Original Research Article

Organoleptic Properties of Guava Fruit Leather with Effectiveness of Increase in Storage Period

Er. Shaik Jakeer Basha*, A. Yerri Swamy, Lingala Ramu and D. Sreenivas

*Department Food Science and Technology, Mahatma Phule Krishi Vidyapeeth, Rahuri, India

*Corresponding author

Abstract

An investigation was carried out to study the effect of storage period on organoleptic properties of guava leather prepared from its cultivars of Sardar (white flesh) and Lalith (pink flesh). Preliminary experiments were conducted to find out the optimum levels of sugar, citric acid and salt for preparation of quality leather. The leather prepared was packed in butter paper and stored at ambient (25±2°C) and refrigerated temperature (5±2°C) for 90 days to study their storage feasibility. Out of the seven treatments, best two T1, T2 are selected for further storage period of 90 days by sensory panel members on 9 point hedonic scale rating. The stored samples were drawn periodically at 30 days interval for analysis. The guava leather (625.76 g/kg pulp) was obtained from treatment V1T1 (750g sugar + 5g salt + 2g citric acid), followed by the other treatments (618.06 g/kg pulp) in V1T2 (750 g sugar) for Sardar guava variety, (624.00 g/kg pulp) in V2T1 (750 g sugar + 5g salt + 2g citric acid) and (617.00 g/kg pulp) in V2T2 (750 g sugar) for Lalith guava variety. The treatments V1T1, V2T1, and V1T2, V2T2 are same but mainly differ in cultivars of guava white and pink flesh. Chemical composition indicated that the fresh guava leather contained on an average 16.80 per cent moisture, 76.20°Brix TSS, 14.36 per cent reducing sugars, 68.70 per cent total sugars, 0.541 per cent titrable acidity, 127.10 mg/100 g ascorbic acid. The guava leather prepared by using sugar, salt, citric acid (Treatment V1T1 and V2T1) were superior over the other treatments in respect of organoleptic properties. The mean score of fresh guava leather for colour and appearance was 8.60, flavor 8.50, texture 8.60, taste 8.30 and overall acceptability 8.50 on 9 point Hedonic scale. The storage studies indicate that there was a gradual decrease in organoleptic properties of leather with advancement of storage period. Sensory quality of guava leather decreased at faster rate during storage, which was more at ambient temperature than refrigerated storage. Total microbial count was low initially but increased slightly during storage. However guava leather was found to be acceptable in good condition even after 90 days of storage at ambient and refrigerated temperature.

Keywords
Guava, Lalith, Sardar, Leather, storage

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Introduction

Guava (Psidium guajava L.) is a member of dicotyledonous, belong to large member of Myrtaceae or Myrtle family believed to be originated in Central America and Southern part of Mexico (Somogyi et al., 1996). It is a small tree or shrub of 2 to 8 m in height with
wide spreading branches (Singh 1988). In India it is claimed to be the fourth most important cultivated fruit in both area and production wise after mango, banana and citrus (Singhal, 1996). Whole guava fruit is edible along with skin, quite hardy, prolific bearer with sweet aroma and pleasant sour sweet taste, considered as one of most delicious and luxurious fruits, often marketed as “Super fruits”.

The quality and nutritional value of guava fruits are influenced by physical and biochemical changes during maturation by photosynthesis and accumulation. Fully mature guava fruits have very strong flavour therefore it is unsuitable to use as a table purpose. The fruit has about 83% moisture and is an excellent source of ascorbic acid (100 – 260 mg/100 g pulp) and pectin (0.5 – 1.8 %) (Verma and Shrivastava, 1965), but has low energy (66 Cal/100 g) and protein content (1%) (Bose et al., 1999). The fruit is rich in minerals like phosphorous (23-37 mg/100 g), calcium (14-30 mg/100 g), iron (0.6-1.4 mg/100 g), as well as vitamins like Niacin, Pantothenic acid, Thiamine, Riboflavin, vitamin A (Bose et al., 1999). Guava is normally consumed fresh as a desert fruit can be processed into juice, nectar, pulp, jam, jelly, slices in syrup, fruit bar or dehydrated products, as well as being used as an additive to other fruit juices or pulps (Leite et al., 2006). Excellent salad, pudding, jam, jelly, cheese, canned fruit, RTS, nectar, squash, ice cream and toffees are made from guava (Jain and Asati, 2004). However, guava is highly perishable and cannot be stored for longer period. Moreover considerable proportion of the produce is lost during post-harvest linkage (Ahire, 1989). It is, therefore, imperative to develop suitable technology for preservation and processing of such surplus produce. There has been greater increase in the production rate of these fruits over the years, and this may be due to their increased consumption pattern in the tropics (FAO, 1983). It is common experience that 20-25% of the fruit is completely damaged and spoiled before it reaches the consumer (Yadav, 1997). Therefore, to utilize the produce at the time of glut and to save it from spoilage; the development of low cost processing technology of guava is highly required. It will also generate enough opportunities of self-employment by starting small scale processing unit or cottage industry that will be remunerative to the growers. Thus the preparations of guava pulp with simple technology and its utilization in the form of pulp and leather have a great scope.

