interaction between them. Significantly highest mean score for colour and appearance irrespective of storage period was observed in T_4 (4.54), whereas least score was observed in T_2 (2.49). During storage, the mean scores for colour and appearance irrespective of treatment reduced from an initial value of 4.05 to 3.60 at 5 MAS. Among the interactions, the highest score was observed in T_4 (4.75) at initial period, whereas the least score was observed in T_2 (2.05) at 5 MAS.

4.2.14 Taste of jamun jelly (scores out of 5.0)

The data pertaining to the taste of jamun jelly as influenced by treatments, storage period and their interaction effects are presented in Table 25 and depicted in Fig. 5. The perusal of data indicates that there were that there were significant difference among the treatments, storage period and the interaction between them.

Irrespective of storage period, significantly highest score for taste was observed in T_3 (4.10), whereas least score was observed in T_1 (2.32). During storage, the mean score for taste irrespective of treatment reduced from an initial value of 3.62 to 3.09 at 5 MAS. Among the interactions, the highest score was observed in T_3 (4.27) at initial period, whereas the least score was observed in T_1 (2.00) at 5 MAS.

4.2.15 Texture of jamun jelly (scores out of 5.0)

The data pertaining to the texture of jamun jelly as influenced by treatments, storage period and their interaction effects are presented in Table 26 and depicted in Fig. 5.

The results on texture indicated significant difference among the treatments, storage period and the interaction between treatments and storage period. Significantly highest mean score for texture irrespective of storage period was observed in T_4 (4.18), whereas the least score was observed in T_1 (2.32). During storage, the mean score for texture irrespective of treatment reduced from 3.61 of initial value to 3.15 at 5 MAS. Among the interactions, the highest score was observed in T_4 (4.35) at initial period, whereas the least score was observed in T_1 (2.00) at 5 MAS.

4.2.16 Flavour of jamun jelly (scores out of 5.0)

The data pertaining to the flavour of jamun jelly as influenced by treatments, storage period and their interaction effects are presented in Table 27 and depicted in Fig. 5.

The data on flavour of jamun jelly varied significantly with treatments, storage period and the interaction between treatments and storage period. Significantly highest score for flavour irrespective of storage period was observed in T_3 (4.11), whereas least score was observed in T_1 (1.93). During storage, the mean score for flavour irrespective of treatment reduced from an initial value of 3.52 to 3.13 at 5 MAS. Among the interactions, the highest score was observed in T_3 (4.27) at initial period, whereas the least score was observed in T_1 (1.75) at 5 MAS.

4.2.17 Overall acceptability of jamun jelly (scores out of 5.0)

The data pertaining to the overall acceptability of jamun jelly as influenced by treatments, storage period and their interaction effects are presented in Table 28 and depicted in Fig. 5. The results indicated that the treatments, storage period and interaction between them had significant effect on scores of overall acceptability.

Irrespective of storage period, maximum mean score for overall acceptability (4.30) was recorded in T_3, whereas minimum score was recorded in T_1 (2.33). Maximum preference with respect to overall acceptability for genotype KJP-215 was recorded in recipe 3 followed by recipe 2. For KJP-32, the highest score for overall acceptability was found in recipe 1 followed by recipe 3 and the lowest in recipe 2. Similarly, the highest scores for overall acceptability for KJP-11 were recorded in recipe 1 followed by recipe 3.

Irrespective of treatments, scores for overall acceptability of jamun jelly were found significant at different stages of storage. The scores decreased gradually with advancement in storage period. A linear decrease in overall acceptability scores from 3.73 to 3.20 was noticed during five months storage period. Among the interactions, the highest score was observed in T_3 (4.51) at initial period, whereas the least score was observed in T_1 (1.98) at 5 MAS.

4.2.18 Total soluble solids (%) of jamun jelly

The data on changes in total soluble solids (TSS) with respect to different treatments and storage period are presented in Table 29 and depicted in Fig. 6.

The data on TSS indicated significant differences among the treatments, storage period and the interaction between treatments and storage period. The mean maximum TSS

was observed in T_3 (66.85%), while the least TSS was recorded in T_4 (65.51%). Irrespective of treatments, the mean TSS of jamun jelly increased significantly from an initial value of 65.75 per cent to final value of 67.05 per cent at 5 MAS. The interaction effect between treatments and storage period was also significant. Among the different treatments at different storage period, the highest TSS was recorded in T_3 (67.75%) at 5 MAS, while the lowest of 65.03 per cent was recorded in T_4 at initial stage.

4.2.19 Titratable acidity (%) of jamun jelly

The data on titratable acidity of jamun jelly as influenced by treatments and storage period are presented in Table 30 and depicted in Fig. 6.

The results on titratable acidity indicated significant differences among the treatments and storage period but not with respect to interaction between treatments and storage period. The mean maximum titratable acidity was recorded in T_9 (0.67%), while the least titratable acidity was recorded in treatment T_1 (0.53%). The mean titratable acidity was significantly high at initial stage of storage (0.69%) which decreased to a least value of 0.48 per cent at 5 MAS.

4.2.20 Anthocyanin (mg/100 g) of jamun jelly

The data on changes in anthocyanin content with respect to different treatments and storage period are presented in Table 31 and depicted in Fig. 6.

The results on anthocyanin content (mg/100 g) indicated significant differences among the treatments, storage period and interaction between the treatments and storage period. The mean maximum anthocyanin content was observed in T_7 (54.41 mg/100 g), while the least anthocyanin content was recorded in T_1 (44.19 mg/100 g). Irrespective of treatments, the mean value of anthocyanin content of jamun jelly decreased from an initial value of 49.06 to 47.01 mg per 100 g at 5 MAS. Among the interaction effects, the highest anthocyanin content was observed in T_7 (55.15 mg/100 g) at initial stage of storage, whereas the least value was recorded in T_1 (43.01 mg/100 g) at 5 MAS.

4.2.21 Reducing sugar (%)

The data with respect to reducing sugar content of the jamun jelly in different treatments stored upto five months are presented in Table 32 and depicted in Fig. 6.

The data on reducing sugar content were found to be significant with respect to treatments, storage period and the interaction between them. Irrespective of storage period, T_6

recorded highest mean reducing sugar content of 22.27 per cent, whereas the lowest value was observed in T_1 (20.32%). Irrespective of the treatments, the mean reducing sugar content of jamun jelly increased significantly from an initial value of 21.03 to 21.45 per cent at 5 MAS. Among the interaction effects, the highest reducing sugar content was observed in T_6 (22.45%) at 5 MAS, whereas the lowest value was observed in T_1 (20.15%) at initial stage of storage.

4.2.22 Non-reducing sugar (%) of jamun jelly

The data with respect to non-reducing sugar content of jamun jelly in different treatments stored upto five months are presented in Table 33.

Significant differences with respect to non-reducing sugar content of jamun jelly were observed due to treatments, storage period and the interaction between treatments and storage period. The mean non-reducing sugar content of the treatments irrespective of storage period was maximum in T_1 (32.05%), whereas the least value was recorded in T_4 (30.61%). The percentage of non-reducing sugar content at different storage periods irrespective of treatment increased from an initial value of 30.83 to 31.58 per cent at 5 MAS. Among the interaction effects, the highest non-reducing sugar content was recorded in treatment T_1 (32.40%) at 5 MAS, whereas the least value was recorded in T_4 (30.39%) at initial stage of storage.

4.2.23 Total sugars (%) of jamun jelly

The data on total sugar content of jamun jelly as influenced by treatments and storage period are presented in Table 34 and depicted in Fig. 6.

The results on total sugar content revealed that there were significant differences between the treatments, storage period and the interaction between them. The mean total sugar content of the treatments irrespective of storage period was highest in T_6 (54.78%), whereas the least value was observed in T_4 (52.75%). Irrespective of treatments, the total sugar content increased from an initial value of 53.49 to 54.69 per cent at 5 MAS. Among the interaction effects, the highest total sugar content was recorded in T_6 (55.62%) at 5 MAS, whereas the lowest was in T_4 (52.35%) at initial stage of storage.

4.2.24 Microbial load on jamun jelly (CFU/g)

The data presented in Table 35 indicates the microbial load of jamun jelly as influenced by treatments and storage period. At the beginning and at 5 MAS, the bacterial population as influenced by treatments was minimum in T_3 (0.35×10^5 CFU/g and 1.38×10^5

CFU/g), whereas the highest bacterial population was observed under T_4 at the beginning and at 5 MAS (0.66 x 10^5 CFU/g, 1.75 x 10^5 CFU/g, respectively).

Maximum fungal population was observed in T_4 (0.62 x 10^3 CFU/g) at the beginning of storage. At 5 MAS, the lowest fungal population was observed in T_3 (1.33 x 10^3 CFU/g) followed by T_9 (1.39 x 10^3 CFU/g), whereas the highest fungal population was observed in T_4 (1.70 x 10^3 CFU/g) at 5 MAS.

The yeast population was least at the beginning (0.67 x 10^3 CFU/g) and at 5 MAS (1.61 x 10^3 CFU/g) in T_3, whereas T_4 showed the highest yeast population (1.97 x 10^3 CFU/g) at 5 MAS.

4.3 EXPERIMENT-III

STANDARDISATION OF PROTOCOL FOR PREPARATION OF JAMUN LEATHER

4.3.1 Colour and appearance (scores out of 5.0)

The data pertaining to the colour and appearance as influenced by treatments and storage period are presented in Table 36 and depicted in Fig. 7.

The perusal of data indicates that there were significant differences between treatments, storage period and the interaction between them. Within the treatments, the highest mean score for colour and appearance was recorded in T_9 (3.91), whereas the lowest value was noticed in T_1 (3.53). The mean score for colour and appearance at different storage periods irrespective of treatment varied significantly. It decreased linearly from 3.94 at initial stage to 3.32 at 6 MAS. Among the interaction effects, maximum scores was recorded in T_9 (4.20) at initial stage, whereas the least score was observed in T_1 (3.12) at 6 MAS.

4.3.2 Texture (scores out of 5.0)

The data pertaining to the texture of jamun leather as influenced by treatments and storage period are presented in Table 37 and depicted in Fig. 7. The perusal of data indicates that there were significant differences between treatments, storage period and the interaction between them.

Maximum mean scores for texture was recorded in T_9 (3.95), whereas the least score was noticed in T_1 (3.41). The mean score for texture at different storage periods irrespective of treatment also varied significantly. It decreased linearly from 3.96 at initial stage to 3.13 at

6 MAS. Among the interaction effects, maximum score was recorded in T_9 (4.26) at initial stage, whereas the least score was observed in T_1 (2.75) at 6 MAS.

4.3.3 Taste (scores out of 5.0)

The results of organoleptic evaluation for taste of jamun leather as influenced by treatments and storage period are presented in Table 38 and depicted in Fig. 7. The perusal of data indicates that there were significant differences between treatments, storage period and the interaction between them.

Maximum mean scores for taste was recorded in T_7 (3.77), whereas the least score was noticed in T_3 (3.06). The mean score for taste at different storage periods irrespective of treatment also varied significantly. It decreased linearly from 3.61 at initial stage to 3.14 at 6 MAS. Among the interaction effects, maximum score was recorded in T_7 (4.00) at initial stage, whereas the least score was observed in T_3 (2.82) at 6 MAS.

4.3.4 Flavour (scores out of 5.0)

The data pertaining to the flavour of jamun leather as influenced by treatments and storage period are presented in Table 39 and depicted in Fig. 7. Flavour of jamun leather varied significantly with treatments, storage period and the interaction between them.

Significantly highest mean score for flavour irrespective of storage period was observed in T_9 (4.08), whereas it was least in T_1 (3.54). During storage, the mean scores for flavour irrespective of treatment reduced from an initial value of 4.11 to 3.18 at 6 MAS. Among the interaction, the highest score was observed in T_9 (4.35) at initial period, whereas the least score was observed in T_1 (3.03) at 6 MAS.

4.3.5 Overall acceptability (scores out of 5.0)

The results of organoleptic evaluation for overall acceptability of jamun leather as influenced by treatments and storage period are presented in Table 40 and depicted in Fig. 7. The perusal of data indicates that there were significant differences between treatments, storage period and the interaction between them.

The mean score for overall acceptability irrespective of storage period was maximum in T_7 (3.70), whereas minimum score was observed in T_3 (3.15). The mean score for overall acceptability irrespective of treatment was highest at initial stage (3.64), which decreased marginally to 3.11 at 6 MAS. Among the interactions, maximum score was recorded in T_7 (3.95) at initial stage, whereas minimum score was observed in T_3 (2.89) at 6 MAS.

4.3.6 Titratable acidity (%)

The data on titratable acidity of jamun leather as influenced by treatments stored upto six months are presented in Table 41 and depicted in Fig. 8.

The data pertaining to titratable acid content revealed that there were significant differences between treatments and storage period but not with respect to their interaction effects. Within the treatments, the highest mean titratable acid content was noticed in T_7 (0.78%), whereas the lowest was noticed in T_3 (0.55%). During storage, the mean titratable acid content decreased from an initial value of 0.77 to 0.56 at 6 MAS.

4.3.7 Moisture content (%)

The data on moisture content of jamun leather as influenced by treatments stored upto six months are presented in Table 42 and depicted in Fig. 8.

The data on moisture content were found to be significant with respect to treatments and storage period, but not with respect to their interaction effects. The highest mean moisture content was found in T_9 (11.54%), whereas the lowest mean was in T_1 (11.39%). During storage, the mean moisture content increased significantly from an initial value of 11.10 to 12.15 per cent at 6 MAS.

4.3.8 Anthocyanin content (mg/100 g)

The data pertaining to anthocyanin content of jamun leather as influenced by treatments and storage period are presented in Table 43 and depicted in Fig. 8.

The data on anthocyanin content was found significant with respect to treatments, stages of storage period and interaction between treatments and storage period. The highest mean anthocyanin content was recorded in T_9 (28.51 mg/100 g), whereas the lowest value was recorded in T_1 (26.92 mg/100 g). Irrespective of treatments, the mean anthocyanin content of jamun leather decreased significantly from an initial value of 28.14 to 26.44 mg per 100 g at 6 MAS. Among interaction effects, the highest anthocyanin content was in T_9 (28.93 mg/100 g) at initial stage, whereas the lowest content was recorded in T_1 (25.93 mg/100 g) at 6 MAS.

4.3.9 Total sugars (%)

The data on total sugar content of jamun leather as influenced by treatments and storage period are presented in Table 44 and depicted in Fig. 8.

The results on total sugar content revealed that there were significant differences between the treatments, storage period and the interaction between them. The mean total sugar content of the treatments irrespective of storage period was highest in T_9 (6.58%), whereas the least value was observed in T_1 (5.57%). Irrespective of treatments, the total sugar content increased from an initial valueof 5.51 to 6.68 per cent at 6 MAS. Among interaction effects, the highest total sugar content was recorded in T_9 (7.16%) at 6 MAS, whereas the lowest was in T_1 (5.00%) at initial stage of storage.

4.3.10 Microbial load on jamun leather (CFU/g)

The data pertaining to the microbial load on jamun leather initially and at 6 MAS are presented in Table 45.

The population of bacteria, fungi and yeast were found to be minimum in T_3 (1.29×10^5, 1.10×10^3 and 1.35×10^3 CFU/g, respectively) at initial stage and at 6 MAS (2.72×10^5, 1.66×10^3 and 2.89×10^3 CFU/g, respectively), while maximum population of bacteria, fungi and yeast were recorded in T_7 (1.54×10^5, 1.39×10^3 and 1.69×10^3 CFU/g, respectively) at initial and at 6 MAS (2.97×10^5, 1.94×10^3 and 3.19×10^3 CFU/g, respectively).

Table 1. Changes in colour and appearance of jamun juice as influenced by treatments and storage period

Treatments	Colour and appearance (scores out of 5.0)					
	Initial	2 MAS	4 MAS	6 MAS	8 MAS	Mean
T_1 – Control	4.50	4.25	4.16	3.95	3.15	4.00
T_2 – Pasteurisation of juice at 85°C for 10 minutes + 300 ppm sodium benzoate	4.50	4.30	4.17	4.00	3.19	4.03
T_3 – Pasteurisation of juice at 85°C for 10 minutes + 400 ppm sodium benzoate	4.50	4.36	4.22	4.02	3.23	4.06
T_4 – Pasteurisation of juice at 85°C for 10 minutes + 500 ppm sodium benzoate	4.50	4.30	4.23	4.00	3.30	4.06
T_5 – Juice + 600 ppm sodium benzoate	4.50	4.33	4.25	4.05	3.75	4.18
T_6 – Juice + 800 ppm sodium benzoate	4.50	4.32	4.26	4.07	3.82	4.19
T_7 – Juice + 1000 ppm sodium benzoate	4.00	3.95	3.89	3.70	3.07	3.72
Mean	4.42	4.25	4.16	3.97	3.36	
For comparing the means of	S.Em±			C.D. at 1%		
Treatments (T)	0.0365			0.1367		
Storage period (S)	0.0309			0.1156		
Interaction (T x S)	0.0816			0.3057		

MAS = Months after storage

Table 2. Changes in taste of jamun juice as influenced by treatments and storage period

Treatments	Taste (scores out of 5.0)					
	Initial	2 MAS	4 MAS	6 MAS	8 MAS	Mean
T_1 – Control	4.00	3.75	3.52	3.35	3.20	3.56
T_2 – Pasteurisation of juice at 85°C for 10 minutes + 300 ppm sodium benzoate	4.30	4.23	4.17	4.10	4.03	4.16
T_3 – Pasteurisation of juice at 85°C for 10 minutes + 400 ppm sodium benzoate	4.16	4.08	3.58	3.45	3.30	3.71
T_4 – Pasteurisation of juice at 85°C for 10 minutes + 500 ppm sodium benzoate	4.08	3.95	3.55	3.35	3.25	3.63
T_5 – Juice + 600 ppm sodium benzoate	4.75	4.65	4.51	4.42	4.24	4.51
T_6 – Juice + 800 ppm sodium benzoate	4.50	4.38	4.31	4.14	4.06	4.27
T_7 – Juice + 1000 ppm sodium benzoate	3.50	3.20	3.00	2.95	2.85	3.10
Mean	4.18	4.03	3.80	3.68	3.56	
For comparing the means of	S.Em±			C.D. at 1%		
Treatments (T)	0.0069			0.0258		
Storage period (S)	0.0058			0.0218		
Interaction (T x S)	0.0154			0.0576		

MAS = Months after storage

Table 3. Changes in flavour of jamun juice as influenced by treatments and storage period

