Studies on physical attributes and processing suitability of sapota cultivars

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Received: 01-12-2018 Accepted: 08-01-2019
DOI: 10.18805/IJARe.A-5183

ABSTRACT

Sapota (Manilkara achras L.) is one of the major crops of India, commonly known as Chikoo and has good nutritional properties. The physical properties of two varieties of sapota viz. cricket ball and kallipati were determined to facilitate the designing of grading machines. It was found that the average weight and values of length, breadth and thickness for cricket ball were 51.63g, 41.7mm, 46.2mm and 46.3mm whereas for kallipati they were 58.13g, 46.9 mm, 46.8 and 47.0mm respectively. The TSS values for cricket ball was 26.25 and for kallipati 25.37°B and their respective acidity were 0.16% and 0.18%. Jam was prepared from two varieties of sapota viz. cricket ball and kallipati to determine their processing suitability. The sensory evaluation of the samples revealed that the jam prepared from cricket ball variety obtained higher overall acceptability scores (7.86) on a 9 point hedonic scale owing to the higher values for appearance and taste. The B:C ratio for sapota jam was found to be 1.87 showing its viability for processing the fruit into jam.

Key words: Economics, Gravimetric properties, Jam making, Physical properties, Sapota.

INTRODUCTION

Sapota (Manilkara achras Mill Fosberg) is an important fruit crop of tropical India. It is also known as chikoo or sapodilla in India. India is considered to be largest producer of sapota in world occupying an area of 107 thousand hectares with an annual production of 1294 thousand MT (Anonymous, 2016). It is commercially grown in south Indian states like Gujarat, Maharashtra, Karnataka, Tamil Nadu, Andhra Pradesh and Kerala where it flowers and produces fruits throughout the year. But under subtropical regions like Punjab and Haryana it is successfully grown in higher elevation or sub-mountainous regions and produces one crop in a year. The cultivation of sapota is gaining popularity due to hardy nature, low production cost and less susceptible to disease and pest. In Punjab, sapota can be successfully grown in Roopnagar, Mohali, Pathankot, Hoshiarpur, and Patiala districts (Anonymous, 2017). Sapota is mainly cultivated for its fruit value in India. It is a good source of digestible sugars (12-14%) and contains appreciable amounts of protein, fat, fibre, and ascorbic acid. It is also good source of minerals like calcium, phosphorus and iron (Ugalat et al., 2012). It is rich in bioactive compounds and high in antioxidant activity (Moo-Huchin et al., 2014 and Ribeiro da Silva et al., 2014). Sapota fruits have very poor shelf life as compared to other fruits (Diaz-Perez et al., 2000). Proper handling, grading and packaging interventions can go a long way in extending its shelf life for which knowledge of the various physical and mechanical properties of the fruit is mandatory for designing of equipment (Rehal et al., 2017).

Moreover, there is need to develop some low cost technologies to process fruits into value added products to reduce post harvest losses which can help farmers in getting good returns for their produce and can improve acceptability in the market. In view of above, a study was conducted to know about the various physical properties of two popular varieties grown in the region and explore the possibility of using them for preparation of jam and analyze its acceptability.

MATERIALS AND METHODS

Two varieties of sapota fruit namely, Kallipati and Cricket ball were obtained from the department of Fruit Science, Punjab Agricultural University, Ludhiana for the year 2016 (Fig 1). Random sampling was done to obtain a representative sample of the harvested produce. The bruised and diseased fruits were sorted out and only sound fruits were selected for the study. The total soluble solids (TSS) content was determined with Erma Hand Refractometer (0-32°B), TitraTable Acidity (TA) was determined by using the method described by Hortzwiz (1960).

\[
\text{TA} (%) = \frac{N/10 \times 0.0067 \times 100}{\text{Volume of sample used}}
\]

Physical parameters: Fifty fruits of each cultivar were randomly selected and length, width and thickness of each fruit was measured using a digital Vernier caliper (Mitutoyo, model Absolute Digimatic, Japan) precision 0.01mm. The measurement of length (l) was made on the polar axis of fruit i.e. from the calyx to the pedicel, the diameter (w) and equatorial width (t) perpendicular to major axis.
weight of the fruit was recorded on a digital balance with an accuracy of 0.001g. The geometric, arithmetic and harmonic mean diameters were evaluated as per (Mohsenin, 1980).