Fruit leathers are dehydrated fruit based products. They are a tasty, chewy, dried fruit product. Fruit leathers are made by pouring pureed fruit onto a flat surface for drying. When dried the fruit is pulled from the surface and rolled, it gets the name “Leather” from the fact that when the pureed fruit is dried, it is shiny and has the texture of leather. Due to its novel and attractive structure, and for being products that do not require refrigeration, they constitute a practical way to incorporate fruit solids, especially for children and adolescents. Fruit leathers allow leftover ripe fruits to be preserved. Therefore guava leather from two kinds of fully ripened guava fruits one is of white flesh of Sardar variety and another of pink flesh Lalith fruits is prepared and kept for storage period of 3 months for organoleptic studies at both ambient and refrigerated storage.

Materials and Methods

Raw materials

Well-matured, healthy, uniform sized over ripen fruits of local Lalith of pink and Sardar or Lucknow-49 of white flesh cultivars were collected from the Department of Horticulture and progressive farmers of the Rahuri, Nasik, Yeola Tahashils.
**Ingredients**

Citric acid, salt, sugar and hydrogenated fat were obtained from market and used as ingredients for preparation of guava leather (Table 1).

**Chemicals**

Most of the chemicals used in this investigation were of analytical grade, obtained from M/s. British Drug House Mumbai, M/s. Sarabhai M. Chemicals, M/s. Baroda, S.D. Fine Chemical Ltd., Mumbai and E. Merck (India), Mumbai.

**Preparation of guava leathers**

Fine guava fruit pulp was used for the preparation of fruit leather. In this pulp content ingredient like sugar, salt and citric acid as per the formula, which are further mixed well and then smeared with vegetable oil on the aluminum or stainless steel trays into thin layers (0.5 to 1.0 cm thick). Then the pulp was dried in hot air oven at 50°C for 8-10 hrs. After that semi surface-dried pulp sheets were cut into desired size usually of rectangular and again dried for 8-10 hrs. After drying three layers of sheets were kept together and pressed properly to form one sheet. Then desired size (3 x 4 cm) cutting was done and dried under fan for 2-3 hrs and then wrapped into a metalized polyester wrapper and then kept in plastic bag for storage study.

**Flow sheet for preparation of guava leather**

- Over ripen guava fruits
- Thoroughly washing under running water
- Extraction of fine pulp by pulp extractor
- Addition of Ingredients
- Smearing of trays with vegetable oil
- Spreading of fine pulp in thin layer (0.5-1.0 cm on smeared trays)
- Initial drying for 8-10 hrs
- Cutting surface dried pulp as per required size
- Final drying for 8-10 hrs
- Triple dried layers pressed together
- Cutting dried sheets
- Wrapping in butter paper
- Filling in dry plastic jars
- Sealing and storage

**Standardization of ingredient levels for guava leather**

Preliminary experiments were conducted to select the optimum level of each ingredient like sugar, salt, citric acid. The optimum levels of ingredients were finalized by sensory evaluation of guava leather by a panel of minimum ten semi-trained judges using 9 points Hedonic scale (Amerine et al., 1965).

**Packaging**

The prepared leathers were packed in a butter paper stored at both ambient (25±2°C) and refrigerated (7±2°C) temperature safely in laboratory at the middle compartment of the refrigerator for 3 months storage study. Analysis of stored guava leathers was carried out at an interval of 0, 30, 60, 90 day’s storage period.

**Physico-chemical analysis**

The over ripen guava fruit pulp was analyzed for the moisture, TSS, titrable acidity, reducing sugars, total sugars, and vitamin C using standard methods of AOAC (2005).
Statistical analysis

Results and experiments were planned and carried out using Factorial Completely Randomized Design (FCRD) using three to ten replications according to methods of the procedure given by Panse and Sukhatme (1967).

Results and Discussion

Physio-chemical characteristics of Sardar guava fruit and pulp

The physio-chemical composition of fruit plays a very important role in processing technology of guava as well as final quality of the product. The Physio-chemical composition of Sardar cultivar of guava is presented in Table 2. The over ripened fruits were round, yellowish in color. The average weight of fruit was 139 g/fruit. The average values for recovery of pulp and processing losses were 92.60 and 7.40 per cent, respectively.

Physio-chemical characteristics of Lalith guava fruit and its pulp

Lalith fruits were attractive, saffron yellow with occasional red blush and medium sized with firm pink colored flesh. It has good blend of sugar and acid and suitable for both processing and table purpose. Its yield was more than 24 per cent than the Allahabad Safeda variety (Yadav, 2007). The over ripen fruits of Lalith were round, yellowish in color. The average weight of fruit was 126 g/fruit. The average values for recovery of pulp and processing losses were 91.0 and 9.0 per cent, respectively.