Treatments	Flavour (scores out of 5.0)					
	Initial	2 MAS	4 MAS	6 MAS	8 MAS	Mean
T_1 – Control	4.06	3.94	3.73	3.54	3.34	3.72
T_2 – Pasteurisation of juice at 85°C for 10 minutes + 300 ppm sodium benzoate	4.07	3.97	3.69	3.51	3.30	3.70
T_3 – Pasteurisation of juice at 85°C for 10 minutes + 400 ppm sodium benzoate	4.02	3.92	3.66	3.46	3.21	3.65
T_4 – Pasteurisation of juice at 85°C for 10 minutes + 500 ppm sodium benzoate	4.12	3.90	3.61	3.40	3.17	3.64
T_5 – Juice + 600 ppm sodium benzoate	4.14	4.04	3.87	3.67	3.53	3.85
T_6 – Juice + 800 ppm sodium benzoate	4.10	4.00	3.81	3.61	3.49	3.80
T_7 – Juice + 1000 ppm sodium benzoate	4.08	3.98	3.76	3.57	3.41	3.76
Mean	4.08	3.96	3.73	3.53	3.35	
For comparing the means of	S.Em±			C.D. at 1%		
Treatments (T)	0.0063			0.0236		
Storage period (S)	0.0053			0.0199		
Interaction (T x S)	0.0141			0.0527		

MAS = Months after storage

Table 4. Changes in overall acceptability of jamun juice as influenced by treatments and storage period

Treatments	Overall acceptability (scores out of 5.0)					
	Initial	2 MAS	4 MAS	6 MAS	8 MAS	Mean
T_1 – Control	3.95	3.60	3.50	3.35	3.11	3.50
T_2 – Pasteurisation of juice at 85°C for 10 minutes + 300 ppm sodium benzoate	4.50	4.41	3.56	3.44	3.26	3.83
T_3 – Pasteurisation of juice at 85°C for 10 minutes + 400 ppm sodium benzoate	4.29	4.22	3.51	3.40	3.12	3.70
T_4 – Pasteurisation of juice at 85°C for 10 minutes + 500 ppm sodium benzoate	4.00	3.96	3.41	3.36	3.07	3.56
T_5 – Juice + 600 ppm sodium benzoate	4.75	4.67	4.12	4.01	3.86	4.28
T_6 – Juice + 800 ppm sodium benzoate	4.59	4.52	4.03	3.93	3.78	4.17
T_7 – Juice + 1000 ppm sodium benzoate	3.75	3.55	3.43	3.25	2.95	3.38
Mean	4.26	4.13	3.65	3.53	3.30	
For comparing the means of	S.Em±			C.D. at 1%		
Treatments (T)	0.0057			0.0214		
Storage period (S)	0.0048			0.0181		
Interaction (T x S)	0.0128			0.0478		

MAS = Months after storage

Table 5. Changes in total soluble solids of jamun juice as influenced by treatments and storage period

Treatments	Total soluble solids (%)					
	Initial	2 MAS	4 MAS	6 MAS	8 MAS	Mean
T_1 – Control	13.40	13.48	13.52	13.62	13.77	13.55
T_2 – Pasteurisation of juice at 85°C for 10 minutes + 300 ppm sodium benzoate	13.51	13.61	13.66	13.77	13.90	13.69
T_3 – Pasteurisation of juice at 85°C for 10 minutes + 400 ppm sodium benzoate	13.59	13.68	13.77	13.90	14.00	13.78
T_4 – Pasteurisation of juice at 85°C for 10 minutes + 500 ppm sodium benzoate	13.66	13.74	13.82	13.95	14.06	13.85
T_5 – Juice + 600 ppm sodium benzoate	12.25	12.33	12.41	12.54	12.68	12.44
T_6 – Juice + 800 ppm sodium benzoate	12.39	12.45	12.51	12.67	12.81	12.56
T_7 – Juice + 1000 ppm sodium benzoate	12.42	12.51	12.59	12.76	12.95	12.64
Mean	13.03	13.11	13.18	13.31	13.45	
For comparing the means of	S.Em±			C.D. at 1%		
Treatments (T)	0.0061			0.0227		
Storage period (S)	0.0051			0.0192		
Interaction (T x S)	0.0135			0.0507		

MAS = Months after storage

Table 6. Changes in titratable acidity of jamun juice as influenced by treatments and storage period

Treatments	Titratable acidity (%)					
	Initial	2 MAS	4 MAS	6 MAS	8 MAS	Mean
T_1 – Control	0.93	0.87	0.83	0.80	0.74	0.83
T_2 – Pasteurisation of juice at 85°C for 10 minutes + 300 ppm sodium benzoate	0.87	0.82	0.77	0.71	0.63	0.76
T_3 – Pasteurisation of juice at 85°C for 10 minutes + 400 ppm sodium benzoate	0.89	0.84	0.79	0.74	0.64	0.78
T_4 – Pasteurisation of juice at 85°C for 10 minutes + 500 ppm sodium benzoate	0.91	0.85	0.81	0.78	0.69	0.80
T_5 – Juice + 600 ppm sodium benzoate	0.96	0.92	0.89	0.81	0.79	0.87
T_6 – Juice + 800 ppm sodium benzoate	0.97	0.94	0.92	0.86	0.84	0.90
T_7 – Juice + 1000 ppm sodium benzoate	1.00	0.96	0.94	0.91	0.86	0.93
Mean	0.93	0.88	0.85	0.80	0.74	
For comparing the means of	S.Em±			C.D. at 1%		
Treatments (T)	0.0053			0.0198		
Storage period (S)	0.0045			0.0168		
Interaction (T x S)	0.0118			0.0444		

MAS = Months after storage

Table 7. Changes in ascorbic acid content of jamun juice as influenced by treatments and storage period

Treatments	Ascorbic acid (mg/100 g)					
	Initial	2 MAS	4 MAS	6 MAS	8 MAS	Mean
T_1 – Control	17.30	17.12	17.00	16.92	16.03	16.87
T_2 – Pasteurisation of juice at 85°C for 10 minutes + 300 ppm sodium benzoate	16.75	16.53	16.42	16.33	15.57	16.32
T_3 – Pasteurisation of juice at 85°C for 10 minutes + 400 ppm sodium benzoate	16.78	16.60	16.48	16.36	15.67	16.37
T_4 – Pasteurisation of juice at 85°C for 10 minutes + 500 ppm sodium benzoate	16.82	16.62	16.52	16.44	15.77	16.43
T_5 – Juice + 600 ppm sodium benzoate	17.62	17.45	17.32	17.24	16.13	17.15
T_6 – Juice + 800 ppm sodium benzoate	17.68	17.48	17.36	17.30	16.16	17.19
T_7 – Juice + 1000 ppm sodium benzoate	17.75	17.56	17.42	17.36	16.24	17.26
Mean	17.24	17.05	16.93	16.85	15.93	
For comparing the means of	S.Em±			C.D. at 1%		
Treatments (T)	0.0103			0.0386		
Storage period (S)	0.0087			0.0326		
Interaction (T x S)	0.0230			0.0862		

MAS = Months after storage

Table 8. Changes in anthocyanin (mg/100 ml) of jamun juice as influenced by treatments and storage period

Treatments	Anthocyanin (mg/100 ml)					
	Initial	2 MAS	4 MAS	6 MAS	8 MAS	Mean
T_1 – Control	52.33	52.05	51.24	51.03	50.55	51.44
T_2 – Pasteurisation of juice at 85°C for 10 minutes + 300 ppm sodium benzoate	52.31	52.03	51.27	51.05	50.59	51.45
T_3 – Pasteurisation of juice at 85°C for 10 minutes + 400 ppm sodium benzoate	52.33	52.08	51.32	51.10	50.65	51.50
T_4 – Pasteurisation of juice at 85°C for 10 minutes + 500 ppm sodium benzoate	52.39	52.14	51.37	51.14	50.69	51.55
T_5 – Juice + 600 ppm sodium benzoate	52.46	52.20	51.42	51.20	50.73	51.60
T_6 – Juice + 800 ppm sodium benzoate	52.49	52.26	51.48	51.25	50.79	51.65
T_7 – Juice + 1000 ppm sodium benzoate	52.26	52.00	51.21	51.00	50.50	51.40
Mean	52.36	52.10	51.33	51.11	50.64	
For comparing the means of	S.Em±			C.D. at 1%		
Treatments (T)	0.0030			0.0111		
Storage period (S)	0.0025			0.0094		
Interaction (T x S)	0.0066			0.0249		

MAS = Months after storage

Table 9. Changes in phenol content of jamun juice as influenced by treatments and storage period

Treatments	Phenols (mg/100 ml)					
	Initial	2 MAS	4 MAS	6 MAS	8 MAS	Mean
T_1 – Control	355.60	355.37	355.00	354.83	353.93	354.95
T_2 – Pasteurisation of juice at 85°C for 10 minutes + 300 ppm sodium benzoate	355.41	355.17	354.93	354.61	353.34	354.69
T_3 – Pasteurisation of juice at 85°C for 10 minutes + 400 ppm sodium benzoate	355.15	355.01	354.87	354.52	353.27	354.56
T_4 – Pasteurisation of juice at 85°C for 10 minutes + 500 ppm sodium benzoate	355.01	354.92	354.83	354.43	353.16	354.47
T_5 – Juice + 600 ppm sodium benzoate	356.15	356.00	355.51	355.13	354.05	355.37
T_6 – Juice + 800 ppm sodium benzoate	356.21	356.06	355.58	355.22	354.14	355.44
T_7 – Juice + 1000 ppm sodium benzoate	356.29	356.11	355.67	355.31	354.23	355.52
Mean	355.69	355.52	355.20	354.86	353.73	
For comparing the means of	S.Em±			C.D. at 1%		
Treatments (T)	0.0085			0.0317		
Storage period (S)	0.0071			0.0268		
Interaction (T x S)	0.0189			0.0708		

MAS = Months after storage

Table 10. Changes in total sugars of jamun juice as influenced by treatments and storage period

Treatments	Total sugar (%)					
	Initial	2 MAS	4 MAS	6 MAS	8 MAS	Mean
T_1 – Control	8.44	8.53	8.59	8.72	8.90	8.64
T_2 – Pasteurisation of juice at 85°C for 10 minutes + 300 ppm sodium benzoate	8.49	8.60	8.69	8.78	8.97	8.71
T_3 – Pasteurisation of juice at 85°C for 10 minutes + 400 ppm sodium benzoate	8.54	8.64	8.75	8.91	9.06	8.78
T_4 – Pasteurisation of juice at 85°C for 10 minutes + 500 ppm sodium benzoate	8.59	8.70	9.82	9.01	9.17	8.86
T_5 – Juice + 600 ppm sodium benzoate	8.10	8.15	8.24	8.38	8.51	8.28
T_6 – Juice + 800 ppm sodium benzoate	8.14	8.27	8.31	8.48	8.56	8.35
T_7 – Juice + 1000 ppm sodium benzoate	8.19	8.37	8.44	8.54	8.65	8.44
Mean	8.35	8.46	8.56	8.69	8.83	
For comparing the means of	S.Em±			C.D. at 1%		
Treatments (T)	0.0068			0.0253		
Storage period (S)	0.0057			0.0214		
Interaction (T x S)	0.0151			0.0566		

MAS = Months after storage

Table 11. Microbial load on jamun juice as influenced by treatments and storage period

Treatments	Bacteria (No. x 10^5 CFU/ml)		Fungi (No. x 10^3 CFU/ml)		Yeast (No. x 10^3 CFU/ml)	
	Initial	8 MAS	Initial	8 MAS	Initial	8 MAS
T_1 – Control	3.15	4.50	1.85	3.85	3.80	5.00
T_2 – Pasteurisation of juice at 85°C for 10 minutes + 300 ppm sodium benzoate	2.47	4.03	1.29	3.15	3.33	4.19
T_3 – Pasteurisation of juice at 85°C for 10 minutes + 400 ppm sodium benzoate	2.35	3.95	1.23	3.09	3.27	4.13
T_4 – Pasteurisation of juice at 85°C for 10 minutes + 500 ppm sodium benzoate	2.28	3.89	1.18	3.02	3.20	4.07
T_5 – Juice + 600 ppm sodium benzoate	2.90	4.25	1.45	3.39	3.63	4.60
T_6 – Juice + 800 ppm sodium benzoate	2.81	4.19	1.40	3.34	3.55	4.52
T_7 – Juice + 1000 ppm sodium benzoate	2.72	4.10	1.34	3.29	3.50	4.45

MAS = Months after storage

Table 12. Changes in colour and appearance of jamun jam as influenced by treatments and storage period

Treatments	Colour and appearance (scores out of 5.0)						
	Initial	1 MAS	2 MAS	3 MAS	4 MAS	5 MAS	Mean
T_1 – KJP-215 - Recipe-1	4.55	4.50	4.44	4.37	4.30	3.93	4.35
T_2 – KJP-215 - Recipe-2	4.09	4.05	4.00	3.93	3.81	3.60	3.92
T_3 – KJP-215 - Recipe-3	4.22	4.18	4.12	4.05	3.97	3.75	4.05
T_4 – KJP-32 - Recipe-1	4.40	4.36	4.32	4.23	4.16	3.92	4.24
T_5 – KJP-32 - Recipe-2	4.15	4.10	4.03	3.95	3.83	3.79	3.98
T_6 – KJP-32 - Recipe-3	4.48	4.45	4.39	4.30	4.20	3.90	4.29
T_7 – KJP-11 - Recipe-1	4.31	4.27	4.25	4.20	4.11	3.80	4.16
T_8 – KJP-11 - Recipe-2	3.85	3.81	3.76	3.70	3.62	3.50	3.71
T_9 – KJP-11 - Recipe-3	3.99	3.95	3.88	3.80	3.70	3.58	3.82
Mean	4.23	4.19	4.13	4.06	3.97	3.76	
For comparing the means of	S.Em±			C.D. at 1%			
Treatments (T)	0.0050			0.0184			
Storage period (S)	0.0041			0.0150			
Interaction (T x S)	0.0122			0.0451			

MAS = Months after storage

Table 13. Changes in taste of jamun jam as influenced by treatments and storage period

Treatments	Taste (scores out of 5.0)						
	Initial	1 MAS	2 MAS	3 MAS	4 MAS	5 MAS	Mean
T_1 – KJP-215 - Recipe-1	4.39	4.30	4.24	4.26	4.03	3.90	4.19
T_2 – KJP-215 - Recipe-2	3.84	3.80	3.75	3.70	3.61	3.52	3.70
T_3 – KJP-215 - Recipe-3	4.15	4.11	4.06	4.00	3.92	3.80	4.01
T_4 – KJP-32 - Recipe-1	3.80	3.76	3.73	3.70	3.58	3.47	3.67
T_5 – KJP-32 - Recipe-2	3.96	3.92	3.86	3.78	3.70	3.55	3.80
T_6 – KJP-32 - Recipe-3	4.35	4.20	4.14	4.07	3.96	3.85	4.09
T_7 – KJP-11 - Recipe-1	4.06	4.02	3.95	3.88	3.82	3.75	3.92
T_8 – KJP-11 - Recipe-2	3.65	3.60	3.54	3.45	3.37	3.30	3.49
T_9 – KJP-11 - Recipe-3	3.45	3.40	3.33	3.26	3.19	3.10	3.29
Mean	3.96	3.90	3.84	3.78	3.69	3.59	
For comparing the means of	S.Em±			C.D. at 1%			
Treatments (T)	0.0063			0.0242			
Storage period (S)	0.0053			0.0198			
Interaction (T x S)	0.0160			0.0593			

MAS = Months after storage

Table 14. Changes in texture of jamun jam as influenced by treatments and storage period

Treatments	Texture (scores out of 5.0)						
	Initial	1 MAS	2 MAS	3 MAS	4 MAS	5 MAS	Mean
T_1 – KJP-215 - Recipe-1	4.36	4.30	4.25	4.19	4.07	3.82	4.17
T_2 – KJP-215 - Recipe-2	3.95	3.90	3.85	3.78	3.66	3.57	3.79
T_3 – KJP-215 - Recipe-3	4.24	4.20	4.14	4.09	4.03	3.75	4.08
T_4 – KJP-32 - Recipe-1	4.14	4.10	4.04	3.98	3.90	3.70	3.98
T_5 – KJP-32 - Recipe-2	4.05	4.00	3.94	3.87	3.80	3.65	3.89
T_6 – KJP-32 - Recipe-3	4.28	4.23	4.17	4.10	4.00	3.79	4.10
T_7 – KJP-11 - Recipe-1	4.45	4.40	4.34	4.26	4.13	3.96	4.26
T_8 – KJP-11 - Recipe-2	3.60	3.56	3.50	3.42	3.33	3.24	3.45
T_9 – KJP-11 - Recipe-3	3.86	3.80	3.75	3.66	3.52	3.44	3.68
Mean	4.11	4.06	4.00	3.93	3.83	3.64	
For comparing the means of	S.Em±			C.D. at 1%			
Treatments (T)	0.0049			0.0183			
Storage period (S)	0.0040			0.0149			
Interaction (T x S)	0.0121			0.0448			

MAS = Months after storage

Table 15. Changes in flavour of jamun jam as influenced by treatments and storage period

Treatments	Flavour (scores out of 5.0)						
	Initial	1 MAS	2 MAS	3 MAS	4 MAS	5 MAS	Mean
T_1 – KJP-215 - Recipe-1	4.53	4.47	4.40	4.31	4.12	3.95	4.30
T_2 – KJP-215 - Recipe-2	4.01	3.97	3.91	3.83	3.62	3.50	3.81
T_3 – KJP-215 - Recipe-3	3.89	3.81	3.76	3.70	3.51	3.40	3.68
T_4 – KJP-32 - Recipe-1	4.19	4.12	4.05	3.97	3.75	3.61	3.95
T_5 – KJP-32 - Recipe-2	4.36	4.30	4.23	4.15	3.95	3.83	4.14
T_6 – KJP-32 - Recipe-3	4.54	4.48	4.40	4.29	4.04	3.91	4.28
T_7 – KJP-11 - Recipe-1	4.45	4.404	4.33	4.23	4.00	3.89	4.22
T_8 – KJP-11 - Recipe-2	3.83	3.77	3.71	3.62	3.45	3.31	3.62
T_9 – KJP-11 - Recipe-3	3.74	3.68	3.60	3.51	3.37	3.30	3.54
Mean	4.17	4.11	4.05	3.96	3.76	3.64	
For comparing the means of	S.Em±			C.D. at 1%			
Treatments (T)	0.0049			0.0182			
Storage period (S)	0.0040			0.0149			
Interaction (T x S)	0.0120			0.0446			

MAS = Months after storage

Table 16. Changes in overall acceptability of jamun jam as influenced by treatments and storage period