Geometric Mean Diameter, $D_g = (btl)^{1/3}$  
Arithmetic Mean Diameter, $D_a = (b+t+l)/3$  
Harmonic Mean Diameter, $D_h = n/(1/b+1/t+1/l)$

The sphericity ($\phi$) of the fruit was evaluated using the equation as given by Khazaei et al. (2008).

$$ \phi = D_g/b $$

Surface area: The surface area was calculated on the basis of geometric shape of the fruit. For the sapota fruit it was calculated using the formula

$$ S_f = \pi (D_R)^2 $$

where $D_R$ is the geometric mean diameter

**Gravimetric parameters:** The sapota fruits was put into 4 cylindrical containers with known weights and volumes (Dash et al., 2008). Bulk density ($D_b$) was calculated from the mass of bulk material divided by volume containing the mass. The fruits true density ($D_t$) was determined using the water displacement method. The porosity ($\epsilon$) of the fruit samples was calculated based on bulk density and true density, following the equation as reported by Nazari et al., (2008).

$$ \epsilon = 1 - \left( \frac{D_b}{D_t} \right) \times 100 $$

where, $\epsilon$ is porosity; $D_b$ is bulk density; $D_t$ is true density.

**Product preparation:** The sapota pulp was extracted after peeling the fruits, separating the seeds and maceration of the pulp to obtain a smooth consistency. The ratio of 45:55 was taken for fruit pulp and sugar with addition of 0.5% each of pectin and citric acid. Sodium benzoate was added in recommended levels in the finished product. Jam was stored for four months and evaluated for pH, acidity, TSS and organoleptic evaluation. Flow diagram of the process is given in Fig 2.

Total acidity was determined through method of AOAC, (2007) by taking 10g sample of sapodilla jam dissolving in 100mL and then titrate it against 0.1 N NaOH solutions till the appearance of pink end point. Soluble solids was measured at 20°C by hand held refractometer expressed in Brix (AOAC, 2007). For pH determination 50g sapodilla jam was taken in beaker and digital pH meter was used according to the method described in AOAC, 2007.

**Sensory evaluation:** The jam prepared from the two cultivars of sapota *viz.* Kallipati and Cricket ball was subjected to sensory evaluation by a semi-trained panel on a 9-point hedonic scale for evaluating its acceptability (Larmond, 1977).

**Statistical analysis:** The experimental data was analysed by randomised block design using OPSTAT software (Sheoran, 1998).

**RESULTS AND DISCUSSION**

**Physical and gravimetric parameters:** The dimensional characteristics are important for designing mechanism for harvesting, storage and transportation. (Erod’gan et al., 2003). The geometric properties such as length, breadth and thickness, geometric mean diameter (GMD), arithmetic mean diameter (AMD), harmonic mean diameter (HMD), surface area and specific surface area are tabulated in Table 1. The breadth and thickness of both the cultivars was at par with
Table 1: Physical and gravimetric parameters of two cultivars of sapota.