Recovery of pulp

The recovery of pulp from Sardar guava variety was 92.60 %, while recovery of pulp for Lalith guava variety was 91.0 % (Table 6).

Organoleptic properties of pretreatment guava leathers

From the organoleptic evaluation presented in Tables 3, 4 treatments T2 and T3 were selected as best among the 7 various treatments for both Sardar and Lalith guava leathers. Selected treatments T2 and T3 were renamed as V1T1 and V1T2 in Sardar guava leather, and for Lalith guava leather as V2T1 and V2T2.

Organoleptic properties of fresh guava leathers (selected treatments)

The selected treatments leather was prepared for further study. The organoleptic evaluations of fresh guava leather from both varieties are presented in Table 5. During organoleptic evaluation, V1T1 and V2T1 found similar and better than V1T2 and V2T2 for overall acceptability. So again T2 and T3 samples of guava leather (both varieties) are prepared and kept for storage of 3 months at both ambient and refrigerated conditions.

Yield and chemical properties of fresh guava leathers

The yield and chemical properties of fresh guava leather of both Sardar as well as Lalith cultivars are shown in Table 6. The yield of guava leathers ranged from 617-625 g/kg of pulp. The yield of guava leather V1T1 was slightly higher as compared to V1T2, V2T1, and V2T2. There was no much difference in yield between three treatments, as the levels of ingredients are same.

Changes in chemical composition of guava leathers during storage

Guava leather prepared from selected treatments from both varieties was kept for storage study at ambient (27 ± 2°C) and refrigerator (7 ± 2°C) temperatures. The storage study results of guava leather are presented in Tables 9 to 12.
Chemical properties of guava leathers

Chemical properties of guava leathers are mentioned in Table 6. There was slight variation in chemical properties which might be due to change in variety. Pink flesh guava leather has low amount of ascorbic content when compared to the sardar guava leather.

Changes on organoleptic properties of guava leathers during storage

The freshly prepared guava leathers were evaluated organoleptically by a panel of semi trained judges on a 9 point Hedonic scale. The mean sensory scores of fresh and stored guava leather samples for parameters like color and appearance, texture, flavor, taste and overall acceptability of guava leather samples are presented in Tables 9-12.

Color and appearance

The score for color and appearance in the present investigation of guava leather as influenced by storage temperature and period is presented in Tables 9-12. A gradual decrease in score from 8.35 to 7.45 at ambient temperature and from 8.35 to 7.80 at refrigerated temperature was observed for 90 days of storage. The score 8.35 was observed in V_1T_1 guava leather sample stored at refrigerated condition. Similar trend for color and appearance of guava leathers was observed at ambient condition but the values were at lower level than the refrigerated storage. The color deterioration was more in guava leathers stored at ambient condition. This may be due to degradation of pigments that might have occurred at ambient temperature.

Flavor

The results on flavor score of guava leather samples as influenced by storage are presented in Tables 9-12. A gradual decrease in score for flavor from 8.20 to 7.55 at ambient temperature and from 8.20 to 7.62 at refrigerated temperature was observed. The flavor retention was higher at refrigerated condition than the ambient condition. In both storage conditions treatment V_2T_1 produced highest flavor score when stored at refrigerated condition. The flavoring compounds may be lost at higher rate at higher storage temperature (thus causing lower flavor score) at ambient condition than at refrigerated condition.

Texture

The sensory results for texture score of guava leather samples are presented in Tables 9-12. A gradual decrease in texture score was observed in guava leathers from 8.27 to 7.56 at ambient temperature and from 8.27 to 7.80 at refrigerated temperature.
Table 1: Treatment details for experimentation

| Treatments | Pulp (%) | Sugar (%) | Salt (%) | Citric acid (%) |
|------------|----------|-----------|----------|-----------------|
| T<sub>1</sub> | 100      | 500       | 5        | 2               |
| T<sub>2</sub> | 100      | 750       | 5        | 2               |
| T<sub>3</sub> | 100      | 1000      | 5        | 2               |
| T<sub>4</sub> | 100      | 750       | 5        | 4               |
| T<sub>5</sub> | 100      | 750       | -        | -               |
| T<sub>6</sub> | 100      | 750       | 5        | -               |
| T<sub>7</sub> | 100      | 750       | -        | 4               |

Table 2: Physio-chemical characteristics of Sardar, Lalith guava fruits

| S. No. | Parameters | Sardar (white flesh) | Lalith (Pink flesh) |
|--------|------------|----------------------|---------------------|
| A.     | Physical parameters of fruits | | |
| 1.     | Shape | Round | Round |
| 2.     | Color | Yellow | Saffron yellow |
| 3.     | Average length (cm) | 6.20 | 4.10 |
| 4.     | Average fruit weight (g) | 139.0 | 126 |
| 5.     | Diameter (cm) | 6.20 | 6.2 |
| 6.     | Per cent of pulp recovery (%) | 92.60 | 91.0 |
| 7.     | Waste material/Seed content losses (%) | 7.40 | 9.0 |
| B.     | Chemical constituents of Pulp | | |
| 1.     | TSS (°Brix) | 9.20 | 9.10 |
| 2.     | Acidity (%) | 0.450 | 0.380 |
| 3.     | Total sugars (%) | 7.70 | 5.10 |
| 4.     | Reducing sugars (%) | 5.30 | 7.40 |
| 5.     | Vitamin C (mg/100 g) | 210 | 130 |
| 6.     | Moisture (%) | 82.56 | 83.60 |