Treatments	Overall acceptability (scores out of 5.0)						
	Initial	1 MAS	2 MAS	3 MAS	4 MAS	5 MAS	Mean
T_1 – KJP-215 - Recipe-1	4.71	4.65	4.58	4.50	4.26	3.98	4.45
T_2 – KJP-215 - Recipe-2	3.89	3.85	3.80	3.73	3.51	3.45	3.71
T_3 – KJP-215 - Recipe-3	4.12	4.07	4.00	3.90	3.73	3.66	3.92
T_4 – KJP-32 - Recipe-1	4.31	4.25	4.17	4.08	3.89	3.80	4.09
T_5 – KJP-32 - Recipe-2	4.42	4.37	4.30	4.21	4.00	3.85	4.20
T_6 – KJP-32 - Recipe-3	4.67	4.60	4.53	4.45	4.16	3.95	4.40
T_7 – KJP-11 - Recipe-1	4.55	4.50	4.44	4.36	4.05	3.90	4.30
T_8 – KJP-11 - Recipe-2	3.63	3.57	3.50	3.41	3.19	3.04	3.39
T_9 – KJP-11 - Recipe-3	3.75	3.70	3.62	3.53	3.27	3.18	3.51
Mean	4.23	4.18	4.11	4.02	3.79	3.65	
For comparing the means of	S.Em±			C.D. at 1%			
Treatments (T)	0.0056			0.0207			
Storage period (S)	0.0046			0.0169			
Interaction (T x S)	0.0137			0.0506			

MAS = Months after storage

Table 17. Changes in titratable acidity of jamun jam as influenced by treatments and storage period

Treatments	Titratable acidity (%)						
	Initial	1 MAS	2 MAS	3 MAS	4 MAS	5 MAS	Mean
T_1 – KJP-215 - Recipe-1	0.82	0.81	0.78	0.71	0.63	0.50	0.71
T_2 – KJP-215 - Recipe-2	0.87	0.85	0.80	0.75	0.69	0.60	0.76
T_3 – KJP-215 - Recipe-3	0.95	0.93	0.87	0.81	0.73	0.63	0.82
T_4 – KJP-32 - Recipe-1	0.84	0.83	0.80	0.74	0.66	0.57	0.74
T_5 – KJP-32 - Recipe-2	0.90	0.87	0.83	0.77	0.69	0.62	0.78
T_6 – KJP-32 - Recipe-3	0.96	0.92	0.88	0.83	0.71	0.66	0.83
T_7 – KJP-11 - Recipe-1	0.86	0.83	0.78	0.90	0.58	0.53	0.75
T_8 – KJP-11 - Recipe-2	0.91	0.88	0.84	0.78	0.73	0.62	0.80
T_9 – KJP-11 - Recipe-3	1.05	1.03	0.97	0.88	0.77	0.70	0.90
Mean	0.91	0.89	0.84	0.78	0.69	0.61	
For comparing the means of	S.Em±			C.D. at 1%			
Treatments (T)	0.0049			0.0183			
Storage period (S)	0.0040			0.0149			
Interaction (T x S)	0.0121			0.0448			

MAS = Months after storage

Table 18. Changes in total soluble solids of jamun jam as influenced by treatments and storage period

Treatments	Total soluble solids (%)						
	Initial	1 MAS	2 MAS	3 MAS	4 MAS	5 MAS	Mean
T_1 – KJP-215 - Recipe-1	68.80	68.86	68.92	69.04	70.00	70.09	69.29
T_2 – KJP-215 - Recipe-2	69.47	69.55	69.63	69.75	69.85	70.25	69.75
T_3 – KJP-215 - Recipe-3	69.93	69.97	70.02	70.10	70.15	70.46	70.11
T_4 – KJP-32 - Recipe-1	68.53	68.58	68.66	68.78	68.92	69.00	68.75
T_5 – KJP-32 - Recipe-2	69.20	69.25	69.31	69.39	69.47	70.13	69.46
T_6 – KJP-32 - Recipe-3	69.90	69.95	70.00	70.07	70.12	70.40	70.08
T_7 – KJP-11 - Recipe-1	68.90	68.96	69.01	69.07	69.13	70.00	69.18
T_8 – KJP-11 - Recipe-2	69.27	69.36	69.43	69.50	69.57	70.18	69.56
T_9 – KJP-11 - Recipe-3	69.80	69.87	69.92	70.00	70.08	70.34	70.01
Mean	69.31	69.38	69.44	69.53	69.70	70.10	
For comparing the means of	S.Em±			C.D. at 1%			
Treatments (T)	0.0055			0.0203			
Storage period (S)	0.0045			0.0166			
Interaction (T x S)	0.0134			0.0497			

MAS = Months after storage

Table 19. Changes in anthocyanin content of jamun jam as influenced by treatments and storage period

Treatments	Anthocyanin (mg/100 g)						
	Initial	1 MAS	2 MAS	3 MAS	4 MAS	5 MAS	Mean
T_1 – KJP-215 - Recipe-1	49.80	49.75	49.71	49.63	49.55	48.63	49.51
T_2 – KJP-215 - Recipe-2	50.95	50.92	50.86	50.81	50.70	49.52	50.63
T_3 – KJP-215 - Recipe-3	51.97	51.93	51.77	51.70	51.63	50.63	51.60
T_4 – KJP-32 - Recipe-1	54.03	53.98	53.92	53.84	53.81	52.65	53.71
T_5 – KJP-32 - Recipe-2	51.92	51.88	51.83	51.77	51.70	50.85	51.66
T_6 – KJP-32 - Recipe-3	52.86	52.83	52.79	52.70	52.57	51.92	52.61
T_7 – KJP-11 - Recipe-1	60.18	60.15	60.10	60.04	59.93	59.75	60.03
T_8 – KJP-11 - Recipe-2	56.76	56.74	56.70	56.65	56.53	55.53	56.49
T_9 – KJP-11 - Recipe-3	58.45	58.41	58.36	58.30	58.18	57.65	58.23
Mean	54.10	54.06	54.01	53.94	53.85	53.01	
For comparing the means of	S.Em±			C.D. at 1%			
Treatments (T)	0.0180			0.0667			
Storage period (S)	0.0147			0.0544			
Interaction (T x S)	0.0440			0.1633			

MAS = Months after storage

Table 20. Changes in reducing sugar content of jamun jam as influenced by treatments and storage period

Treatments	Reducing sugar (%)						
	Initial	1 MAS	2 MAS	3 MAS	4 MAS	5 MAS	Mean
T_1 – KJP-215 - Recipe-1	26.33	26.36	26.40	26.46	26.60	26.64	26.46
T_2 – KJP-215 - Recipe-2	25.95	25.99	26.04	26.11	26.25	26.30	26.11
T_3 – KJP-215 - Recipe-3	24.79	24.83	24.88	24.95	25.12	25.16	24.96
T_4 – KJP-32 - Recipe-1	25.61	25.65	25.70	25.78	26.00	26.04	25.80
T_5 – KJP-32 - Recipe-2	25.88	25.93	25.99	26.06	26.19	26.23	26.05
T_6 – KJP-32 - Recipe-3	24.52	24.56	24.60	24.66	24.80	24.85	24.67
T_7 – KJP-11 - Recipe-1	26.00	26.04	26.17	26.32	26.32	26.34	26.20
T_8 – KJP-11 - Recipe-2	25.67	25.70	25.83	26.13	26.13	26.15	25.94
T_9 – KJP-11 - Recipe-3	24.70	24.74	24.90	25.10	25.10	25.13	25.95
Mean	25.50	25.54	25.66	25.73	25.84	25.88	
For comparing the means of	S.Em±			C.D. at 1%			
Treatments (T)	0.0049			0.0181			
Storage period (S)	0.0040			0.0148			
Interaction (T x S)	0.0119			0.0443			

MAS = Months after storage

Table 21. Changes in non-reducing sugar content of jamun jam as influenced by treatments and storage period

Treatments	Non-reducing sugar (%)						
	Initial	1 MAS	2 MAS	3 MAS	4 MAS	5 MAS	Mean
T_1 – KJP-215 - Recipe-1	28.88	28.91	28.94	28.99	29.09	29.14	29.00
T_2 – KJP-215 - Recipe-2	29.64	29.67	29.70	29.74	30.10	30.13	29.83
T_3 – KJP-215 - Recipe-3	31.72	31.75	31.79	31.84	32.11	32.15	31.90
T_4 – KJP-32 - Recipe-1	29.25	29.28	29.32	29.38	29.45	29.49	29.37
T_5 – KJP-32 - Recipe-2	29.81	29.84	29.88	29.92	30.22	30.26	29.99
T_6 – KJP-32 - Recipe-3	32.14	32.18	32.21	32.24	32.48	32.55	32.30
T_7 – KJP-11 - Recipe-1	29.54	29.57	29.60	29.65	29.78	29.82	29.66
T_8 – KJP-11 - Recipe-2	30.12	30.15	30.18	30.22	30.40	30.44	30.26
T_9 – KJP-11 - Recipe-3	31.86	31.88	31.91	31.94	32.15	32.19	31.99
Mean	30.33	30.36	30.40	30.44	30.65	30.69	
For comparing the means of	S.Em±			C.D. at 1%			
Treatments (T)	0.0049			0.0181			
Storage period (S)	0.0040			0.0148			
Interaction (T x S)	0.0120			0.0444			

MAS = Months after storage

Table 22. Changes in total sugars of jamun jam as influenced by treatments and storage period

Treatments	Total sugars (%)						
	Initial	1 MAS	2 MAS	3 MAS	4 MAS	5 MAS	Mean
T_1 – KJP-215 - Recipe-1	56.73	56.79	56.86	56.98	57.22	57.31	56.99
T_2 – KJP-215 - Recipe-2	57.15	57.33	57.30	57.42	57.94	58.02	57.53
T_3 – KJP-215 - Recipe-3	58.18	58.24	58.34	58.47	58.92	59.00	58.53
T_4 – KJP-32 - Recipe-1	56.40	56.47	56.56	56.69	57.00	57.08	56.70
T_5 – KJP-32 - Recipe-2	57.26	57.34	57.44	57.56	58.00	58.08	57.62
T_6 – KJP-32 - Recipe-3	58.36	58.43	58.50	58.60	58.99	59.12	58.67
T_7 – KJP-11 - Recipe-1	57.10	57.17	57.26	57.38	57.67	57.75	57.39
T_8 – KJP-11 - Recipe-2	57.38	57.44	57.52	57.64	58.13	58.23	57.73
T_9 – KJP-11 - Recipe-3	58.24	58.30	58.40	58.52	58.95	59.03	58.58
Mean	57.43	57.49	57.58	57.70	58.09	58.18	
For comparing the means of	S.Em±			C.D. at 1%			
Treatments (T)	0.0049			0.0182			
Storage period (S)	0.0040			0.0142			
Interaction (T x S)	0.0121			0.0447			

MAS = Months after storage

Table 23. Microbial load on jamun jam as influenced by treatments and storage period

Treatments	Bacteria (No. x 10^5 CFU/g)		Fungi (No. x 10^3 CFU/g)		Yeast (No. x 10^3 CFU/g)	
	Initial	5 MAS	Initial	5 MAS	Initial	5 MAS
T_1 – KJP-215 - Recipe-1	0.69	1.74	0.65	1.70	0.91	1.96
T_2 – KJP-215 - Recipe-2	0.58	1.61	0.55	1.56	0.80	1.82
T_3 – KJP-215 - Recipe-3	0.47	1.49	0.43	1.42	0.68	1.69
T_4 – KJP-32 - Recipe-1	0.75	1.82	0.71	1.77	0.99	2.06
T_5 – KJP-32 - Recipe-2	0.65	1.70	0.63	1.65	0.87	1.91
T_6 – KJP-32 - Recipe-3	0.50	1.52	0.46	1.48	0.72	1.73
T_7 – KJP-11 - Recipe-1	0.72	1.79	0.68	1.73	0.95	2.01
T_8 – KJP-11 - Recipe-2	0.61	1.66	0.58	1.61	0.85	1.86
T_9 – KJP-11 - Recipe-3	0.55	1.57	0.50	1.51	0.76	1.77

MAS = Months after storage

Table 24. Changes in colour and appearance of jamun jelly as influenced by treatments and storage period

Treatments	Colour and appearance (scores out of 5.0)						
	Initial	1 MAS	2 MAS	3 MAS	4 MAS	5 MAS	Mean
T_1 – KJP-215 - Recipe-1	2.90	2.83	2.75	2.60	2.45	2.19	2.62
T_2 – KJP-215 - Recipe-2	2.78	2.69	2.63	2.50	2.27	2.05	2.49
T_3 – KJP-215 - Recipe-3	4.52	4.48	4.43	4.25	4.13	4.04	4.31
T_4 – KJP-32 - Recipe-1	4.75	4.67	4.62	4.54	4.40	4.25	4.54
T_5 – KJP-32 - Recipe-2	4.21	4.19	4.14	4.09	4.00	3.93	4.10
T_6 – KJP-32 - Recipe-3	4.15	4.12	4.07	4.00	3.95	3.87	4.03
T_7 – KJP-11 - Recipe-1	4.51	4.45	4.41	4.35	4.17	4.03	4.32
T_8 – KJP-11 - Recipe-2	4.29	4.23	4.19	4.13	4.06	3.97	4.15
T_9 – KJP-11 - Recipe-3	4.35	4.30	4.26	4.20	4.11	4.00	4.21
Mean	4.05	4.00	3.95	3.85	3.73	3.60	
For comparing the means of	S.Em±			C.D. at 1%			
Treatments (T)	0.0050			0.0186			
Storage period (S)	0.0041			0.0152			
Interaction (T x S)	0.0123			0.0455			

MAS = Months after storage

Table 25. Changes in taste of jamun jelly as influenced by treatments and storage period

Treatments	Taste (scores out of 5.0)						
	Initial	1 MAS	2 MAS	3 MAS	4 MAS	5 MAS	Mean
T_1 – KJP-215 - Recipe-1	2.52	2.47	2.42	2.35	2.12	2.00	2.32
T_2 – KJP-215 - Recipe-2	2.96	2.92	2.86	2.81	2.63	2.14	2.72
T_3 – KJP-215 - Recipe-3	4.27	4.23	4.15	4.07	3.98	3.90	4.10
T_4 – KJP-32 - Recipe-1	4.02	3.97	3.90	3.82	3.75	3.55	3.84
T_5 – KJP-32 - Recipe-2	3.56	3.50	3.45	3.36	3.16	3.05	3.35
T_6 – KJP-32 - Recipe-3	3.75	3.70	3.64	3.58	3.36	3.17	3.54
T_7 – KJP-11 - Recipe-1	4.08	4.02	3.97	3.90	3.79	3.61	3.90
T_8 – KJP-11 - Recipe-2	3.67	3.61	3.56	3.50	3.23	3.15	3.46
T_9 – KJP-11 - Recipe-3	3.70	3.66	3.60	3.55	3.29	3.20	3.50
Mean	3.62	3.57	3.51	3.44	3.26	3.09	
For comparing the means of	S.Em±		C.D. at 1%				
Treatments (T)	0.0049		0.0181				
Storage period (S)	0.0040		0.0147				
Interaction (T x S)	0.0119		0.0442				

MAS = Months after storage

Table 26. Changes in texture of jamun jelly as influenced by treatments and storage period

Treatments	Texture (scores out of 5.0)						
	Initial	1 MAS	2 MAS	3 MAS	4 MAS	5 MAS	Mean
T_1 – KJP-215 - Recipe-1	2.50	2.47	2.41	2.37	2.15	2.00	2.32
T_2 – KJP-215 - Recipe-2	2.64	2.60	2.56	2.49	2.23	2.08	2.44
T_3 – KJP-215 - Recipe-3	4.15	4.11	4.05	4.00	3.90	3.75	4.00
T_4 – KJP-32 - Recipe-1	4.35	4.30	4.23	4.18	4.09	3.92	4.18
T_5 – KJP-32 - Recipe-2	4.00	3.95	3.88	3.82	3.71	3.55	3.82
T_6 – KJP-32 - Recipe-3	4.25	4.20	4.14	4.09	3.95	3.80	4.08
T_7 – KJP-11 - Recipe-1	4.03	3.97	3.93	3.85	3.79	3.60	3.87
T_8 – KJP-11 - Recipe-2	3.00	2.95	2.90	2.83	2.72	2.59	2.84
T_9 – KJP-11 - Recipe-3	3.50	3.46	3.40	3.32	3.20	3.00	3.32
Mean	3.61	3.56	3.50	3.44	3.31	3.15	3.43
For comparing the means of	S.Em±		C.D. at 1%				
Treatments (T)	0.0049		0.0180				
Storage period (S)	0.0040		0.0147				
Interaction (T x S)	0.0119		0.0442				

MAS = Months after storage

Table 27. Changes in flavour of jamun jelly as influenced by treatments and storage period

Treatments	Flavour (scores out of 5.0)						
	Initial	1 MAS	2 MAS	3 MAS	4 MAS	5 MAS	Mean
T_1 – KJP-215 - Recipe-1	2.05	2.03	1.98	1.93	1.82	1.75	1.93
T_2 – KJP-215 - Recipe-2	3.06	3.00	2.95	2.88	2.80	2.66	2.90
T_3 – KJP-215 - Recipe-3	4.27	4.22	4.17	4.10	4.00	3.86	4.11
T_4 – KJP-32 - Recipe-1	4.06	4.01	3.95	3.87	3.80	3.69	3.90
T_5 – KJP-32 - Recipe-2	3.56	3.53	3.49	3.46	3.42	3.21	3.45
T_6 – KJP-32 - Recipe-3	3.77	3.74	3.70	3.69	3.63	3.35	3.64
T_7 – KJP-11 - Recipe-1	3.74	3.70	3.64	3.59	3.47	3.22	3.56
T_8 – KJP-11 - Recipe-2	3.51	3.48	3.42	3.35	3.28	3.17	3.37
T_9 – KJP-11 - Recipe-3	3.68	3.65	3.60	3.52	3.44	3.20	3.52
Mean	3.52	3.49	3.44	3.38	3.30	3.13	
For comparing the means of	S.Em±			C.D. at 1%			
Treatments (T)	0.0050			0.0184			
Storage period (S)	0.0041			0.0150			
Interaction (T x S)	0.0122			0.0451			

MAS = Months after storage

Table 28. Changes in overall acceptability of jamun jelly as influenced by treatments and storage period