| Parameters        | Kallipati | Cricket ball |
|-------------------|-----------|--------------|
| Length (mm)       | 54.04±3.74| 49.44±3.37   |
| Max.              | 49.44     | 51.67±3.37   |
| Min.              | 40.81     | 40.7±4.03    |
| Breadth (mm)      | 56.67±4.26| 57.58±4.07   |
| Max.              | 57.58     | 54.16±3.30   |
| Min.              | 38.98     | 40.02±4.45   |
| Thickness (mm)    | 58.09±4.26| 60.34±4.01   |
| Max.              | 60.34     | 46.18±4.15   |
| Min.              | 37.78     | 40.61±4.45   |
| GMD (mm)          | 55.16±3.51| 54.91±3.30   |
| Max.              | 54.91     | 44.40±3.35   |
| Min.              | 39.54     | 44.40±3.30   |
| Sphericity (%)    | 1.06±0.03 | 1.05±0.04    |
| Max.              | 1.06      | 0.96±0.04    |
| Min.              | 0.91      | 0.89±0.04    |
| AMD (mm)          | 55.46±4.03| 58.75±4.03   |
| Max.              | 58.75     | 46.17±4.45   |
| Min.              | 40.18     | 44.40±3.35   |
| HMD (mm)          | 55.31±4.45| 54.80±4.16   |
| Max.              | 54.80     | 44.47±3.28   |
| Min.              | 39.64     | 44.47±3.28   |
| S area (mm²)      | 9563.79±1047.73 | 9477.68±1034.31 |
| Max.              | 9477.68   | 6230.38±980.57 |
| Min.              | 4914.92   | 5704.31      |
| Mass (g)          | 94.98±13.02| 93.19±11.55  |
| Max.              | 93.19     | 51.63±11.55  |
| Min.              | 37.03     | 44.40±11.55  |
| BD (kg/m³)        | 519.31±17.02| 501.74±15.30 |
| Max.              | 501.74    | 465.54±31.40 |
| Min.              | 485.45    | 445.71       |
| TD (kg/m³)        | 964.71±73.00| 969.23±73.00 |
| Max.              | 969.23    | 977.89±15.30 |
| Min.              | 898.18    | 977.89       |
| Porosity(%)       | 57.31±6.77| 53.99±2.44   |
| Max.              | 53.99     | 52.42±2.44   |
| Min.              | 44.1      | 52.42±2.44   |

± SD are Standard Deviation; means with same superscripts in a row are not statistically different (p<0.05%).

Table 2: Sensory scores of the jam prepared from two cultivars of sapota.

| Cultivar     | Parameters               | Color | Taste | Texture | Flavor | Overall acceptability |
|--------------|--------------------------|-------|-------|---------|--------|-----------------------|
| Kallipati    |                          | 7.57±0.53 | 7.29±1.11 | 7.00±1.15 | 7.14±0.69 | 7.00±0.82          |
| Cricket ball |                          | 7.86±0.69 | 7.71±0.95 | 7.43±0.97 | 7.43±0.79 | 7.86±0.69          |

Means with same superscripts in a column are not statistically different (p<0.05%).

Table 3: Storage studies of the jam prepared from sapota.

| Cultivar     | Parameter | 0   | 1   | 2   | 3   | 4   |
|--------------|-----------|-----|-----|-----|-----|-----|
| Kallipatti   | TSS(°B)   | 68.5 | 68.5 | 68.7 | 69.8 | 69.9 |
|              | pH        | 2.89 | 2.87 | 2.85 | 2.83 | 2.82 |
|              | Acidity (%)| 1.12 | 1.13 | 1.15 | 1.20 | 1.20 |
|              | Overall acceptability | 7.00 | 7.00 | 6.89 | 6.85 | 6.80 |
|              | Visual changes | Attractive color, no fungal growth | Attractive color, no fungal growth | Dulled color, no fungal growth | Darkened color, no fungal growth | Darkened color, no fungal growth |
| Cricket ball | TSS(°B)   | 68.45 | 68.6 | 68.72 | 68.7 | 68.9 |
|              | pH        | 3.19 | 3.15 | 3.07 | 3.0 | 2.97 |
|              | Acidity (%)| 1.11 | 1.12 | 1.16 | 1.2 | 1.2 |
|              | Overall acceptability | 7.86 | 7.85 | 7.81 | 7.81 | 7.68 |
|              | Visual changes | Attractive color, no fungal growth | Attractive color, no fungal growth | Attractive color, no fungal growth | Attractive color, no fungal growth | Darkened color, no fungal growth |