Table 3: Organoleptic evaluation of fresh Sardar variety guava leather<sup>a</sup>

| S. No | Treatments | Color and appearance | Flavor | Taste | Texture | Overall acceptability | Selected for further study |
|-------|------------|----------------------|--------|-------|---------|-----------------------|---------------------------|
| 1     | V<sub>1</sub>T<sub>1</sub> | 7.60 | 8.00 | 8.00 | 7.90 | 7.87 | Not selected |
| 2     | V<sub>1</sub>T<sub>2</sub> | 8.80 | 8.30 | 8.20 | 8.30 | **8.40** | V<sub>1</sub>T<sub>1</sub> selected |
| 3     | V<sub>1</sub>T<sub>3</sub> | 8.00 | 7.70 | 7.60 | 8.10 | 7.85 | Not selected |
| 4     | V<sub>1</sub>T<sub>4</sub> | 7.90 | 7.50 | 7.60 | 7.60 | 7.65 | Not selected |
| 5     | V<sub>1</sub>T<sub>5</sub> | 8.40 | 7.80 | 8.00 | 7.80 | **8.00** | V<sub>1</sub>T<sub>2</sub> selected |
| 6     | V<sub>1</sub>T<sub>6</sub> | 6.50 | 6.40 | 6.50 | 6.90 | 6.57 | Not selected |
| 7     | V<sub>1</sub>T<sub>7</sub> | 6.70 | 6.90 | 6.90 | 6.80 | 6.82 | Not selected |

Whereas,  <sup>a</sup>  = Ten replications with 9 point hedonic scale  
V<sub>1</sub> = Sardar guava variety (white flesh)
Table.4 Organoleptic evaluation of fresh Lalith variety guava leather$^a$

| S. No | Treatments | Color and appearance | Flavor | Taste | Texture | Overall acceptability | Selected for further study |
|-------|------------|----------------------|--------|-------|---------|-----------------------|---------------------------|
| 1     | V$_2$T$_1$ | 7.5                  | 8.0    | 7.5   | 7.6     | 7.65                  | Not selected              |
| 2     | V$_2$T$_2$ | 8.7                  | 8.2    | 8.2   | 8.7     | **8.45**              | V$_2$T$_1$ selected        |
| 3     | V$_2$T$_3$ | 8.5                  | 8.2    | 8.5   | 8.0     | 8.30                  | Not selected              |
| 4     | V$_2$T$_4$ | 7.8                  | 8.0    | 8.0   | 7.9     | 7.92                  | Not selected              |
| 5     | V$_2$T$_5$ | 8.5                  | 8.2    | 8.2   | 8.4     | **8.33**              | V$_2$T$_2$ selected        |
| 6     | V$_2$T$_6$ | 7.6                  | 7.9    | 8.3   | 7.6     | 7.85                  | Not selected              |
| 7     | V$_2$T$_7$ | 7.7                  | 8.0    | 8.0   | 7.8     | 7.87                  | Not selected              |

Whereas,

$^a$ = Ten replications with 9 point hedonic scale

V$_2$ = Lalith guava variety (pink flesh)

Table.5 Organoleptic properties of selected fresh guava leathers$^a$

| Treatments | Color and appearance | Flavor | Texture | Taste | Overall acceptability |
|------------|----------------------|--------|---------|-------|-----------------------|
| V$_1$T$_1$ | 8.59                 | 8.46   | 8.39    | 8.64  | 8.53                  |
| V$_1$T$_2$ | 8.14                 | 8.03   | 8.14    | 8.12  | 8.07                  |
| V$_2$T$_1$ | 8.65                 | 8.52   | 8.66    | 8.32  | 8.56                  |
| V$_2$T$_2$ | 8.05                 | 7.80   | 7.90    | 8.13  | 8.37                  |
| SEm+       | 0.022                | 0.019  | 0.022   | 0.016 | 0.018                 |
| CD at 5 %  | 0.068                | 0.059  | 0.068   | 0.049 | 0.055                 |

Whereas, $^a$ = Four replications.