Treatments	Overall acceptability (scores out of 5.0)						
	Initial	1 MAS	2 MAS	3 MAS	4 MAS	5 MAS	Mean
T_1 – KJP-215 - Recipe-1	2.54	2.50	2.44	2.39	2.10	1.98	2.33
T_2 – KJP-215 - Recipe-2	3.06	3.00	2.93	3.87	2.59	2.25	2.79
T_3 – KJP-215 - Recipe-3	4.51	4.46	4.40	4.32	4.13	3.95	4.30
T_4 – KJP-32 - Recipe-1	4.28	4.22	4.17	4.10	3.97	3.83	4.10
T_5 – KJP-32 - Recipe-2	3.73	3.68	3.60	3.55	3.35	3.23	3.53
T_6 – KJP-32 - Recipe-3	3.99	3.95	3.88	3.83	3.65	3.40	3.79
T_7 – KJP-11 - Recipe-1	4.05	4.00	3.93	3.87	3.70	3.59	3.86
T_8 – KJP-11 - Recipe-2	3.59	3.55	3.50	3.44	3.21	3.13	3.41
T_9 – KJP-11 - Recipe-3	3.78	3.74	3.69	3.62	3.47	3.37	3.62
Mean	3.73	3.68	3.62	3.56	3.36	3.20	
For comparing the means of	S.Em±			C.D. at 1%			
Treatments (T)	0.0049			0.0183			
Storage period (S)	0.0040			0.0149			
Interaction (T x S)	0.0121			0.0448			

MAS = Months after storage

Table 29. Changes in total soluble solids of jamun jelly as influenced by treatments and storage period

Treatments	Total soluble solids (%)						
	Initial	1 MAS	2 MAS	3 MAS	4 MAS	5 MAS	Mean
T_1 – KJP-215 - Recipe-1	65.23	65.29	65.33	65.40	66.15	66.55	65.66
T_2 – KJP-215 - Recipe-2	65.97	66.02	66.10	66.16	66.55	67.00	66.30
T_3 – KJP-215 - Recipe-3	66.43	66.47	66.54	66.60	67.30	67.75	66.85
T_4 – KJP-32 - Recipe-1	65.03	65.10	65.15	65.19	66.00	66.59	65.51
T_5 – KJP-32 - Recipe-2	65.70	65.75	65.81	65.86	66.48	66.89	66.09
T_6 – KJP-32 - Recipe-3	66.07	66.12	66.19	66.25	67.00	67.49	66.52
T_7 – KJP-11 - Recipe-1	65.40	65.44	65.50	65.56	66.33	66.75	65.83
T_8 – KJP-11 - Recipe-2	65.60	65.66	65.72	65.79	66.8	66.79	65.99
T_9 – KJP-11 - Recipe-3	66.30	66.38	66.44	66.49	67.15	67.62	66.73
Mean	65.75	65.81	65.87	65.93	66.60	67.05	
For comparing the means of	S.Em±			C.D. at 1%			
Treatments (T)	0.0049			0.0182			
Storage period (S)	0.0040			0.0149			
Interaction (T x S)	0.0120			0.0446			

MAS = Months after storage

Table 30. Changes in titratable acidity of jamun jelly as influenced by treatments and storage period

Treatments	Titratable acidity (%)						
	Initial	1 MAS	2 MAS	3 MAS	4 MAS	5 MAS	Mean
T_1 – KJP-215 - Recipe-1	0.61	0.58	0.55	0.51	0.47	0.43	0.53
T_2 – KJP-215 - Recipe-2	0.68	0.63	0.59	0.54	0.50	0.46	0.57
T_3 – KJP-215 - Recipe-3	0.73	0.70	0.65	0.60	0.54	0.50	0.62
T_4 – KJP-32 - Recipe-1	0.64	0.60	0.56	0.52	0.48	0.44	0.54
T_5 – KJP-32 - Recipe-2	0.70	0.67	0.62	0.57	0.52	0.48	0.60
T_6 – KJP-32 - Recipe-3	0.75	0.72	0.68	0.63	0.57	0.51	0.65
T_7 – KJP-11 - Recipe-1	0.63	0.60	0.57	0.52	0.49	0.45	0.55
T_8 – KJP-11 - Recipe-2	0.69	0.65	0.59	0.54	0.51	0.47	0.58
T_9 – KJP-11 - Recipe-3	0.78	0.75	0.70	0.65	0.60	0.54	0.67
Mean	0.69	0.66	0.62	0.57	0.52	0.48	
For comparing the means of	S.Em±			C.D. at 1%			
Treatments (T)	0.0049			0.0182			
Storage period (S)	0.0040			0.0149			
Interaction (T x S)	0.0120			NS			

MAS = Months after storage NS = Non-significant

Table 31. Changes in anthocyanin content of jamun jelly as influenced by treatments and storage period

Treatments	Anthocyanin (mg/100 g)						
	Initial	1 MAS	2 MAS	3 MAS	4 MAS	5 MAS	Mean
T_1 – KJP-215 - Recipe-1	44.79	44.75	44.70	44.66	43.23	43.01	44.19
T_2 – KJP-215 - Recipe-2	45.90	45.86	45.79	45.72	44.32	44.03	45.27
T_3 – KJP-215 - Recipe-3	46.68	46.63	46.57	46.51	45.27	45.09	46.13
T_4 – KJP-32 - Recipe-1	49.02	48.98	48.73	48.67	47.21	47.00	48.27
T_5 – KJP-32 - Recipe-2	46.92	46.89	46.81	46.75	44.40	44.12	45.99
T_6 – KJP-32 - Recipe-3	47.85	47.80	47.75	47.68	46.52	46.21	47.31
T_7 – KJP-11 - Recipe-1	55.15	55.13	55.04	55.00	53.19	52.94	54.41
T_8 – KJP-11 - Recipe-2	51.77	51.73	51.65	51.60	50.17	50.00	51.16
T_9 – KJP-11 - Recipe-3	53.44	53.40	53.33	53.28	52.07	51.75	52.88
Mean	49.06	49.02	48.93	48.88	47.38	47.01	
For comparing the means of	S.Em±			C.D. at 1%			
Treatments (T)	0.1117			0.4141			
Storage period (S)	0.0912			0.3381			
Interaction (T x S)	0.2736			1.0144			

MAS = Months after storage

Table 32. Changes in reducing sugar content of jamun jelly as influenced by treatments and storage period

Treatments	Reducing sugar (%)						
	Initial	1 MAS	2 MAS	3 MAS	4 MAS	5 MAS	Mean
T_1 – KJP-215 - Recipe-1	20.15	20.17	20.21	20.26	20.52	20.59	20.32
T_2 – KJP-215 - Recipe-2	20.88	20.90	20.93	21.00	21.33	21.40	21.08
T_3 – KJP-215 - Recipe-3	21.92	21.94	21.96	22.04	22.40	22.47	22.12
T_4 – KJP-32 - Recipe-1	20.35	20.38	20.43	20.52	20.70	20.77	20.53
T_5 – KJP-32 - Recipe-2	21.04	21.08	21.11	21.18	21.30	21.36	21.18
T_6 – KJP-32 - Recipe-3	22.14	22.16	22.19	22.26	22.39	22.45	22.27
T_7 – KJP-11 - Recipe-1	20.28	20.31	20.33	20.40	20.63	20.68	20.44
T_8 – KJP-11 - Recipe-2	20.48	20.41	20.56	20.64	20.79	20.84	20.62
T_9 – KJP-11 - Recipe-3	22.04	22.07	22.13	22.21	22.39	22.45	22.22
Mean	21.03	21.05	21.10	21.17	21.39	21.45	
For comparing the means of	S.Em±			C.D. at 1%			
Treatments (T)	0.0070			0.0260			
Storage period (S)	0.0057			0.0212			
Interaction (T x S)	0.0172			0.0637			

MAS = Months after storage

Table 33. Changes in non-reducing sugar content of jamun jelly as influenced by treatments and storage period

Treatments	Non-reducing sugar (%)						
	Initial	1 MAS	2 MAS	3 MAS	4 MAS	5 MAS	Mean
T_1 – KJP-215 - Recipe-1	31.85	31.87	31.90	31.93	32.33	32.40	32.05
T_2 – KJP-215 - Recipe-2	30.61	30.62	30.65	30.68	31.16	31.24	30.83
T_3 – KJP-215 - Recipe-3	30.60	30.63	30.67	30.71	31.24	31.31	30.86
T_4 – KJP-32 - Recipe-1	30.39	30.41	30.44	30.47	30.92	30.98	30.61
T_5 – KJP-32 - Recipe-2	30.54	30.57	30.60	30.64	31.39	31.46	30.87
T_6 – KJP-32 - Recipe-3	30.55	30.58	30.61	30.67	31.41	31.51	30.89
T_7 – KJP-11 - Recipe-1	31.13	31.16	31.18	31.23	31.74	31.82	31.38
T_8 – KJP-11 - Recipe-2	31.20	31.22	31.25	31.29	32.20	32.26	31.57
T_9 – KJP-11 - Recipe-3	30.53	30.55	30.58	30.63	31.10	31.17	30.76
Mean	30.83	30.85	30.88	30.92	31.50	31.58	
For comparing the means of	S.Em±			C.D. at 1%			
Treatments (T)	0.0049			0.0182			
Storage period (S)	0.0040			0.0149			
Interaction (T x S)	0.0120			0.0446			

MAS = Months after storage

Table 34. Changes in total sugars of jamun jelly as influenced by treatments and storage period

Treatments	Total sugars (%)						
	Initial	1 MAS	2 MAS	3 MAS	4 MAS	5 MAS	Mean
T_1 – KJP-215 - Recipe-1	53.68	53.72	53.79	53.87	54.56	54.69	54.06
T_2 – KJP-215 - Recipe-2	53.10	53.13	53.19	53.30	54.13	54.29	53.53
T_3 – KJP-215 - Recipe-3	54.13	54.18	54.25	54.37	55.29	55.43	54.61
T_4 – KJP-32 - Recipe-1	52.35	52.40	52.47	52.59	53.25	53.39	52.75
T_5 – KJP-32 - Recipe-2	53.21	53.26	53.32	53.43	54.35	54.50	53.68
T_6 – KJP-32 - Recipe-3	54.31	54.35	54.41	54.54	55.45	55.62	54.78
T_7 – KJP-11 - Recipe-1	53.05	53.11	53.14	53.27	54.05	54.18	53.47
T_8 – KJP-11 - Recipe-2	53.33	53.37	53.45	53.58	54.69	54.80	53.87
T_9 – KJP-11 - Recipe-3	54.19	54.24	54.32	54.45	55.13	55.26	54.60
Mean	53.49	53.53	53.6	53.71	54.55	54.69	
For comparing the means of	S.Em±			C.D. at 1%			
Treatments (T)	0.0049			0.0181			
Storage period (S)	0.0040			0.0147			
Interaction (T x S)	0.0119			0.0442			

MAS = Months after storage

Table 35. Microbial load on jamun jelly as influenced by treatments and storage period

Treatments	Bacteria (No. x 10^5 CFU/g)		Fungi (No. x 10^3 CFU/g)		Yeast (No. x 10^3 CFU/g)	
	Initial	5 MAS	Initial	5 MAS	Initial	5 MAS
T_1 – KJP-215 - Recipe-1	0.61	1.71	0.56	1.67	0.93	1.92
T_2 – KJP-215 - Recipe-2	0.45	1.51	0.41	1.46	0.78	1.74
T_3 – KJP-215 - Recipe-3	0.35	1.38	0.30	1.33	0.67	1.61
T_4 – KJP-32 - Recipe-1	0.66	1.75	0.62	1.70	0.95	1.97
T_5 – KJP-32 - Recipe-2	0.50	1.57	0.47	1.51	0.81	1.79
T_6 – KJP-32 - Recipe-3	0.42	1.47	0.39	1.43	0.74	1.70
T_7 – KJP-11 - Recipe-1	0.60	1.67	0.55	1.64	0.90	1.87
T_8 – KJP-11 - Recipe-2	0.56	1.62	0.52	1.58	0.86	1.83
T_9 – KJP-11 - Recipe-3	0.39	1.42	0.33	1.39	0.72	1.66

MAS = Months after storage

Table 36. Changes in colour and appearance of jamun leather as influenced by treatments and storage period

Treatments	Colour and appearance (scores out of 5.0)							
	Initial	1 MAS	2 MAS	3 MAS	4 MAS	5 MAS	6 MAS	Mean
T_1 – Pomace + 30% sugar + 1% citric acid + heating at 60°C + drying	3.75	3.70	3.66	3.63	3.50	3.35	3.12	3.53
T_2 – Pomace + 35% sugar + 1.5% citric acid + heating at 60°C + drying	3.79	3.73	3.70	3.66	3.56	3.39	3.18	3.57
T_3 – Pomace + 40% sugar + 2% citric acid + heating at 60°C + drying	3.82	3.78	3.74	3.70	3.61	3.41	3.18	3.61
T_4 – Pomace + 30% sugar + 1% citric acid + microoven heating + drying	3.85	3.80	3.75	3.71	3.64	3.52	3.25	3.65
T_5 – Pomace + 35% sugar + 1.5% citric acid + microoven heating + drying	3.92	3.86	3.80	3.75	3.70	3.55	3.30	3.70
T_6 – Pomace + 40% sugar + 2% citric acid + microoven heating + drying	3.97	3.92	3.86	3.80	3.75	3.60	3.39	3.76
T_7 – Pomace + 30% sugar + 1% citric acid + drying	4.00	3.95	3.91	3.87	3.81	3.67	3.45	3.81
T_8 – Pomace + 35% sugar + 1.5% citric acid + drying	4.15	3.98	3.95	3.92	3.86	3.72	3.50	3.87
T_9 – Pomace + 40% sugar + 2% citric acid + drying	4.20	4.03	3.99	3.96	3.90	3.76	3.53	3.91
Mean	3.94	3.86	3.82	3.78	3.71	3.55	3.32	
For comparing the means of	S.Em±				C.D. at 1%			
Treatments (T)	0.0047				0.0173			
Storage period (S)	0.0041				0.0153			
Interaction (T x S)	0.0124				0.0459			

MAS = Months after storage

Table 37. Changes in texture of jamun leather as influenced by treatments and storage period

Treatments	Texture (scores out of 5.0)							
	Initial	1 MAS	2 MAS	3 MAS	4 MAS	5 MAS	6 MAS	Mean
T_1 – Pomace + 30% sugar + 1% citric acid + heating at 60°C + drying	3.72	3.69	3.61	3.49	3.43	3.15	2.75	3.41
T_2 – Pomace + 35% sugar + 1.5% citric acid + heating at 60°C + drying	3.75	3.71	3.65	3.53	3.46	3.21	2.79	3.44
T_3 – Pomace + 40% sugar + 2% citric acid + heating at 60°C + drying	3.80	3.74	3.67	3.57	3.49	3.25	3.03	3.51
T_4 – Pomace + 30% sugar + 1% citric acid + microoven heating + drying	3.84	3.79	3.73	3.65	3.53	3.32	3.13	3.57
T_5 – Pomace + 35% sugar + 1.5% citric acid + microoven heating + drying	3.89	3.84	3.79	3.68	3.55	3.37	3.17	3.62
T_6 – Pomace + 40% sugar + 2% citric acid + microoven heating + drying	3.95	3.91	3.85	3.73	3.59	3.43	3.24	3.67
T_7 – Pomace + 30% sugar + 1% citric acid + drying	4.17	4.11	4.03	3.97	3.83	3.56	3.30	3.86
T_8 – Pomace + 35% sugar + 1.5% citric acid + drying	4.21	4.15	4.07	4.01	3.87	3.61	3.34	3.90
T_9 – Pomace + 40% sugar + 2% citric acid + drying	4.26	4.21	4.14	4.07	3.93	3.65	3.37	3.95
Mean	3.96	3.91	3.84	3.75	3.63	3.40	3.13	
For comparing the means of	S.Em±				C.D. at 1%			
Treatments (T)	0.0051				0.0190			
Storage period (S)	0.0045				0.0167			
Interaction (T x S)	0.0136				0.0501			

MAS = Months after storage

Table 38. Changes in taste of jamun leather as influenced by treatments and storage period

Treatments	Taste (scores out of 5.0)							
	Initial	1 MAS	2 MAS	3 MAS	4 MAS	5 MAS	6 MAS	Mean
T_1 – Pomace + 30% sugar + 1% citric acid + heating at 60°C + drying	3.80	3.75	3.70	3.65	3.49	3.41	3.31	3.59
T_2 – Pomace + 35% sugar + 1.5% citric acid + heating at 60°C + drying	3.28	3.25	3.20	3.15	3.03	2.94	2.86	3.10
T_3 – Pomace + 40% sugar + 2% citric acid + heating at 60°C + drying	3.25	3.20	3.15	3.10	2.99	2.91	2.82	3.06
T_4 – Pomace + 30% sugar + 1% citric acid + microoven heating + drying	3.35	3.30	3.25	3.20	3.08	3.01	2.95	3.17
T_5 – Pomace + 35% sugar + 1.5% citric acid + microoven heating + drying	3.45	3.40	3.35	3.30	3.17	3.08	3.01	3.25
T_6 – Pomace + 40% sugar + 2% citric acid + microoven heating + drying	3.85	3.80	3.75	3.70	3.57	3.49	3.37	3.65
T_7 – Pomace + 30% sugar + 1% citric acid + drying	4.00	3.95	3.90	3.85	3.64	3.57	3.45	3.77
T_8 – Pomace + 35% sugar + 1.5% citric acid + drying	3.90	3.85	3.80	3.75	3.59	3.51	3.37	3.68
T_9 – Pomace + 40% sugar + 2% citric acid + drying	3.60	3.55	3.50	3.45	3.25	3.19	3.07	3.38
Mean	3.61	3.56	3.51	3.46	3.31	3.24	3.14	
For comparing the means of	S.Em±				C.D. at 1%			
Treatments (T)	0.0045				0.0168			
Storage period (S)	0.0040				0.0148			
Interaction (T x S)	0.0120				0.0445			

MAS = Months after storage

Table 39. Changes in flavour of jamun leather as influenced by treatments and storage period

Treatments	Flavour (scores out of 5.0)							
	Initial	1 MAS	2 MAS	3 MAS	4 MAS	5 MAS	6 MAS	Mean
T_1 – Pomace + 30% sugar + 1% citric acid + heating at 60°C + drying	3.87	3.83	3.75	3.69	3.45	3.13	3.03	3.54
T_2 – Pomace + 35% sugar + 1.5% citric acid + heating at 60°C + drying	3.89	3.85	3.79	3.73	3.53	3.17	3.05	3.58
T_3 – Pomace + 40% sugar + 2% citric acid + heating at 60°C + drying	3.95	3.89	3.83	3.79	3.59	3.23	3.10	3.63
T_4 – Pomace + 30% sugar + 1% citric acid + microoven heating + drying	4.07	4.04	4.00	3.94	3.74	3.53	3.15	3.78
T_5 – Pomace + 35% sugar + 1.5% citric acid + microoven heating + drying	4.12	4.09	4.03	4.00	3.80	3.59	3.18	3.83
T_6 – Pomace + 40% sugar + 2% citric acid + microoven heating + drying	4.15	4.12	4.07	4.04	3.84	3.65	3.20	3.87
T_7 – Pomace + 30% sugar + 1% citric acid + drying	4.25	4.19	4.12	4.07	3.95	3.83	3.25	3.95
T_8 – Pomace + 35% sugar + 1.5% citric acid + drying	4.29	4.24	4.17	4.12	4.03	3.90	3.30	4.01
T_9 – Pomace + 40% sugar + 2% citric acid + drying	4.35	4.29	4.23	4.17	4.11	4.00	3.36	4.08
Mean	4.11	406	4.00	3.95	3.79	3.56	3.18	
For comparing the means of	S.Em±				C.D. at 1%			
Treatments (T)	0.0046				0.0170			
Storage period (S)	0.0041				0.0150			
Interaction (T x S)	0.0122				0.0451			