Table 4: Economics of the sapota jam.

| Particulars                      | Rupees |
|----------------------------------|--------|
| Cost of Sapota fruits @ 10/kg    | 1000   |
| Cost of Sugar@ Rs 30/kg          | 300    |
| Citric acid@Rs 200/kg            | 10     |
| Pectin@ Rs 500/100g              | 50     |
| Jam bottle@ Rs 10 per bottle     | 300    |
| Labour charges@ Rs 300/day       | 150    |
| Fuel charges@Rs 5/kg             | 50     |
| Total cost                       | 960    |
| Gross return                     | 1800   |
| Net return                       | 840    |
| B: C ratio                       | 1.87   |

Each other whereas the length of Kallipati was significantly greater than that of cricket ball. This is evident from the sphericity values of both the cultivars. The sphericity of the grain is an index of its roundness. The surface area values of Kallipati were greater than that of cricket ball but are less than that reported by Ganjyal et al., 2003.

Gravimetric properties are important for the design of the packaging material and transportation system. It is recorded that the average weight of Kallipati (58.14 g) and cricket ball (51.63 g) varied from each other significantly and was less than that reported by Ganjyal et al., (2003). The bulk density and true density is 680.14 kg/m³ and 750 kg/m³. The porosity is reported as 0.09.
The TSS values for cricket ball was 26.25 and for Kallipati 25.37 and their respective acidity were 0.16% and 0.18%.

The results of the sensory analysis of sapota jam made from both the cultivars are tabulated in Table 2. They reveal that the scores for color, texture and flavor of the jam from Kallipati and cricket ball do not vary from each other significantly whereas cricket ball jam obtained significantly higher scores for texture and overall acceptability as compared to Kallipati jam.

**Storage studies:** The jam from both the varieties were stored under ambient temperatures and the quality was evaluated by visual, chemical and sensory analysis every 30 days and the results are tabulated under Table 3. The results show that there is an increase in the TSS content of the jam with increase in storage time which might be a result of hydrolysis of pectin due to the presence of acids. Similar results were reported by Khan et al., (2012) for strawberry jam, Ehsan et al., (2002) for watermelon lemon jam. The increase in storage period also showed an increase in the acidity percent and a subsequent decrease in the pH of the jam of both cultivars. The oxidative changes might be responsible for the increased acidity whereas the breakdown of organic acids might be the cause of decreasing pH of the jam. The present findings are in line with the work of Sogi and Singh, (2001) who reported an increase in percent acidity (0.65% - 0.70%) of apricot jam during storage period. The scores for the overall acceptability of the jam showed a decrease probably due to the darkening of jam due to oxidative changes which resulted in lower scores for color, however, the scores for jams of both cultivars remained above the acceptability level during the storage period studied. Similar results were quoted by Bhardwaj et al., (2016) for guava jamun jam. The visual observation of the jam showed no visible microbial growth during the study period though there was a progressive darkening of jam, more so for the Kallipatti cultivar.

The economics of the jam was calculated and tabulated under Table 4. The cost of both the cultivars is taken as same as they fetch the same price in the market. The results showed a B:C ratio of 1.87 which shows that it is a viable and profitable venture to add value to the fruit which helps in preservation, shelf life extension, providing variety and increase in income to the processor. Economics of mixed fruit jam prepared by Rangre et al., (2017) also showed similar results.

**CONCLUSION**

It can be concluded that among the two cultivars of sapota, Kallipati had a greater mass, bulk density, surface area than cricket ball cultivar. The jam prepared from Cricket ball obtained higher overall acceptability scores than Kallipati though the scores for Kallipati jam were also acceptable. The economics of the jam from sapota fruit showed that it is more remunerative to prepare jam from sapota to get better returns from the produce.

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