V$_1$: Sardar guava variety (white flesh), V$_2$: Lalith guava variety (Pink flesh)

T$_1$: 750 g sugar + 5 g salt + 2 g citric acid per kg guava pulp

T$_2$: 750 g sugar per kg guava pulp

Table.6 Yield and chemical properties of fresh guava leathers$^a$

| Treatments | Yield (g/kg Pulp) | Moisture (%) | TSS (°Brix) | Titrable acidity (%) | Reducing sugars (%) | Total sugars (%) | Ascorbic acid (mg/100g) | Total cost |
|------------|-------------------|--------------|-------------|----------------------|--------------------|-----------------|------------------------|------------|
| V$_1$T$_1$ | 625.76            | 15.29        | 76.10       | 0.541                | 14.32              | 68.72           | 125.28                 | 135.55     |
| V$_1$T$_2$ | 618.06            | 15.12        | 76.00       | 0.462                | 14.12              | 68.23           | 127.30                 | 135.00     |
| V$_2$T$_1$ | 624.00            | 16.75        | 75.85       | 0.490                | 14.19              | 68.47           | 71.81                  | 155.55     |
| V$_2$T$_2$ | 617.00            | 16.27        | 75.85       | 0.412                | 12.92              | 68.28           | 73.34                  | 155.00     |
| SEm+       | 1.711             | 0.024        | 0.036       | 0.0011               | 0.014              | 0.010           | 0.127                  | -          |
| CD at 5 %  | NS                | 0.073        | NS          | NS                   | 0.045              | 0.032           | NS                     | -          |

Whereas, $^a$ = Four replications.

V$_1$: Sardar guava variety (white flesh), V$_2$: Lalith guava variety (Pink flesh)

T$_1$: 750 g sugar + 5 g salt + 2 g citric acid per kg guava pulp

T$_2$: 750 g sugar per kg guava pulp.
Table 8: Texture analysis of guava leathers

| Treatments | Colour and appearance | Flavour | Texture | Taste | Overall acceptability |
|------------|-----------------------|---------|---------|-------|-----------------------|
| Variety    |                       |         |         |       |                       |
| V₁         | 8.36                  | 8.24    | 8.27    | 8.38  | 8.30                  |
| V₂         | 8.35                  | 8.16    | 8.28    | 8.22  | 8.46                  |
| SEm(±)     | 0.015                 | 0.013   | 0.015   | 0.011 | 0.012                 |
| CD @ 5%    | NS                    | 0.041   | NS      | 0.035 | 0.039                 |
| Treatments |                       |         |         |       |                       |
| T₁         | 8.62                  | 8.49    | 8.52    | 8.48  | 8.54                  |
| T₂         | 8.09                  | 7.92    | 8.02    | 8.13  | 8.22                  |
| SEm(±)     | 0.015                 | 0.013   | 0.015   | 0.011 | 0.012                 |
| CD @ 5%    | 0.048                 | 0.041   | 0.048   | 0.035 | 0.039                 |
| Two factor interaction |     |         |         |       |                       |
| V₁T₁       | 8.59                  | 8.46    | 8.39    | 8.64  | 8.53                  |
| V₁T₂       | 8.14                  | 8.03    | 8.14    | 8.12  | 8.07                  |
| V₂T₁       | 8.65                  | 8.52    | 8.66    | 8.32  | 8.56                  |
| V₂T₂       | 8.05                  | 7.80    | 7.90    | 8.13  | 8.37                  |
| SEm(±)     | 0.022                 | 0.019   | 0.022   | 0.016 | 0.018                 |
| CD @ 5%    | 0.068                 | 0.050   | 0.068   | 0.049 | 0.055                 |

Whereas,
AT= Ambient temperature, RT= Refrigerated temperature
V₁: Sardar guava variety (white flesh), V₂: Lalith guava variety (Pink flesh)
T₁: 750 g sugar + 5 g salt + 2 g citric acid per kg guava pulp
T₂: 750 g sugar per kg guava pulp.
**Table 9** Effect of storage period on organoleptic properties of fresh guava leathers at 0 days storage

| Treatments | Colour and appearance | Flavour | Texture | Taste | Overall acceptability |
|------------|-----------------------|---------|---------|-------|-----------------------|
| **Variety** |                       |         |         |       |                       |
| V<sub>1</sub> | 8.36                  | 8.24    | 8.27    | 8.38  | 8.30                  |
| V<sub>2</sub> | 8.35                  | 8.16    | 8.28    | 8.22  | 8.46                  |
| SEm(±)     | 0.015                 | 0.013   | 0.015   | 0.011 | 0.012                 |
| CD @ 5%    | NS                    | 0.041   | NS      | 0.035 | 0.039                 |
| **Treatments** |                     |         |         |       |                       |
| T<sub>1</sub> | 8.62                  | 8.49    | 8.52    | 8.48  | 8.54                  |
| T<sub>2</sub> | 8.09                  | 7.92    | 8.02    | 8.13  | 8.22                  |
| SEm(±)     | 0.015                 | 0.013   | 0.015   | 0.011 | 0.012                 |
| CD @ 5%    | 0.048                 | 0.041   | 0.048   | 0.035 | 0.039                 |
| **Two factor interaction** |             |         |         |       |                       |
| V<sub>1</sub>T<sub>1</sub> | 8.59                  | 8.46    | 8.39    | 8.64  | 8.53                  |
| V<sub>1</sub>T<sub>2</sub> | 8.14                  | 8.03    | 8.14    | 8.12  | 8.07                  |
| V<sub>2</sub>T<sub>1</sub> | 8.65                  | 8.52    | 8.66    | 8.32  | 8.56                  |
| V<sub>2</sub>T<sub>2</sub> | 8.05                  | 7.80    | 7.90    | 8.13  | 8.37                  |
| SEm(±)     | 0.022                 | 0.019   | 0.022   | 0.016 | 0.018                 |
| CD @ 5%    | 0.068                 | 0.050   | 0.068   | 0.049 | 0.055                 |