MAS = Months after storage

Table 40. Changes in overall acceptability of jamun leather as influenced by treatments and storage period

Treatments	Overall acceptability (scores out of 5.0)							
	Initial	1 MAS	2 MAS	3 MAS	4 MAS	5 MAS	6 MAS	Mean
T_1 – Pomace + 30% sugar + 1% citric acid + heating at 60°C + drying	3.73	3.70	3.64	3.60	3.54	3.25	3.13	3.51
T_2 – Pomace + 35% sugar + 1.5% citric acid + heating at 60°C + drying	3.39	3.35	3.31	3.27	3.11	3.07	2.97	3.21
T_3 – Pomace + 40% sugar + 2% citric acid + heating at 60°C + drying	3.35	3.31	3.26	3.19	3.07	3.00	2.89	3.15
T_4 – Pomace + 30% sugar + 1% citric acid + microoven heating + drying	3.52	3.48	3.50	3.45	3.21	3.17	3.07	3.34
T_5 – Pomace + 35% sugar + 1.5% citric acid + microoven heating + drying	3.48	3.44	3.42	3.34	3.17	3.09	2.99	3.28
T_6 – Pomace + 40% sugar + 2% citric acid + microoven heating + drying	3.80	3.75	3.69	3.63	3.41	3.34	3.13	3.54
T_7 – Pomace + 30% sugar + 1% citric acid + drying	3.95	3.92	3.87	3.82	3.55	3.43	3.39	3.70
T_8 – Pomace + 35% sugar + 1.5% citric acid + drying	3.89	3.85	3.81	3.76	3.49	3.37	3.31	3.64
T_9 – Pomace + 40% sugar + 2% citric acid + drying	3.65	3.60	3.55	3.49	327	3.19	3.09	3.41
Mean	3.64	3.60	3.56	3.51	3.31	3.21	3.11	
For comparing the means of	S.Em±				C.D. at 1%			
Treatments (T)	0.0022				0.0082			
Storage period (S)	0.0020				0.0073			
Interaction (T x S)	0.0059				0.0218			

MAS = Months after storage

Table 41. Changes in titratable acidity of jamun leather as influenced by treatments and storage period

Treatments	Titratable acidity (%)							
	Initial	1 MAS	2 MAS	3 MAS	4 MAS	5 MAS	6 MAS	Mean
T_1 – Pomace + 30% sugar + 1% citric acid + heating at 60°C + drying	0.76	0.73	0.70	0.66	0.63	0.59	0.54	0.66
T_2 – Pomace + 35% sugar + 1.5% citric acid + heating at 60°C + drying	0.70	0.67	0.64	0.60	0.57	0.53	0.49	0.60
T_3 – Pomace + 40% sugar + 2% citric acid + heating at 60°C + drying	0.64	0.62	0.59	0.55	0.52	0.49	0.45	0.55
T_4 – Pomace + 30% sugar + 1% citric acid + microoven heating + drying	0.85	0.82	0.80	0.75	0.72	0.70	0.64	0.76
T_5 – Pomace + 35% sugar + 1.5% citric acid + microoven heating + drying	0.79	0.77	0.74	0.71	0.68	0.64	0.59	0.71
T_6 – Pomace + 40% sugar + 2% citric acid + microoven heating + drying	0.73	0.70	0.66	0.63	0.61	0.59	0.53	0.64
T_7 – Pomace + 30% sugar + 1% citric acid + drying	0.87	0.85	0.81	0.78	0.75	0.70	0.65	0.78
T_8 – Pomace + 35% sugar + 1.5% citric acid + drying	0.81	0.78	0.76	0.73	0.69	0.65	0.59	0.72
T_9 – Pomace + 40% sugar + 2% citric acid + drying	0.75	0.73	0.71	0.65	0.61	0.58	0.53	0.65
Mean	0.77	0.74	0.72	0.68	0.64	0.61	0.56	
For comparing the means of	S.Em±				C.D. at 1%			
Treatments (T)	0.0045				0.0167			
Storage period (S)	0.0040				0.0148			
Interaction (T x S)	0.0120				NS			

MAS = Months after storage NS = Non-significant

Table 42. Changes in moisture content of jamun leather as influenced by treatments and storage period

Treatments	Moisture content (%)							
	Initial	1 MAS	2 MAS	3 MAS	4 MAS	5 MAS	6 MAS	Mean
T_1 – Pomace + 30% sugar + 1% citric acid + heating at 60°C + drying	11.03	11.06	11.11	11.17	11.24	12.02	12.06	11.39
T_2 – Pomace + 35% sugar + 1.5% citric acid + heating at 60°C + drying	11.07	11.11	11.16	11.23	11.30	12.05	12.10	11.43
T_3 – Pomace + 40% sugar + 2% citric acid + heating at 60°C + drying	11.11	11.15	11.21	11.26	11.35	12.09	12.14	11.47
T_4 – Pomace + 30% sugar + 1% citric acid + microoven heating + drying	11.05	11.08	11.13	11.19	11.27	12.04	12.10	11.41
T_5 – Pomace + 35% sugar + 1.5% citric acid + microoven heating + drying	11.09	11.14	11.17	11.24	11.32	12.07	12.15	11.46
T_6 – Pomace + 40% sugar + 2% citric acid + microoven heating + drying	11.14	11.17	11.22	11.31	11.39	12.12	12.18	11.51
T_7 – Pomace + 30% sugar + 1% citric acid + drying	11.09	11.11	11.15	11.21	11.31	12.07	12.13	11.44
T_8 – Pomace + 35% sugar + 1.5% citric acid + drying	11.13	11.16	11.19	11.27	11.38	12.14	12.23	11.50
T_9 – Pomace + 40% sugar + 2% citric acid + drying	11.16	11.19	11.24	11.33	11.43	12.17	12.27	11.54
Mean	11.10	11.13	11.18	11.25	11.34	12.09	12.15	
For comparing the means of	S.Em±				C.D. at 1%			
Treatments (T)	0.0059				0.0219			
Storage period (S)	0.0052				0.0193			
Interaction (T x S)	0.0157				NS			

MAS = Months after storage NS = Non-significant

Table 43. Changes in anthocyanin content of jamun leather as influenced by treatments and storage period

Treatments	Anthocyanin (mg/100 g)							
	Initial	1 MAS	2 MAS	3 MAS	4 MAS	5 MAS	6 MAS	Mean
T_1 – Pomace + 30% sugar + 1% citric acid + heating at 60°C + drying	21.23	27.20	27.16	27.10	26.95	26.86	25.93	26.92
T_2 – Pomace + 35% sugar + 1.5% citric acid + heating at 60°C + drying	27.35	27.28	27.22	27.14	27.06	26.93	25.99	27.00
T_3 – Pomace + 40% sugar + 2% citric acid + heating at 60°C + drying	27.42	27.36	27.30	27.21	27.10	27.01	26.06	27.07
T_4 – Pomace + 30% sugar + 1% citric acid + microoven heating + drying	28.15	28.12	28.06	27.97	27.85	27.63	26.13	27.70
T_5 – Pomace + 35% sugar + 1.5% citric acid + microoven heating + drying	28.23	28.19	28.12	28.04	27.95	27.69	26.19	27.78
T_6 – Pomace + 40% sugar + 2% citric acid + microoven heating + drying	28.32	28.28	28.22	28.13	28.03	27.73	26.24	27.85
T_7 – Pomace + 30% sugar + 1% citric acid + drying	28.78	28.73	28.68	28.60	28.49	28.15	27.07	28.36
T_8 – Pomace + 35% sugar + 1.5% citric acid + drying	28.85	28.82	28.76	28.67	28.55	28.21	27.13	28.43
T_9 – Pomace + 40% sugar + 2% citric acid + drying	28.93	28.90	28.85	28.76	28.63	28.27	27.19	28.51
Mean	28.14	28.10	28.04	27.96	27.85	27.61	26.44	
For comparing the means of	S.Em±				C.D. at 1%			
Treatments (T)	0.0046				0.0171			
Storage period (S)	0.0041				0.0151			
Interaction (T x S)	0.0122				0.0452			

MAS = Months after storage

Table 44. Changes in total sugars of jamun leather as influenced by treatments and storage period

Treatments	Total sugars (%)							
	Initial	1 MAS	2 MAS	3 MAS	4 MAS	5 MAS	6 MAS	Mean
T_1 – Pomace + 30% sugar + 1% citric acid + heating at 60°C + drying	5.00	5.11	5.19	5.29	6.05	6.12	6.20	5.57
T_2 – Pomace + 35% sugar + 1.5% citric acid + heating at 60°C + drying	5.32	5.45	5.54	5.62	6.32	6.40	6.52	5.88
T_3 – Pomace + 40% sugar + 2% citric acid + heating at 60°C + drying	5.65	5.77	5.87	6.00	6.63	6.70	6.81	6.21
T_4 – Pomace + 30% sugar + 1% citric acid + microoven heating + drying	5.15	5.23	5.33	5.41	6.20	6.26	6.35	5.71
T_5 – Pomace + 35% sugar + 1.5% citric acid + microoven heating + drying	5.42	5.52	5.61	5.71	6.45	6.54	6.63	5.99
T_6 – Pomace + 40% sugar + 2% citric acid + microoven heating + drying	5.81	5.89	5.97	6.06	6.76	6.85	6.93	6.33
T_7 – Pomace + 30% sugar + 1% citric acid + drying	5.33	5.43	5.51	5.61	6.33	6.40	6.50	5.88
T_8 – Pomace + 35% sugar + 1.5% citric acid + drying	5.83	5.95	6.04	6.12	6.78	6.85	6.97	6.37
T_9 – Pomace + 40% sugar + 2% citric acid + drying	6.05	6.16	6.26	6.35	7.00	7.09	7.16	6.58
Mean	5.51	5.62	5.71	5.80	6.51	6.58	6.68	
For comparing the means of	S.Em±				C.D. at 1%			
Treatments (T)	0.0045				0.0167			
Storage period (S)	0.0040				0.0148			
Interaction (T x S)	0.0120				0.0443			

MAS = Months after storage

Table 45. Microbial load on jamun leather as influenced by treatments and storage period

Treatments	Bacteria (No. x 10^5 CFU/g)		Fungi (No. x 10^3 CFU/g)		Yeast (No. x 10^3 CFU/g)	
	Initial	6 MAS	Initial	6 MAS	Initial	6 MAS
T_1 – Pomace + 30% sugar + 1% citric acid + heating at 60°C + drying	2.40	2.83	1.20	1.75	1.56	2.98
T_2 – Pomace + 35% sugar + 1.5% citric acid + heating at 60°C + drying	1.35	2.77	1.14	1.71	1.50	2.94
T_3 – Pomace + 40% sugar + 2% citric acid + heating at 60°C + drying	1.29	2.72	1.10	1.66	1.35	2.89
T_4 – Pomace + 30% sugar + 1% citric acid + microoven heating + drying	1.49	2.90	1.29	1.85	1.62	3.10
T_5 – Pomace + 35% sugar + 1.5% citric acid + microoven heating + drying	1.42	2.85	1.24	1.80	1.59	3.06
T_6 – Pomace + 40% sugar + 2% citric acid + microoven heating + drying	1.37	2.79	1.19	1.77	1.57	3.00
T_7 – Pomace + 30% sugar + 1% citric acid + drying	1.54	2.97	1.39	1.94	1.69	3.19
T_8 – Pomace + 35% sugar + 1.5% citric acid + drying	1.50	2.92	1.35	1.90	1.65	3.16
T_9 – Pomace + 40% sugar + 2% citric acid + drying	1.44	2.86	1.30	1.86	1.63	3.11

MAS = Months after storage

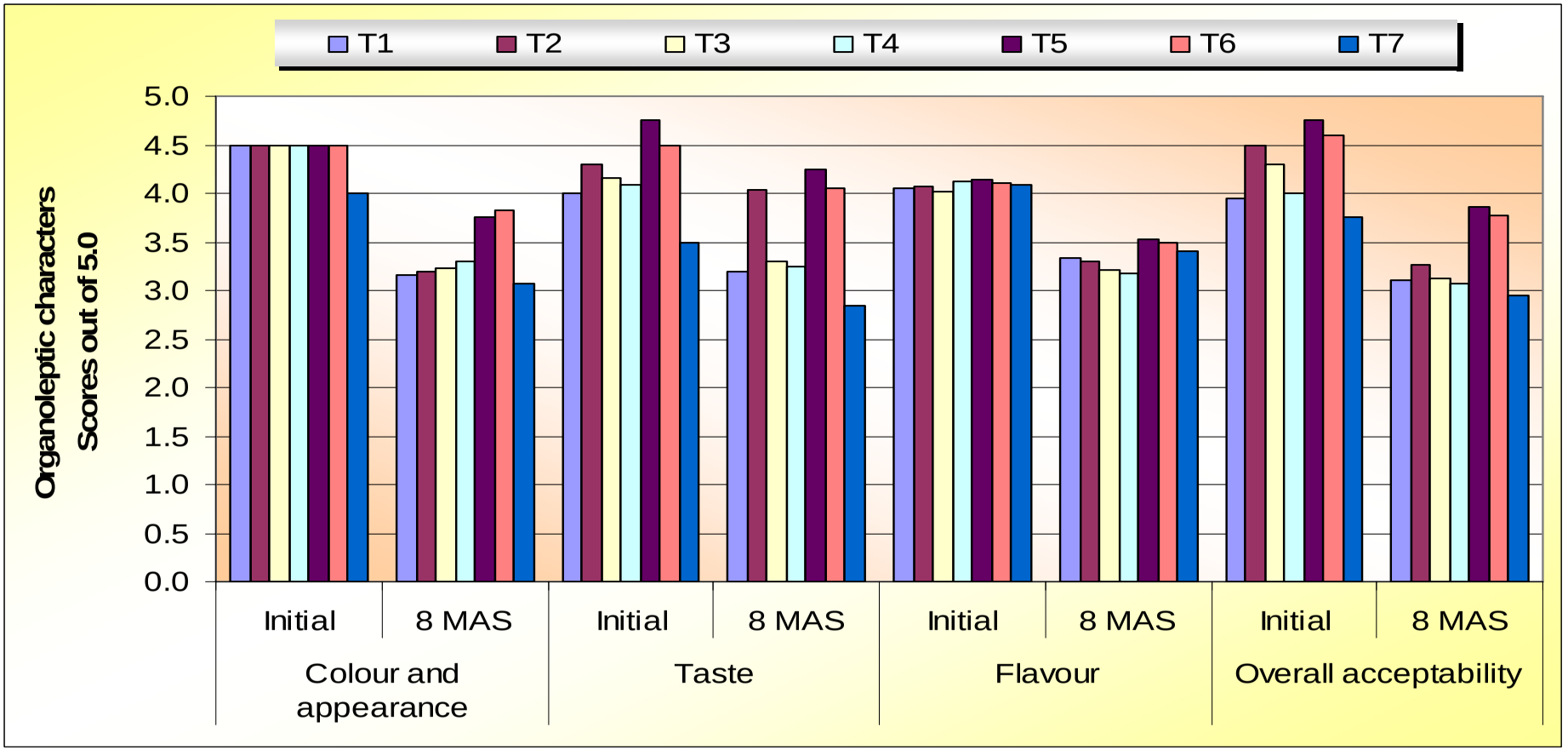

Fig. 1. Effect of treatments and storage period on organoleptic evaluation of jamun juice

T_1 – Control
T_2 – Pasteurisation of juice at 85°C + 300 ppm sodium benzoate
T_3 – Pasteurisation of juice at 85°C + 400 ppm sodium benzoate
T_4 – Pasteurisation of juice at 85°C + 500 ppm sodium benzoate
T_5 – Juice + 600 ppm sodium benzoate
T_6 – Juice + 800 ppm sodium benzoate
T_7 – Juice + 1000 ppm sodium benzoate
MAS = Months after storage

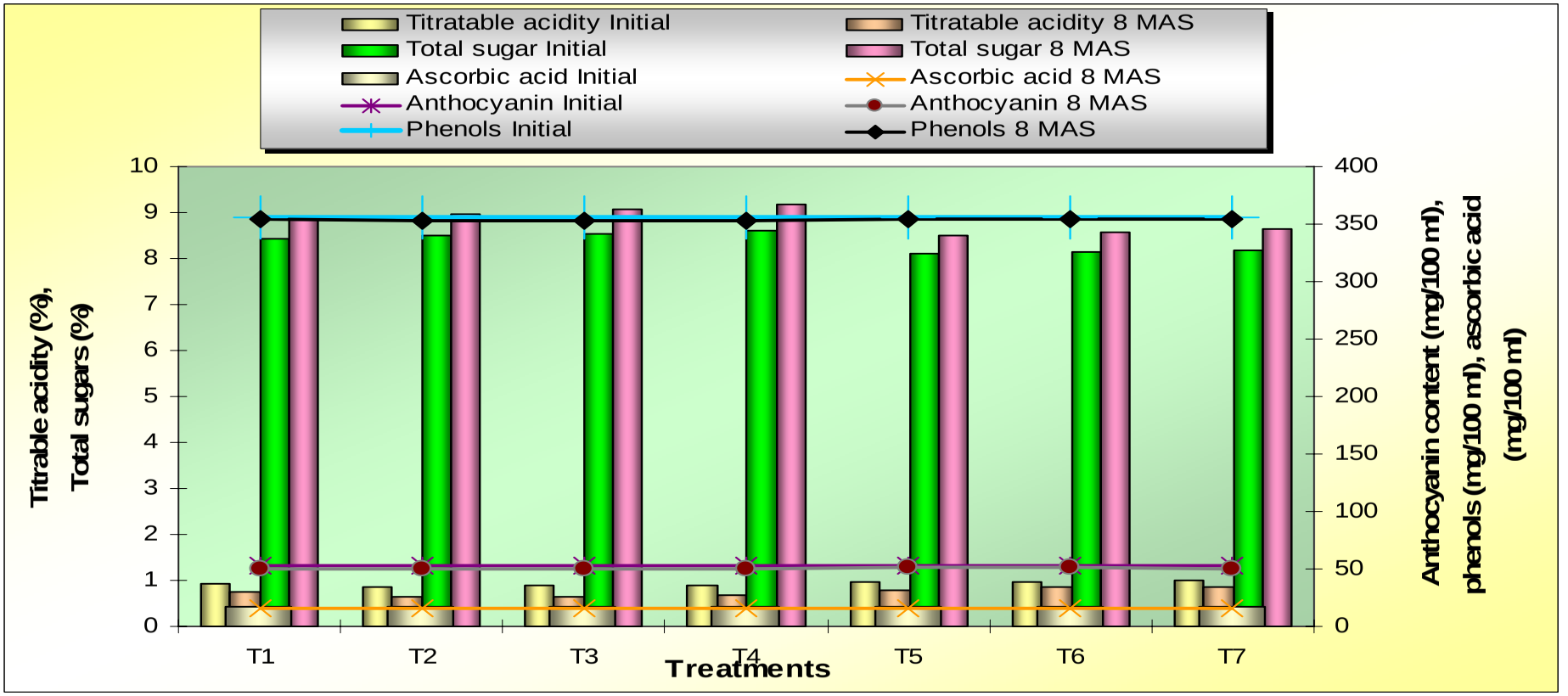

Fig. 2. Effect of treatments and storage period on titrable acidity, anthocyanin, ascorbic acid, phenols and total sugar content of jamun juice