A=Ambient (25±2 °C), R=Refrigerated (5±2 °C)
V<sub>1</sub> Sardar guava variety (white flesh), V<sub>2</sub> Lalith guava variety (Pink flesh).
T<sub>1</sub>: 750g sugar + 5g salt + 2g citric acid per kg guava pulp, T<sub>2</sub>: 750g sugar per kg guava pulp.
### Table 10: Effect of storage period on organoleptic properties of guava leather at 30 days storage

| Treatments | Colour and appearance | Flavour | Texture | Taste | Overall acceptability |
|------------|-----------------------|---------|---------|-------|------------------------|
|            | A | R | A | R | A | R | A | R | A | R |
| Variety    |   |   |   |   |   |   |   |   |   |   |
| V₁         | 7.89 | 8.20 | 7.75 | 7.90 | 7.93 | 8.02 | 8.00 | 8.22 | 7.89 | 8.03 |
| V₂         | 7.93 | 7.93 | 7.79 | 7.97 | 7.86 | 8.08 | 8.10 | 8.18 | 8.11 | 8.23 |
| SEm(±)     | 0.012 | 0.015 | 0.019 | 0.018 | 0.015 | 0.010 | 0.019 | 0.020 | 0.016 | 0.016 |
| CD @ 5%    | 0.038 | 0.048 | NS | 0.058 | 0.047 | 0.030 | 0.061 | NS | 0.049 | 0.050 |
| Treatments |   |   |   |   |   |   |   |   |   |   |
| T₁         | 8.18 | 8.41 | 8.05 | 8.19 | 8.03 | 8.23 | 8.28 | 8.43 | 8.14 | 8.33 |
| T₂         | 7.64 | 7.72 | 7.48 | 7.67 | 7.76 | 7.87 | 7.81 | 7.97 | 7.86 | 7.93 |
| SEm(±)     | 0.012 | 0.015 | 0.019 | 0.018 | 0.015 | 0.010 | 0.019 | 0.020 | 0.016 | 0.016 |
| CD @ 5%    | 0.038 | 0.048 | 0.060 | 0.058 | 0.047 | 0.030 | 0.061 | 0.063 | 0.049 | 0.050 |
| Two factor interaction |   |   |   |   |   |   |   |   |   |   |
| V₁T₁       | 8.12 | 8.56 | 7.97 | 8.08 | 8.04 | 8.12 | 8.45 | 8.61 | 8.13 | 8.33 |
| V₁T₂       | 7.66 | 7.83 | 7.53 | 7.71 | 7.82 | 7.92 | 7.54 | 7.82 | 7.66 | 7.73 |
| V₂T₁       | 8.24 | 8.25 | 8.14 | 8.30 | 8.02 | 8.34 | 8.12 | 8.25 | 8.16 | 8.34 |
| V₂T₂       | 7.62 | 7.62 | 7.44 | 7.63 | 7.70 | 7.82 | 8.08 | 8.12 | 8.06 | 8.12 |
| SEm(±)     | 0.017 | 0.023 | 0.027 | 0.026 | 0.021 | 0.014 | 0.028 | 0.029 | 0.022 | 0.023 |
| CD @ 5%    | 0.054 | 0.066 | 0.085 | 0.082 | 0.066 | 0.043 | 0.086 | 0.089 | 0.070 | 0.071 |

A=Ambient (25±2 °C), R=Refrigerated (5±2 °C)

V₁: Sardar guava variety (white flesh), V₂: Lalith guava variety (Pink flesh).
T₁: 750g sugar + 5g salt + 2g citric acid per kg guava pulp, T₂: 750g sugar per kg guava pulp.
Table 11: Effect of storage period on organoleptic properties of guava leather at 60 days storage

| Treatments     | Colour and appearance | Flavour  | Texture  | Taste  | Overall acceptability |
|----------------|-----------------------|----------|----------|--------|-----------------------|
|                | A         | R       | A        | R      | A        | R        | A         | R         |
| Variety        |           |          |          |        |          |          |           |           |
| V₁             | 7.66      | 8.06    | 7.22     | 7.43   | 7.72     | 7.90     | 7.68      | 8.13      | 7.59      | 7.97      |
| V₂             | 7.78      | 7.76    | 7.59     | 7.73   | 7.59     | 7.83     | 7.95      | 8.18      | 7.82      | 8.06      |
| SEm(±)         | 0.012     | 0.014   | 0.021    | 0.011  | 0.008    | 0.011    | 0.014     | 0.011     | 0.013     | 0.009     |
| CD @ 5%        | 0.038     | 0.045   | 0.066    | 0.035  | 0.025    | 0.035    | 0.044     | 0.036     | 0.041     | 0.029     |
| Treatments     |           |          |          |        |          |          |           |           |
| T₁             |           |          |          |        |          |          |           |           |
| T₂             |           |          |          |        |          |          |           |           |
| SEm(±)         |           |          |          |        |          |          |           |           |
| CD @ 5%        |           |          |          |        |          |          |           |           |
| Two factor interaction | V₁T₁  | 8.00    | 8.33    | 7.39   | 7.62    | 7.82    | 7.98    | 8.02    | 8.63   | 7.84    | 8.40   |
| V₁T₂           | 7.32     | 7.78    | 7.05   | 7.24   | 7.63    | 7.83    | 7.35    | 7.64   | 7.35   | 7.55   |
| V₂T₁           | 8.12     | 8.11    | 7.86   | 7.94   | 7.79    | 8.03    | 8.08    | 8.24   | 7.90   | 8.10   |
| V₂T₂           | 7.44     | 7.42    | 7.32   | 7.53   | 7.39    | 7.64    | 7.81    | 8.12   | 7.75   | 8.02   |
| SEm(±)         | 0.017    | 0.021   | 0.030  | 0.016  | 0.011   | 0.016   | 0.020   | 0.016  | 0.019  | 0.013  |
| CD @ 5%        | NS       | 0.064   | 0.094  | NS     | 0.035   | 0.049   | 0.063   | 0.051  | 0.059  | 0.041  |

A=Ambient (25±2 °C), R=Refrigerated (5±2 °C)
V₁: Sardar guava variety (white flesh), V₂: Lalith guava variety (Pink flesh).
T₁: 750g sugar + 5g salt + 2g citric acid per kg guava pulp, T₂: 750g sugar per kg guava pulp.
Table 12: Effect of storage period on organoleptic properties of guava leather at 90 days storage

| Treatments               | Colour and appearance | Flavour | Texture | Taste | Overall acceptability |
|--------------------------|-----------------------|---------|---------|-------|-----------------------|
|                          | A  | R | A  | R | A  | R | A  | R | A  | R |
| Variety                  |    |   |    |   |    |   |    |   |    |   |
| V₁                        | 7.33 | 7.72 | 7.24 | 7.43 | 7.40 | 7.64 | 7.52 | 8.13 | 7.40 | 7.73 |
| V₂                        | 7.58 | 7.87 | 7.87 | 7.82 | 7.72 | 7.97 | 7.47 | 7.83 | 7.67 | 7.83 |
| SEm(±)                   | 0.012 | 0.009 | 0.013 | 0.011 | 0.012 | 0.019 | 0.009 | 0.012 | 0.014 | 0.014 |
| CD @ 5%                  | 0.039 | 0.030 | 0.041 | 0.035 | 0.038 | 0.059 | 0.027 | 0.038 | 0.043 | 0.044 |
| Treatments               |    |   |    |   |    |   |    |   |    |   |
| T₁                        | 7.68 | 8.02 | 7.73 | 7.78 | 7.65 | 7.99 | 7.71 | 8.28 | 7.72 | 8.00 |
| T₂                        | 7.23 | 7.57 | 7.39 | 7.47 | 7.47 | 7.62 | 7.28 | 7.68 | 7.35 | 7.56 |
| SEm(±)                   | 0.012 | 0.009 | 0.013 | 0.011 | 0.012 | 0.019 | 0.009 | 0.012 | 0.014 | 0.014 |
| CD @ 5%                  | 0.039 | 0.030 | 0.041 | 0.035 | 0.038 | 0.059 | 0.027 | 0.038 | 0.043 | 0.044 |
| Two factor interaction   |    |   |    |   |    |   |    |   |    |   |
| V₁T₁                     | 7.64 | 8.03 | 7.43 | 7.62 | 7.47 | 7.74 | 7.90 | 8.63 | 7.66 | 7.98 |
| V₁T₂                     | 7.03 | 7.42 | 7.06 | 7.24 | 7.34 | 7.53 | 7.14 | 7.64 | 7.13 | 7.47 |
| V₂T₁                     | 7.72 | 8.02 | 8.02 | 7.94 | 7.84 | 8.23 | 7.52 | 7.92 | 7.78 | 8.02 |
| V₂T₂                     | 7.44 | 7.73 | 7.73 | 7.70 | 7.60 | 7.70 | 7.42 | 7.73 | 7.56 | 7.65 |
| SEm(±)                   | 0.018 | 0.013 | 0.019 | 0.016 | 0.017 | 0.027 | 0.012 | 0.017 | 0.020 | 0.020 |
| CD @ 5%                  | 0.055 | 0.042 | NS   | 0.049 | 0.054 | 0.083 | 0.039 | 0.054 | 0.062 | 0.062 |