T_1 – Control
T_2 – Pasteurisation of juice at 85°C + 300 ppm sodium benzoate
T_3 – Pasteurisation of juice at 85°C + 400 ppm sodium benzoate
T_4 – Pasteurisation of juice at 85°C + 500 ppm sodium benzoate
T_5 – Juice + 600 ppm sodium benzoate
T_6 – Juice + 800 ppm sodium benzoate
T_7 – Juice + 1000 ppm sodium benzoate
MAS = Months after storage

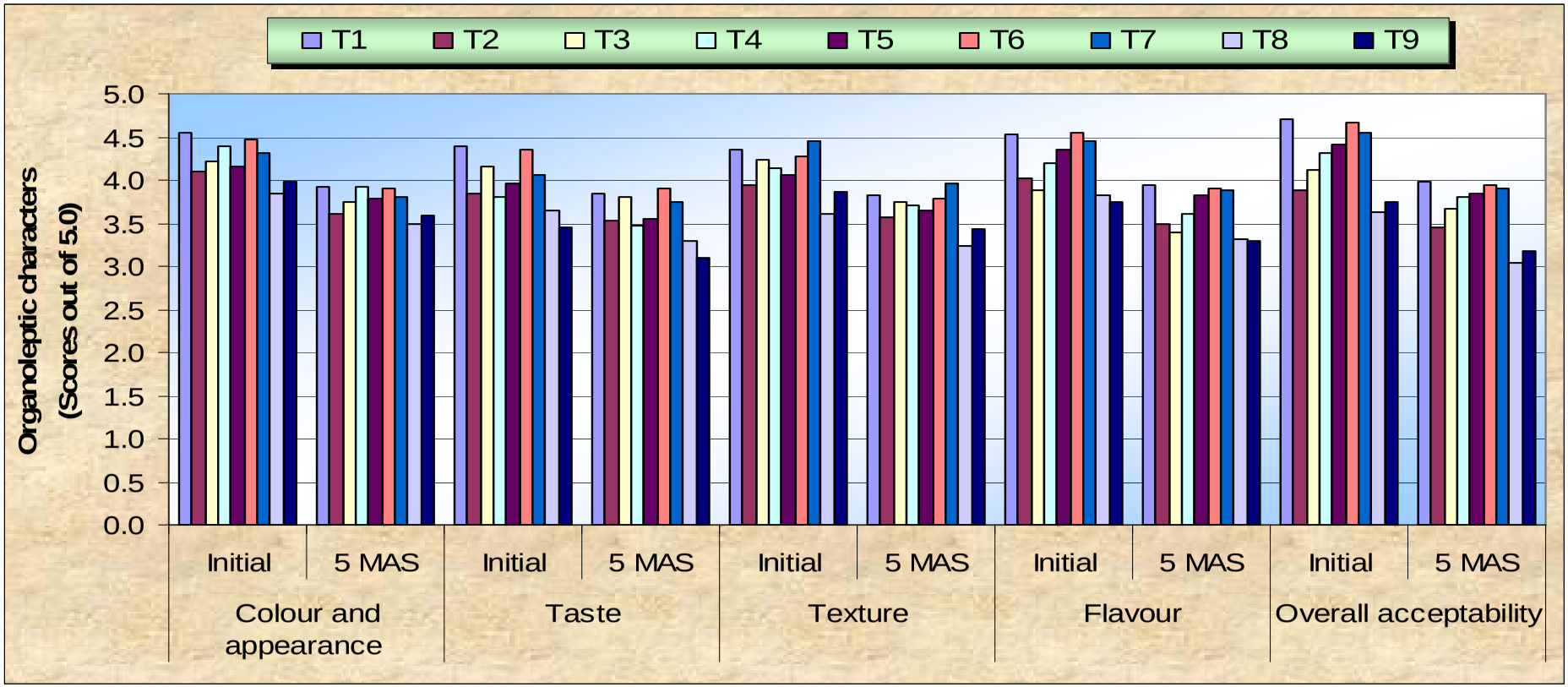

Fig. 3. Effect of treatments and storage period on organoleptic evaluation of jamun jam

T_1 – 1.0 kg fresh pomace + 1 kg sugar
T_2 – 1.0 kg fresh pomace + 1.25 kg sugar
T_3 – 1.0 kg fresh pomace + 1.50 kg sugar
T_4 – 1.0 kg fresh pomace + 1.75 kg sugar
T_5 – 1.0 kg fresh pomace + 2.00 kg sugar
T_6 – 1.0 kg aonla shreds + 2.00 kg sugar
T_7 – 1.0 kg aonla shreds + 2.50 kg sugar
T_8 – 1.0 kg aonla pieces + 1.50 kg sugar
T_9 – 1.0 kg aonla pieces + 2.00 kg sugar
MAS = Months after storage

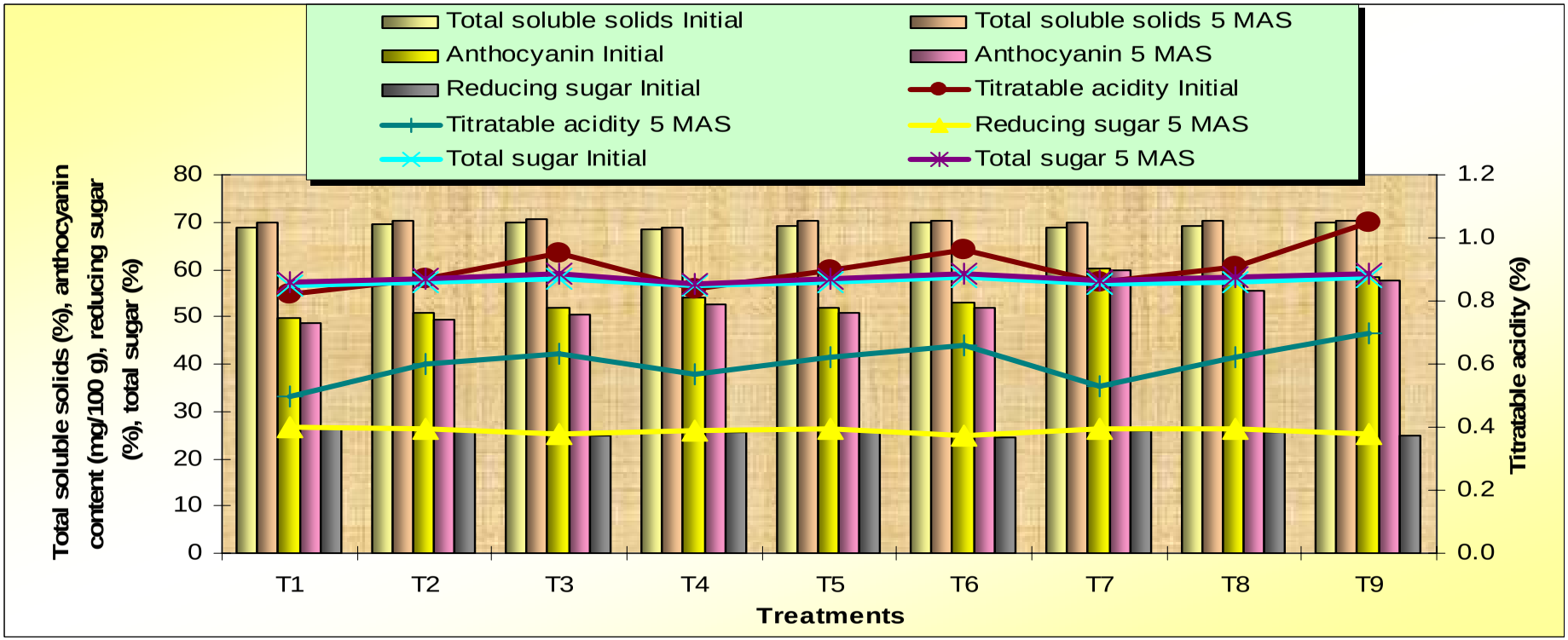

Fig. 4. Effect of treatments and storage period on titrable acidity, anthocyanin, total soluble solids, reducing sugar and total sugar of jamun jam

T1 – KJP-215 - Recipe-1
T2 – KJP-215 - Recipe-2
T3 – KJP-215 - Recipe-3
T4 – KJP-32 - Recipe-1
T5 – KJP-32 - Recipe-2
T6 – KJP-32 - Recipe-3
T7 – KJP-11 - Recipe-1
T8 – KJP-11 - Recipe-2
T9 – KJP-11 - Recipe-3
MAS = Months after storage

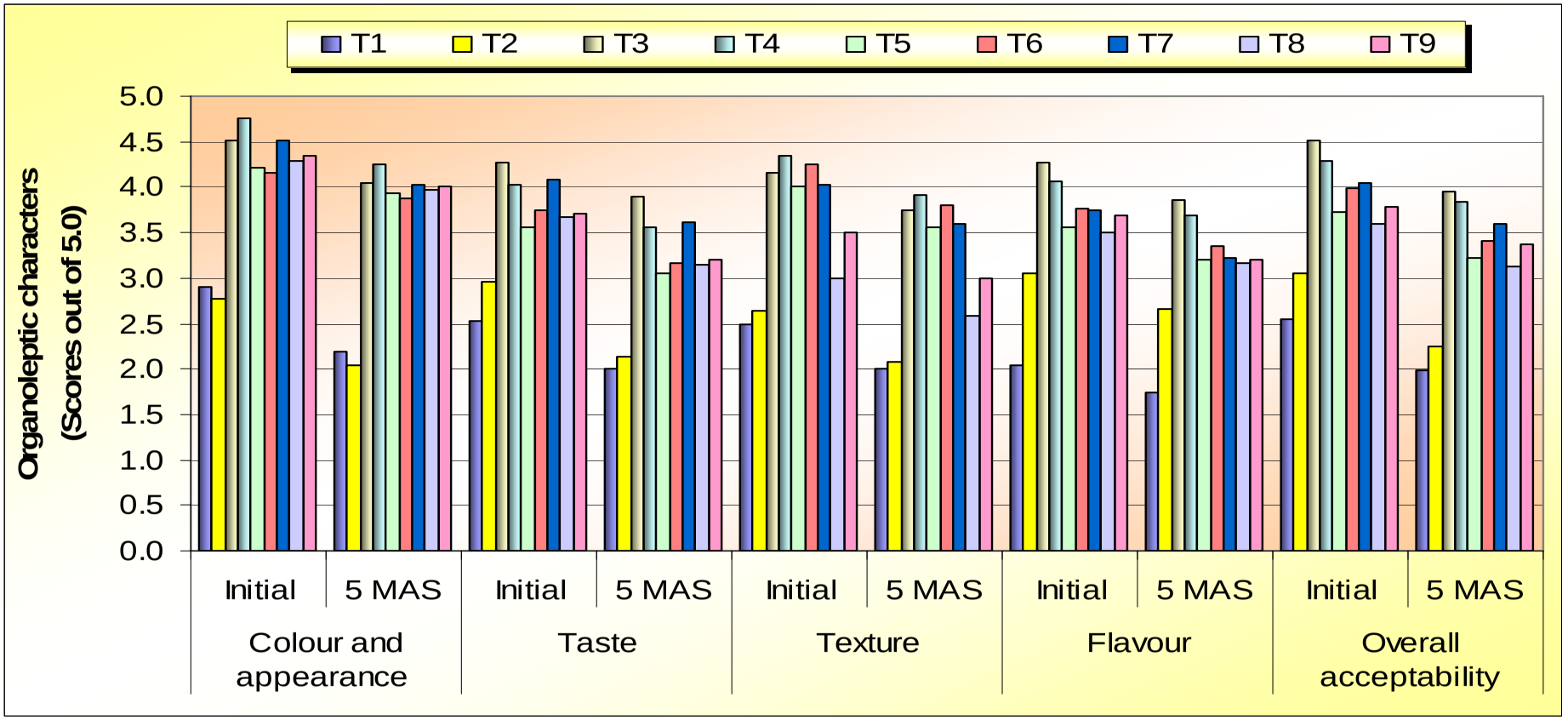

Fig. 5. Effect of treatments and storage period on organoleptic evaluation of jamun jelly

T1 – KJP-215 - Recipe-1
T2 – KJP-215 - Recipe-2
T3 – KJP-215 - Recipe-3
T4 – KJP-32 - Recipe-1
T5 – KJP-32 - Recipe-2
T6 – KJP-32 - Recipe-3
T7 – KJP-11 - Recipe-1
T8 – KJP-11 - Recipe-2
T9 – KJP-11 - Recipe-3
MAS = Months after storage

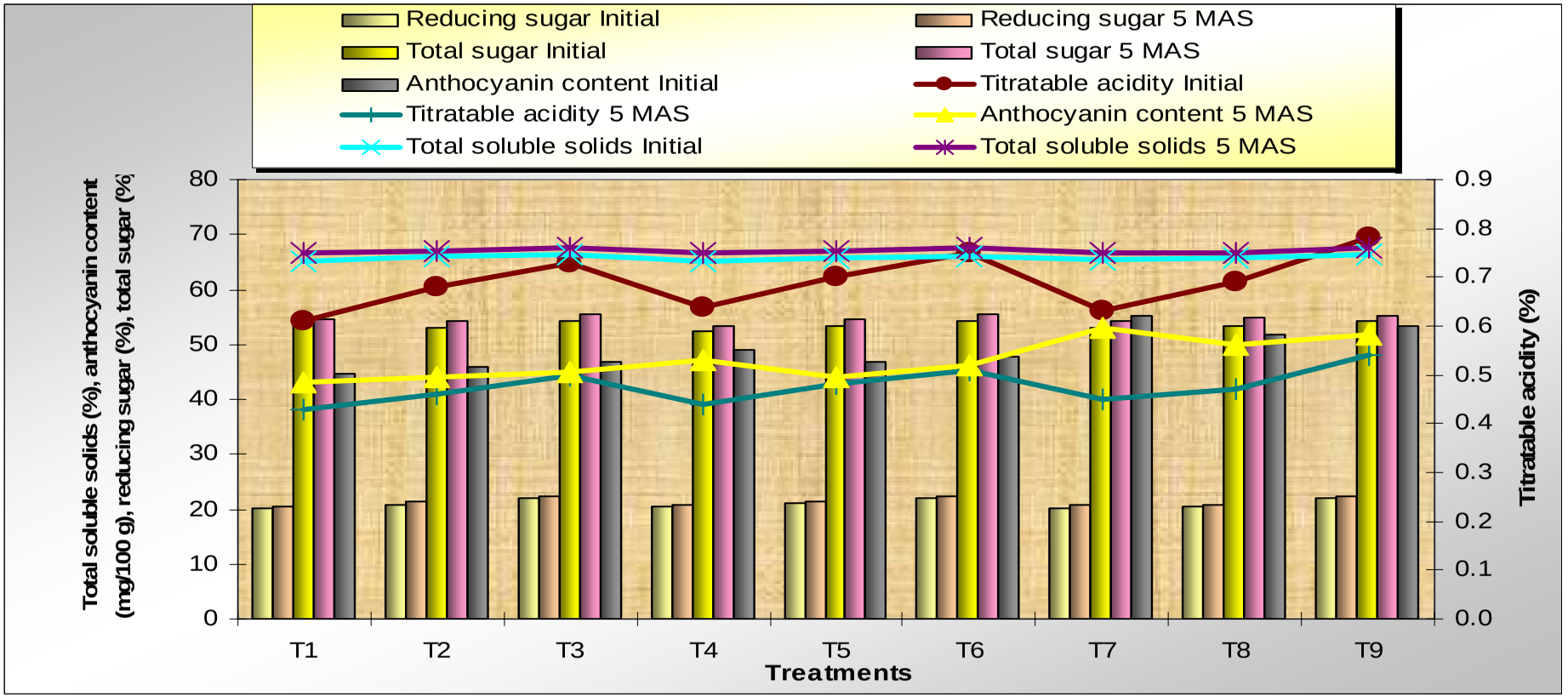

Fig. 6. Effect of treatments and storage period on titratable acidity, anthocyanin, total soluble solids, reducing sugar and total sugar content of jamun jelly

T1 – KJP-215 - Recipe-1
T2 – KJP-215 - Recipe-2
T3 – KJP-215 - Recipe-3
T4 – KJP-32 - Recipe-1
T5 – KJP-32 - Recipe-2
T6 – KJP-32 - Recipe-3
T7 – KJP-11 - Recipe-1
T8 – KJP-11 - Recipe-2
T9 – KJP-11 - Recipe-3
MAS = Months after storage

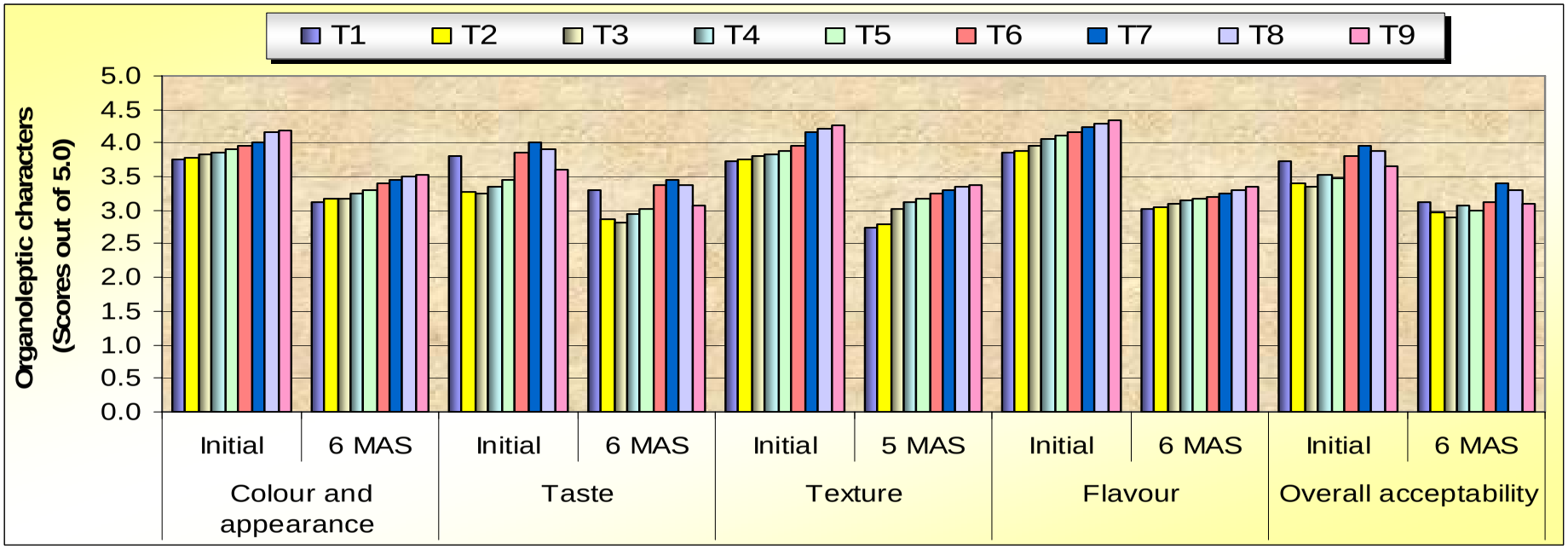

Fig. 7. Effect of treatments and storage period on organoleptic characters and chemical parameters of jamun leather

T1 – Pomace + 30% sugar + 1% citric acid + heating at 60°C + drying
T2 – Pomace + 35% sugar + 1.5% citric acid + heating at 60°C + drying
T3 – Pomace + 40% sugar + 2% citric acid + heating at 60°C + drying
T4 – Pomace + 30% sugar + 1% citric acid + microoven heating + drying
T5 – Pomace + 35% sugar + 1.5% citric acid + microoven heating + drying
T6 – Pomace + 40% sugar + 2% citric acid + microoven heating + drying
T7 – Pomace + 30% sugar + 1% citric acid + drying
T8 – Pomace + 35% sugar + 1.5% citric acid + drying
T9 – Pomace + 40% sugar + 2% citric acid + drying

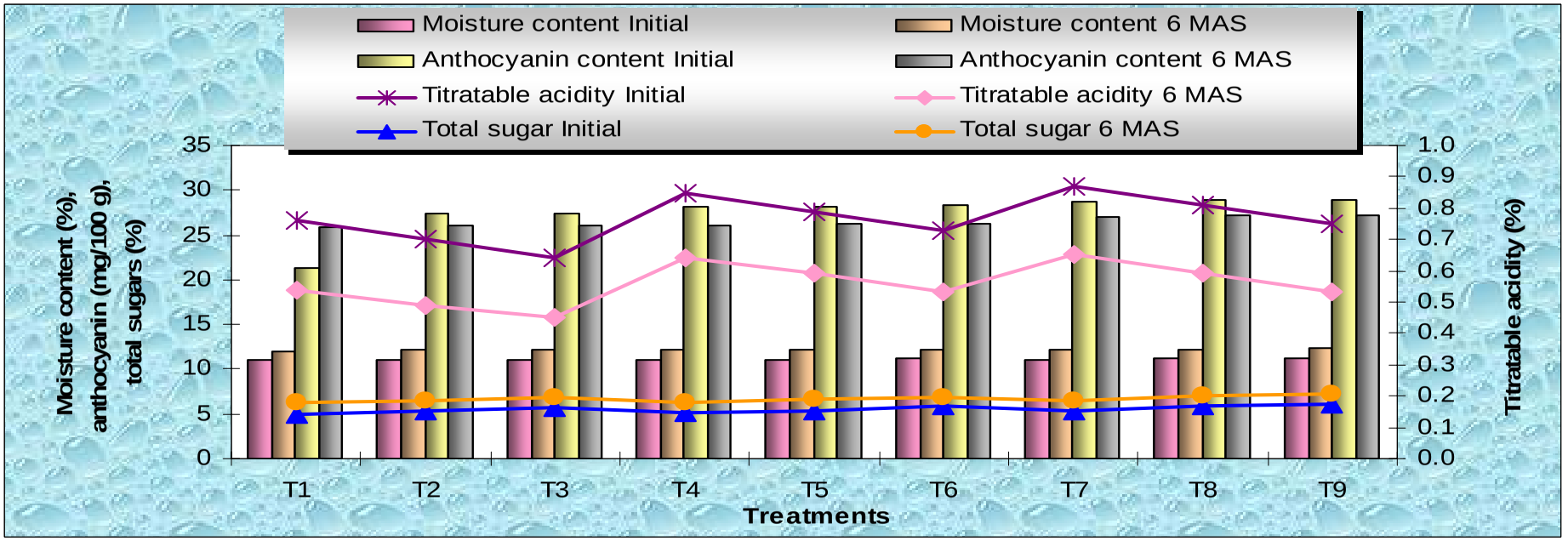

Fig. 8. Effect of treatments and storage period on titratable acidity, moisture content, anthocyanin and total sugar content of jamun leather

T1 – Pomace + 30% sugar + 1% citric acid + heating at 60°C + drying
T2 – Pomace + 35% sugar + 1.5% citric acid + heating at 60°C + drying
T3 – Pomace + 40% sugar + 2% citric acid + heating at 60°C + drying
T4 – Pomace + 30% sugar + 1% citric acid + microoven heating + drying
T5 – Pomace + 35% sugar + 1.5% citric acid + microoven heating + drying
T6 – Pomace + 40% sugar + 2% citric acid + microoven heating + drying
T7 – Pomace + 30% sugar + 1% citric acid + drying
T8 – Pomace + 35% sugar + 1.5% citric acid + drying
T9 – Pomace + 40% sugar + 2% citric acid + drying

KJP-215 **KJP-32** **KJP-11**

Plate 1. View of different jamun genotypes

Plate 2. Jamun juice extraction for experiment

Plate 3. Jamun juice preserved by pasteurisation and sodium benzoate

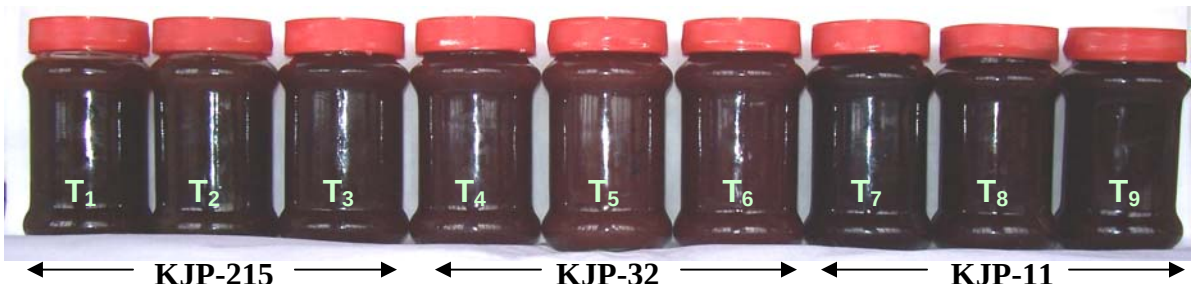

Plate 4. Jamun jam prepared by using different recipes

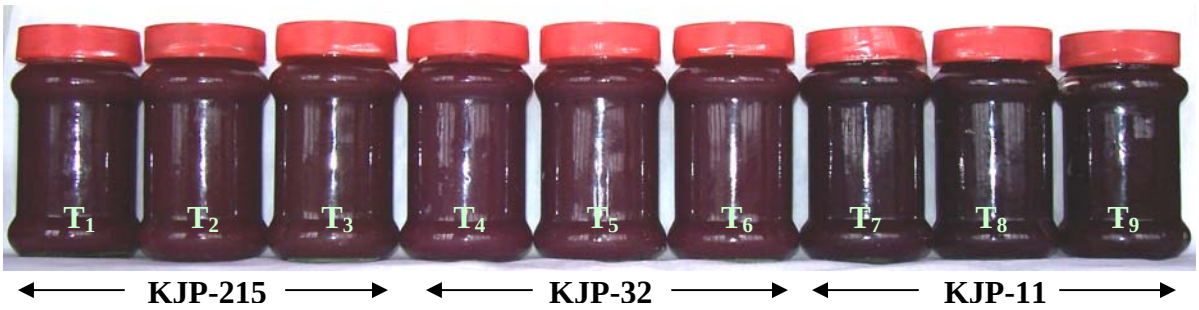

Plate 5. Jamun jelly prepared by using different recipes

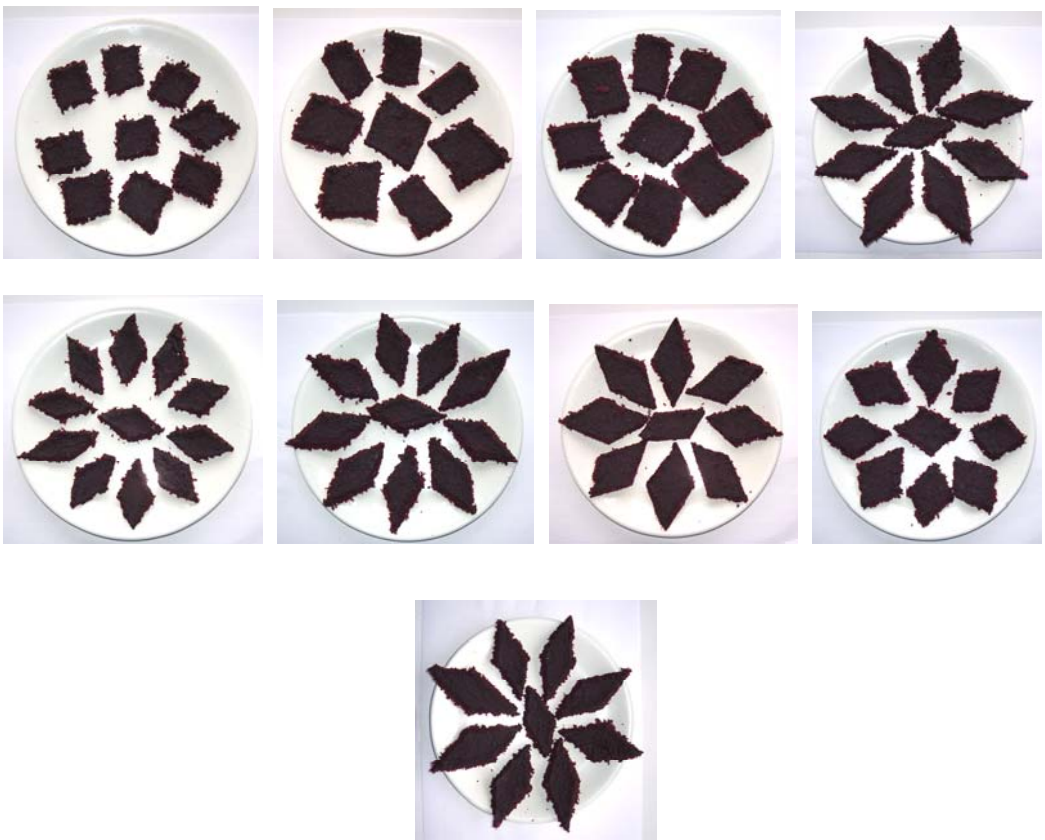

Plate 6. Jamun leather prepared by using different recipes

5. DISCUSSION

Jamun, one of the important unexploited fruit crops, has recently attained major importance as an arid zone horticultural crop because of its hardy nature and high yielding potential. No organised jamun orchards are noticed at present. However, the trees are mostly planted along the avenues or as a wind break on the boundary. Lack of recognised varieties and relatively long pre-bearing period are the main hurdles for expansion of area under this crop. It is widely grown in the larger parts of India from Indo-Gangetic plains in the north to Tamil Nadu in the south (Singh and Srivastava, 2000). The production of jamun fruits is season bound and hence it is available for a limited period of one to two months in a year. This leads to seasonal glut in the market fetching uneconomic prices to the farmers and consumers. Further, jamun fruits being highly perishable need to be consumed fresh or processed immediately after harvest. Therefore, there is an urgent need for development of commercially and economically viable technology for processing of jamun fruits into value added products.

Survey of literature on the processing potential of jamun revealed that little attention was given to develop the processing technologies. Based on the available technologies for other fruits, few products, such as fresh juice and juice based beverages, pulp based products like jam, jelly, leather could be tried both for domestic as well as international market. Further, sincere efforts need to be made to standardise the processing technologies and evaluate the consumer acceptance and economic viability for commercialisation of these products.

Jamun fruits possess an attractive colour, good taste and pleasant flavour and are very much liked by the masses. They are mostly used for dessert purpose and the only processed product of jamun available in the market is jamun syrup. Further, with increasing awareness about the medicinal and nutritional value of jamun fruits among the general public, there has been a great demand for processed products of jamun especially juice without added sugar and sweetened products like jam and jelly. Therefore, an attempt was made in the present investigation to study the preservation of fresh juice, preparation and storability of pulp based products like jam, jelly and leather.

5.1 PRESERVATION OF JAMUN JUICE

Preservation of fruit juice is very important so that the preserved juice can be further used for preparation of juice based beverages. The fruit juices are rich source of sugars,

minerals, vitamins, organic acids, *etc*., which acts as a good source of food for spoilage microorganisms. The enzymes present in juices are also responsible for deterioration of the quality. Thus, any of the preservation methods, either alone on in combination, is a prerequisite for extending the shelf life of fruit juices at ambient temperature. Pasteurisation and use of chemical preservatives are well known methods for preservation of juices. However, correct pasteurisation temperature and suitable chemical preservatives and their concentrations need to be worked out for specific fruit juices as their composition and pH varies. Hence, in the present investigation, an attempt was made to preserve the jamun juice by pasteurisation and by addition of sodium benzoate at different concentrations and a combination of both in order to know their effect on the organoleptic quality and physico-chemical characteristics of stored jamun juice.

Organoleptic quality and chemical composition of jamun juice was significantly affected by the treatments. The Organoleptic evaluation of jamun juice in the present investigation revealed significant differences with respect to colour and appearance, taste, flavour and overall acceptability between different treatments at different stages of storage period. Maximum scores for organoleptic evaluation were obtained in case of treatment wherein 600 ppm sodium benzoate was added to juice throughout the storage period of eight months. At the beginning of storage, the scores were 4.50 and above and at the end of storage period of eight months, the scores were 3.50 and above in this treatment, indicating that the juice treated with 600 ppm sodium benzoate was organoleptically highly acceptable even after eight months of storage. However, in treatments wherever pasteurisation of juice was done, the organoleptic scores in general were lower as compared to the juice without pasteurisation. This may be due to loss of flavour, cooked taste and loss of acids due to heating. Similar findings were also reported by Ranote and Bains (1982) in Kinnow juice, Masoodi *et al*. (1992) in Perlette grape juice, Waskar and Deshmukh (1995) in pomegranate juice, Rege and Pai (1999) in pomegranate, Jayalaxmi (2006) in sapota and Sowjanya (2007) in pomegranate.

Chemical composition of juice in different treatments was affected by the treatments (Tables 5 to 10). The total soluble solids (TSS) and total sugars were found to increase significantly and titratable acidity, anthocyanin, ascorbic acid, phenol content were found to decrease during storage. The increase in TSS and total sugar content of jamun juice might be due to slow hydrolysis of polysaccharides like acids and pectic substances to simpler substances like sugar in presence of acid present in juice. The results were in accordance with Tripathi *et al*. (1989) in aonla juice, Ranote *et al*. (1993) in Kinnow orange and Chobe (1999) in pomegranate juice. The decrease in acidity during storage of the juice could be attributed to

chemical interaction between the chemical constituents of the juice induced by temperature and action of enzymes. These results are in conformity with that reported by Khurdiya (1994) in lime juice and Devaraju (2001) in ber juice. The decrease in ascorbic acid content could be attributed to its oxidation due to release of trapped oxygen in the glass bottles which resulted in the formation of dehydro-ascorbic acid. The decrease in anthocyanin content during storage of juice is due to hydrolysis of protective 3-glucoside linkage of anthocyanin. The decrease in phenols during storage might be due to their oxidation and condensation into brown pigments. These results are in accordance with Urmil and Satinder (1983) in citrus juice, Waskar and Khurdiya (1987) in phalsa beverage, Sarolia and Mukherjee (2002) in lime juice, Abhay *et al*. (2005) in Kinnow juice and Upale (2005) in storage of jamun juice.

The microbial population (bacteria, fungi and yeast) on jamun juice was very low or negligible at the beginning of storage. It was found to increase marginally during the storage period of eight months (Table 11). But, such marginal increase did not affect the wholesomeness of the product. However, at the end of eight months, slightly higher microbial load was observed in the control as compared to the juice preserved by chemical preservatives and juice preserved with combination of pasteurisation and chemical preservative. This may be attributed to the effect of both heat treatment and chemical preservative in checking the growth of microorganisms. These results are in conformity with that reported by Li *et al*. (1989) in orange juice, Acharya and Shah (1999) in mango pulp, Chandan (2004) in aonla juice, Jayalaxmi (2006) in sapota juice and Sowjanya (2007) in pomegranate juice.

Based on the scores for organoleptic evaluation and physico-chemical characteristics and their changes during storage, it can be concluded that jamun juice can be preserved by addition of 600 ppm sodium benzoate upto eight months at ambient storage conditions.

5.2 STANDARDISATION OF RECIPE FOR PREPARATION OF JAMUN JAM AND JELLY

In nature, variations are evident and observed with respect to fruit shape, size, pulp colour, pulp content, TSS, acidity, anthocyanin, phenols, *etc*. Individual fruit or its variety may be suitable for preparing specific processed products. Based on the physico-chemical properties / characteristics individual fruit and its variety, particular value added product can be prepared. For example, fruits with high content of pectin and organic acids are best suited for jam and jelly making. The fruits, such as guava, kumquat, carambola, black berries, apples, citrus peels and papaya are good source of pectin (Swamyrao *et al*., 1989). A wide variation has been reported in jamun fruit with respect to its size, shape, pulp content, pulp

colour, skin, colour, seed content, sugars, acidity, anthocyanins, phenols, *etc*., and hence several genotypes with varied physico-chemical characteristics have been reported (Prabhuraj, 2001). For preparation of different products specific pulp composition is required. Hence in the present investigation, the specific and promising genotypes, namely KJP-215, KJP-32 and KJP-11 identified by the Department of Pomology were used to prepare jam and jelly with three recipes in each with an objective to find out a suitable recipe of jam or jelly for fruits of different size and physico-chemical parameters.