A=Ambient (25±2 °C), R=Refrigerated (5±2 °C)
V₁: Sardar guava variety (white flesh), V₂: Lalith guava variety (Pink flesh).
T₁: 750g sugar + 5g salt + 2g citric acid per kg guava pulp, T₂: 750g sugar per kg guava pulp
Plate.1 Sardar guava leather at 0 days storage

Plate.2 Lalith guava leather at 0 days storage

1-2, Ambient temperature (27 ± 2°C)
3-4, Refrigerated temperature (7 ± 2°C)

The maximum score 8.27 was observed in V₂T₁ sample stored at refrigerated temperature.

The score for texture decreased significantly during storage at ambient temperature than stored at refrigerated temperature. A gradual decrease in texture score is due to hardening effect resulting from loss of moisture during storage.

Similar results were obtained in various experiments performed earlier on sweet potato leather (Collins and Hutsell, 1987),
jack fruit leather (Che Man and Taufik, 1995), fig and other fruit products (Doreyappa Gowda et al., 1995). Guava –papaya fruit bar (Vennilla et al., 2004), fig leather (Kotlawar, 2008) and high protein tamarind leather (Kharche, 2012). The results obtained in the present investigation for guava leathers are in agreement with literature.

**Taste**

The results on taste score of guava leather samples are presented in Tables 9-12. A gradual decrease in score for taste of guava leathers from 8.30 to 7.49 at ambient temperature and from 8.30 to 7.98 at refrigerated temperature was observed. The taste deterioration was more in guava leathers at ambient condition than at refrigerated temperature. The guava leather samples of $V_2T_1$ at refrigerated temperature gave maximum taste score 8.60 in comparison with other treatments. This might be due to proper blending of sugar and acidity as well as consistency of the guava leather. Both conditions of storage for guava leather samples gave acceptable taste score.

It is reported that the taste score decreased during storage with respect to storage condition and period of storage, in sweet potato leather (Collins and Hutsell, 1987), jack fruit leather (Che Man and Taufik, 1995), guava –papaya fruit bar (Vennilla et al., 2004) and fig leather (Kotlawar, 2008).

The results obtained in the present investigation for taste score in guava leathers are in agreement with literature.

**Overall acceptability**

The results on overall acceptability score of guava leathers influenced by storage condition and period with respect to various treatments are presented in Tables 9-12. A gradual decrease in overall acceptability score from 8.38 to 7.53 at ambient temperature and from 8.38 to 7.78 at refrigerated temperature. It was observed that decrease in overall acceptability score at ambient temperature was faster than at refrigerated temperature.

The maximum score of 8.00 was observed in treatment $V_2T_1$ stored at refrigerated temperature.

The highest overall acceptability score was observed in guava leathers stored at refrigerated temperature than at ambient temperature. It may be due to faster deterioration in terms of color, flavor, texture and taste at higher temperature during ambient condition. It is reported that the overall acceptability score decrease during storage with respect to the storage condition and period.

Previous researchers have shown that the decrease in overall acceptability in case of papaya leather (Harvey and Cavaletto, 1978), mango fruit bar (Doreyappa Gowda et al., 1994), jack fruit leathers (Che Man and Taufik, 1995), guava-papaya fruit bar (Vennilla et al., 2004) and mango leather (Gill et al., 2004).

**Texture analysis of guava leathers**

The Texture analysis of guava leathers was done at initial 0 days storage and final after 90 days storage by using the available Shimazdu Texturometer. The force in (N) used to break down the individual leather is recorded separately. The results obtained are presented in Table 8. Results obtained stated that more force was used to break the fresh leather and less force was used after 90 days storage. It may be all due to increase in crystallization of sugar within increase in storage period.
Economics for making guava leathers

The results on production cost of guava leathers are presented in Table 6. The cost of production of 1 kg guava (white flesh) leather of treatment T₁ was Rs.135.55 and for treatment T₂ Rs.135.00 only.

Whereas, the cost of production of 1 kg guava (pink flesh) leather was of treatment T₁ was Rs.155.55 and for treatment T₂ Rs.155.00 only. These costs did not include rent, transport charges, sale commission, local taxes etc. However, there was no significant difference in cost of guava leathers making among the treatments. The costs are for laboratory (small scale) preparation of guava leathers. These may be still reduced during mechanization of the process for mass production.

From the results of this research it was concluded that in physicochemical analysis, guava leather prepared with treatment T₁ (750g sugar + 5g salt + 2g citric acid per kg guava pulp) showed better organoleptic properties as well as good storage stability at both storage (ambient and refrigerated) conditions up to 3 months storage period. Microbial results also stated that product was safe to consume even after 3 months at both storage temperatures.

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