5.2.1 Jamun jam

Jam is a product made by boiling fruit pulp with sufficient sugar to a reasonably thick consistency, firm enough to hold the fruit tissues in portion. Jam should contain 0.5 to 0.6 per cent acid, 68 per cent total soluble solids, invert sugar should not be more than 40 per cent and minimum percentage of the fruit in final product (w/w) should be 45 per cent. Organoleptic evaluation of a product is an important tool for deciding the consumer acceptability. The sensory evaluation in the present investigation revealed significant differences with respect to colour and appearance, texture, taste, flavour and overall acceptability of jam due to the different treatments at different stages of storage period (Tables 12 to 16).

Mean scores for all the sensory characters like colour and appearance, texture, taste, flavour and overall acceptability were found to be significantly higher in the jam prepared by using recipe 1 (1 kg pulp + 675 g sugar + 2 g citric acid + 25 mg pectin), in case of KJP-11 and KJP-215, whereas in case of genotype KJP-32 with medium sized fruits, recipe 3 (1 kg pulp + 850 g sugar + 4 g citric acid + 25 g pectin) was found to be most acceptable. These results suggest that organoleptic quality of a product is influenced by the raw material used. The physico-chemical properties of the jamun fruits of different genotypes varied distinctly (Appendix I). Hence, a quality jam could be obtained by using different recipes from the jamun fruits having different physico-chemical parameters. These results corroborate with Nath and Sharma (1998) in aonla jam, and Diwakar *et al*. (2003), Kannan and Thirumaran (2004) and Sameer (2006) in jamun jam.

Quality of a product may deteriorate during storage due to several changes in its biochemical constituents. In this experiment also, marginal changes in chemical parameters were observed during storage of five months. These changes were also significantly affected by the treatments. Significant variations between the treatments were observed with respect to titratable acidity, total soluble solids (TSS), anthocyanin, reducing sugar, non-reducing and

total sugars. However, during storage, there was a marginal increase with respect to reducing sugar, non-reducing sugar, total sugar, TSS and decrease in acidity, anthocyanin content. The increase in TSS, reducing sugar and total sugar might be due to the inversion of polysaccharides into simpler sugars in the presence of acids present in the jam. The decrease in acidity during storage might be due to chemical interactions between organic acids. The decrease in anthocyanin content during storage may be due to hydrolysis of protective 3-glucoside linkage of anthocyanin. These results corroborate with that of Bhatnagar (1991) in watermelon rind jam, Kannan and Susheela (2002) in jamun jam, Daniel *et al*. (2003) in papaya and rose apple jam and Haridwar and Chopra (2006) in bael jam.

The safety of a product with respect to microbial load is as important as its organoleptic quality and chemical composition. The bacterial population of jam ranged from 0.47×10^5 to 1.82×10^5 CFU per g and the fungal population was much lower ranging from 0.43×10^3 to 1.77×10^3 CFU per g and the yeast population ranged from 0.68×10^3 to 2.06×10^3 CFU per g at different stages of storage. Since the microbial load was comparatively lower, it did not cause spoilage even after five months of storage. The lower microbial load in jam might be due to the high sugar content above 68 per cent which might have inhibited the growth of microorganisms. Salunke *et al*. (1983) also reported that 60 to 65 per cent sugar content is needed in jam to prevent microbial spoilage. Bhatnagar (1991) also reported that complete absence of microbial counts in watermelon rind jam was due to high sugar concentration.

From the above discussion, it can be concluded that the jamun genotypes KJP-215, KJP-32 and KJP-11 can be commercially utilised for jam preparation by using the recipes of one kg pulp + 675 g sugar + 2 g citric acid + 25 mg pectin for KJP-215 and KJP-11 and one kg pulp + 850 g sugar + 4 g citric acid + 25 g pectin for KJP-32.

The jam prepared by these recipes could be successfully stored upto a period of five months without affecting the organoleptic qualities and wholesomeness of the product.

5.2.2 Jamun jelly

A perfect jelly should be transparent, well set but not too stiff and should have the original flavour of fruit. It should possess an attractive colour and should keep its shape and retain a clear cut surface. It should be tender enough to quiver but not to flow.

Organoleptic evaluation of a product is an important tool for deciding the consumers acceptability. The sensory evaluation in the present investigation revealed significant

differences with respect to colour and appearance, texture, taste, flavour and overall acceptability due to the different treatments at different stages of storage period (Tables 24 to 28). Mean scores for all the sensory characters were found to be significantly higher in the jelly prepared by using recipe 3 (500 ml water + 1 g citric acid + 5 g pectin + 1 kg pectin extract) in case of KJP-215, whereas in case of KJP-32 and KJP-11, recipe 1 (500 ml water + 3 g pectin + 1 kg pectin extract) was found to be most acceptable. These results suggest that organoleptic quality of a product is influenced by the raw material used. The physico-chemical properties of the jamun fruits of different genotypes varied distinctly (Appendix I). Hence, a quality jelly could be obtained by using different recipes from the jamun fruits having different physico-chemical parameters. Similar findings were reported by Shah and Bhatia (1983) in apple jelly, Agarwal *et al*. (1997) in grape-guava jelly, Barwal and Kalia (1997) in apple jelly and Sameer (2006) in jamun jelly.

Chemical composition of jelly in different treatments was affected by the treatments (Tables 29 to 34). The TSS, reducing sugar, non-reducing sugar, total sugar were found to increase significantly in all the treatments, whereas acidity and anthocyanin contents decreased during the storage period of five months. The increase in TSS, reducing sugar and total sugar might be due to the inversion of polysaccharides into simpler sugars. The decrease in acidity during storage might be due to chemical interactions between organic acids. The decrease in anthocyanin during storage is due to hydrolysis of protective 3-glucoside linkage of anthocyanin. These results corroborate with that of Muralikrishna (1967), Shah and Bhatia (1983) in culled apples and Yousif *et al*. (1990) in date jelly.

The microbial population (bacteria, fungi and yeast) of jamun jelly was very low or negligible at the beginning of storage, which was found to increase marginally during the storage period of five months (Table 35). However, at the end of the five months, slightly higher microbial load was observed in all the treatments. However, such marginal increase did not affect the wholesomeness of the product as the microbial count was much lower than the critical levels in all the treatments during storage. The results of this investigation are in accordance with the results reported by Giridharilal *et al*. (1986), Frazier and Westoff (1978) and Fields (1979), Barmany *et al*. (1996) in guava jelly.

It is evident from the present study that genotypes KJP-215, KJP-32 and KJP-11 can be commercially exploited for preparing jelly with the recipe consisting of 500 ml water +1 g citric acid + 5 g pectin + 1 kg pectin extract (KJP-215 genotype) and 500 ml water + 3 g pectin + 1 kg pectin extract (KJP-32 and KJP-11 genotypes).

The jelly prepared by these recipes could be successfully stored upto a period of five months without affecting the organoleptic qualities and wholesomeness of the product.

5.3 PREPARATION AND STORAGE OF JAMUN LEATHER

The pomace obtained after extraction of juice from the pulp is generally considered as a waste. It accounts for 35 to 40 per cent of fruit weight. This pomace is also rich in minerals, nutrients, traces of juice, *etc*. Therefore, the present experiment was initiated to utilise the fresh pomace for preparation of value added product like leather.

The sensory evaluation in the present investigation revealed significant difference with respect to colour and appearance, taste, flavour and overall acceptability. The leather prepared from fresh pomace + 40 per cent sugar + two per cent citric acid + drying (T_9) scored significantly higher for colour and appearance, texture, flavour, while the leather prepared by using pomace + 30 per cent sugar + one per cent citric acid + drying (T_7) scored higher for taste and overall acceptability. This suggest that eventhough the colour and texture were improved by addition of higher levels of sugar (40%) and citric acid (2%), the taste and overall acceptability were better with comparatively lower sugar (30%) and citric acid (1%). Similar findings were also reported by Vennila and Kingsly (2001) in sapota-papaya bar, Sagar (2003) in plum leather, Jayalaxmi (2006) in sapota burfi, Shobha (2007) in ber burfi, Dhumal *et al*. (1996) in custard apple toffee and Jagtap *et al*. (2000) in carrot toffee.

Several changes in the biochemical constituents of the preserved products during storage have been reported. In the present study, there were changes in the chemical composition of jamun leather prepared by different treatments during the storage period of six months. These changes were also affected by the treatments (Tables 41 to 44). During the storage period of six months, an increase in moisture content from 11.10 to 12.15 per cent and TSS from 5.51 to 6.68 per cent and decrease in anthocyanin content from 28.14 to 26.44 mg per 100 g and acidity from 0.77 to 0.56 per cent was observed. Similar results were observed by Keshatti (2003), Chandan (2004) in dehydrated aonla slices.

The microbial population of bacteria, fungi and yeast, which was very low or negligible at the beginning of storage, was found to increase marginally during the storage period of six months (Table 45). Even though there was an increase in the microbial load, the wholesomeness of the product was not affected and the product remained acceptable even after six months of storage. These results were corroborate with that of Kichu (2008) in sapota candy.

Thus, from the above discussion, it can be concluded that good quality of jamun leather can be prepared using the recipe consisting of fresh pomace + 30 per cent sugar + one per cent citric acid and drying in electric tray drier.

FUTURE LINE OF WORK

- Extension of shelf life of fresh jamun juice with a combination of different chemical preservatives at lower concentration for eight months at ambient and refrigeration condition of storage.
- Preparation of new products like jamun toffee.
- Preparation of new product from jamun seed powder.
- Standardisation of jamun leather preparation from different recipe with different combination of sugar, citric acid, milk powder, *etc*.
- Estimation of nutritional value of the processed products.

6. SUMMARY AND CONCLUSIONS

An investigation on the processing of jamun fruits was carried out during the year 2006-07 in the Department of Post-harvest Technology, Kittur Rani Channamma College of Horticulture, Arabhavi, Belgaum district, Karnataka. The salient features of the present investigation are summarised hereunder:

6.1 PRESERVATION OF JAMUN JUICE

The treatments consisted of heat treated juice as control, pasteurisation of juice at 85°C for 10 minutes and addition of sodium benzoate at different concentrations with or without pasteurisation. The treated juice was stored in sealed bottles at ambient temperature upto eight months.

Significant differences were observed with respect to organoleptic characters of jamun juice due to the treatments. The juice treated with 600 ppm sodium benzoate was found to be superior with respect to organoleptic characters, *viz*., colour and appearance (4.18), taste (4.51), flavour (3.85) and overall acceptability (4.28). However, during eight months of storage, the mean score reduced significantly from an initial value of 4.42 to 3.36 for colour and appearance, 4.18 to 3.56 for taste, 4.08 to 3.35 for flavour and 4.26 to 3.30 for overall acceptability. It was observed that the juice stored at ambient condition was good and organoleptically acceptable even after eight months of storage.

Only marginal differences were observed with respect to chemical parameters between the treatments. The chemical constituents like total soluble solids (TSS) and total sugar increased marginally from 13.03 to 13.45 per cent and 8.35 to 8.83 per cent, respectively, whereas titratable acidity, anthocyanin, phenols and ascorbic acid content decreased from 0.93 to 0.74 per cent, 52.36 to 50.64 mg per 100 ml, 355.69 to 353.73 mg per 100 ml and 17.24 to 15.93 mg per 100 g, respectively, during storage period of eight months.

The bacterial population in jamun juice ranged from 2.28×10^5 to 3.15×10^5 CFU per ml, the fungal population ranged from 1.18×10^3 to 1.85×10^3 CFU per ml and yeast population ranged from 3.20×10^3 to 3.80×10^3 CFU per ml at initial stage which increased marginally during eight months of storage.

6.2 STANDARDISATION OF RECIPE FOR PREPARATION OF JAMUN JAM AND JELLY

Nine treatments consisting of three recipes having different levels of water, sugar, citric acid and pectin were used for preparation of jam and jelly from three different

genotypes (KJP-215, KJP-32 and KJP-11). In jamun jam, mean scores for all the sensory characters like colour and appearance, texture, taste, flavour and overall acceptability were found to be significantly higher in case of recipe 1 (1 kg pulp + 675 g sugar + 2 g citric acid + 25 ml pectin) for KJP-215 and KJP-11 and recipe 3 (1 kg pulp + 850 g sugar + 4 g citric acid + 25 g pectin) for KJP-32.

With regard to chemical parameters, there was a marginal increase in TSS (69.31 to 70.10%), reducing sugar (25.50 to 25.88%), non-reducing sugar (30.33 to 30.69%) and total sugar (57.43 to 58.18%) content, whereas there was a decrease in acidity (0.91 to 0.61%) and anthocyanin (54.10 to 53.01 mg/100 ml) during the storage period of five months.

At the end of five months of storage, the bacterial population ranged from 1.49 x 10^5 to 1.82 x 10^5 CFU per g, fungal population ranged from 1.42 x 10^3 to 1.77 x 10^3 CFU per g and yeast population ranged from 1.69 x 10^3 to 2.06 x 10^3 CFU per g. The microbial load on jamun jam was minimum and did not cause any spoilage even after five months of storage.

Organoleptic evaluation of jamun jelly indicated that for genotype KJP-215, recipe containing one kg pectin extract + one gram citric acid + five grams pectin + sugar 1 : 0.75 (pectin extract : sugar) and for genotype KJP-32 and KJP-11, recipe having one kg pectin extract + three grams pectin + sugar 1 : 0.75 ratio (pectin extract : sugar) were found to score higher for all the five organoleptic parameters.

Marginal differences were observed among the treatments with respect to chemical constituents. During storage for five months, a linear increase in reducing sugar (21.03 to 21.45%), non-reducing sugar (30.83 to 31.58%), total sugars (53.49 to 54.69%) and TSS (65.75 to 67.05%) were observed. However, a decrease in titratable acidity (0.69 to 0.48%) and anthocyanin content (49.06 to 47.01 mg/100 g) were recorded.

At the end of five months, the bacterial population ranged from 1.38 x 10^5 to 1.75 x 10^5 CFU per g, the fungal population ranged from 1.33 x 10^3 to 1.70 x 10^3 CFU per g and yeast population ranged from 1.61 x 10^3 to 1.79 x 10^3 CFU per g. Even though there was an increase in microbial population, it did not affect the wholesomeness of the product.

6.3 STANDARDISATION OF PROTOCOL FOR PREPARATION OF JAMUN LEATHER

Jamun leather prepared from pomace (pulp left after extraction of juice) with different combination of sugar and citric acid were given two types of heat treatments, *viz*., heating in open vessel to attain a temperature of 60°C and micro-oven heating at 60°C for four minutes.

The highest score for colour and appearance (3.91), texture (3.95), flavour (4.08) was recorded in leather prepared with the recipe of fresh pomace + 40 per cent sugar + two per cent citric acid + drying. But for taste (3.77) and overall acceptability (3.70), the highest score was observed in leather prepared with the recipe of fresh pomace + 30 per cent sugar + one per cent citric acid + drying. The leather prepared by using low concentration of sugar and citric acid was most acceptable.

There was an increase in sugar content (5.51 to 6.68%) and moisture content (11.10 to 12.15%), whereas decrease in acidity (0.77 to 0.56%) and anthocyanin content (28.14 to 26.44 mg/100 g) during storage period of six months was observed.

The microbial load of jamun leather was lower in the treatments where pre-heating upto 60°C followed by drying was carried out as compared to the direct drying. However, the microbial load was minimum and the leather was free from microbial spoilage and was organoleptically acceptable even after six months of storage.

CONCLUSION

- Jamun juice can be preserved by addition of 600 ppm sodium benzoate upto eight months at ambient storage conditions.
- Good quality jamun jam can be prepared with recipe of one kg pulp + 675 g sugar + two g citric acid + 25 mg pectin.
- Good quality jamun jelly can be prepared with recipe of one kg pectin extract + three g pectin + sugar 1 : 0.75 ratio (pectin extract : sugar).
- Good quality jamun leather can be prepared from fresh pomace (pulp left after extraction of juice) with a recipe having fresh pomace + 30 per cent sugar + one per cent citric acid and drying in electric tray drier.

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Appendix I

Physico-chemical characters of different jamun genotypes

Sl. No.	Characters	Genotype		
		KJP-215	KJP-32	KJP-11
1.	Fruit weight (g)	18.40	15.00	11.40
2.	Fruit length (mm)	40.19	36.24	29.09
3.	Fruit diameter (mm)	28.27	22.88	20.77
4.	Seed weight (g)	2.00	1.85	1.02
5.	Seed length (mm)	31.98	24.46	17.63
6.	Seed diameter (mm)	11.85	10.32	10.26
7.	Pulp thickness (mm)	7.24	5.00	5.00
8.	Pulp colour	Light purple	Medium purple	Dark purple
9.	Total soluble solids (%)	11.60	12.50	12.10
10.	Total titratable acidity (%)	1.01	1.02	1.03
11.	Anthocyanin (mg/100 ml)	15.58	16.29	19.96
12.	Reducing sugar (%)	0.03	0.07	0.04
13.	Non-reducing sugar (%)	9.03	9.52	9.31
14.	Total sugars (%)	9.06	10.10	9.84

PROCESSING OF JAMUN FRUITS

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ABSTRACT

An investigation on processing of jamun fruits using different genotypes was carried out at the Department of Post-harvest Technology, Kittur Rani Channamma College of Horticulture, Arabhavi during 2006-07.

Jamun juice can be preserved by addition of 600 ppm sodium benzoate upto eight months at an ambient storage condition. The organoleptic scores of 4.18, 4.51, 3.85 and 4.28 (out of 5.0) were recorded for colour and appearance, taste, flavour and overall acceptability, respectively.

Good quality jam can be prepared from jamun fruits with the recipe having one kg pulp + 675 g sugar + 2 g citric acid + 25 mg pectin. The mean organoleptic scores of 4.25, 4.14, 3.93, 4.16 and 4.28 (out of 5.0) were recorded for colour and appearance, texture, taste, flavour and overall acceptability, respectively.

Good quality jelly can be prepared from jamun fruits with the recipe consisting of 500 ml water + 3 g pectin + 1 kg pectin extract + sugar at 1 : 0.75 ratio (pectin extract : sugar). The mean organoleptic scores of 3.83, 3.53, 3.46, 3.13 and 3.43 (out of 5.0) were recorded for colour and appearance, taste, texture, flavour and overall acceptability, respectively.

Good quality jamun leather can be prepared using the recipe consisting of fresh pomace + 30 per cent sugar + one per cent citric acid and drying in an electric tray drier. The highest scores (out of 5.0) for taste (3.77) and overall acceptability (3.70) were recorded. The leather could be stored well upto five months.