Physical Properties of Jamun Fruit (*Syzygium cumini* L.)

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Abstract

The physical properties of Jamun fruits (*Syzygium cumini* L.) were determined. The wet basis moisture content of Jamun fruits was found to be 71.11%. The fresh fruit weight, size, arithmetic mean diameter, sphericity, surface area, bulk density, true density, porosity, pulp content and seed content were varied in the range 3.09 to 6.35 g, 16.06 to 24.07 mm, 16.71 to 24.21 mm, 0.81 to 0.95, 86.5 to 181.92 mm², 0.464 to 0.507 g/cc, 0.83 to 1.25 g/cc, 41.05 to 60.65 %, 53.15 to 80.27 % and 17.32 to 38.44 %, respectively. This study showed considerable variation in some physical properties of Jamun fruit. These properties can be useful in design and fabrication of handling, transporting, and processing and storage equipment of Jamun fruit.

Keywords: Jamun fruit, physico-chemical properties, value added products.

1. Introduction

Jamun (*Syzygium cumini* L.) is an important underutilized tropical fruit that grows widely in different agro-climatic conditions in India belonging to the family Myrtaceae (Vijayanand *et al*., 2001). The pulp of Jamun is highly nutritive and contains important minerals like sodium, potassium, calcium, phosphorous, iron, and zinc; water-soluble vitamins like ascorbic acid, thiamine, and niacin; carbohydrates like glucose, mannose, sucrose, maltose, fructose, galactose, and mannose; free amino acids like alanine, asparagine, tyrosine, glutamine, and cysteine (Paul and Shaha, 2004).

Jamun fruits are unique in that they constitute a set of properties and characteristics, which distinguish them from all major fruits. Jamun has significance as a stable food as well as an ornamental fruit plant, whilst its use in Jamun products and industrial applications could be increased. According to variety and growth conditions, Jamun fruit varies in shape, size, and weight. Usually, they are elliptical and ovoid though certain varieties may reach a nearly round shape. Agricultural materials and food products have several unique characteristics which set them apart from engineering materials. The design of machines and process to harvest, handle and store agricultural materials and to convert these materials into food and feed requires an understanding of their physical properties (Stroshine, 1998).

Physical properties are often required for the development of post-harvest techniques to make them a value-added product. The physical properties of fruits are important in designing and fabricating for handling, transporting, processing and storage, and also for assessing the behavior of the product quality (Kashaninejad *et al*., 2006; Bart-Plange and Baryeh, 2003). Size and shape are often used when describing grains, seeds, fruits and vegetables. The shape and physical dimensions are important in screening solids to separate foreign materials and in sorting and sizing of fruits and vegetables. The product shape can be determined in terms of its sphericity which affects the flowability characteristics of the products. Size and shape determine how many fruits can be placed in shipping containers or plastic bags of a given size. Quality differences in fruits, vegetables, grain, and seeds can often be detected by differences in density.

In the present study, only a few but important properties have been evaluated which are more commonly considered for their greater applicability in assessing the quality of the product. The objective of this study was to determine some physical properties of Jamun fruit in order to facilitate the design of some machines for its processing.

2. Materials and Methods

2.1 Collection of Jamun

Jamun fruit was procured from local market of Akola (India). The samples of fruits were cleaned manually to remove all foreign materials such as dust, dirt, immature fruits etc.
2.2 Moisture Content

The moisture content of the sample was determined by the loss in weight that occurs when a sample was dried in hot air oven. The fruits of 2 to 5 g transferred into an aluminum box covered with a lid. The boxes were uncovered and placed in a hot air oven at 70-75°C for 16 to 18 hr (Ranganna, 1986).

2.3 Weight

Weight (g) of Jamun fruit was measured using an electronic balance with an accuracy of 0.01 g Sartorius BT (2202 S).

2.4 Axial Dimensions

Three principal axes (length, breadth, and thickness) of the fruit were measured with the help of Vernier caliper (Mitutoyo, Japan) having a least count of 0.02 mm.

2.5 Geometric Mean Diameter

The geometric mean diameter ($D_g$) of fruit was calculated by using following formula:

$$D_g = (l \times w \times t)^{\frac{1}{3}} \quad \ldots (1)$$

Where,
- $l$ is a major axial dimension, mm,
- $w$ is an intermediate axial dimension, mm,
- $t$ is a minor axial dimension, mm.

2.6 Arithmetic Mean Diameter

Arithmetic mean diameter ($D_a$) for each Jamun fruit was calculated using following equation (Mohsenin, 1980):

$$D_a = \frac{(1 + w + t)}{3} \quad \ldots (2)$$

2.7 Sphericity

The sphericity ($\Phi$) of fruits was calculated using following formula:

$$\Phi = (1 \times w \times t)^{\frac{1}{3}} \quad \frac{1}{l} \quad \ldots (3)$$

2.8 Surface Area

The surface area of the fruit was calculated by using following formula given by Topuz (2004).

$$S = \pi \times D_g^2 \quad \ldots (4)$$

Where,
- $S$ is surface area, mm$^2$ and $D_g$ is geometric mean diameter, mm.

2.9 Pulp and Seed Percent

The pulp of Jamun was separated from seed and pulp percentage was calculated by using following formula given by Kolekar and Tagad (2012).

$$\text{Pulp content \%} = \frac{W_p}{W_f} \times 100 \quad \ldots (5)$$

Where,
- $W_p$ is the weight of pulp, g and $W_f$ is the weight of fruit.

The seed content (%) was:

$$\text{Seed content \%} = \frac{W_s}{W_f} \times 100 \quad \ldots (6)$$

Where,
- $W_s$ is weight of seed present in fruit, g and $W_f$ is weight of fruit, g.

2.10 Bulk Density of Fruit

Bulk density which is defined as the ratio of the mass of the sample to its container volume was evaluated by weighing a Jamun fruit filled beaker of known weight and volume and calculated by following equation (Baryeh, 2000).

$$\text{Bulk density (g/cm}^3) = \frac{\text{mass (g)}}{\text{volume (cm}^3) \quad \ldots (7)$$

2.11 True Density of Fruits

It is the ratio of the mass of the sample to its true volume. For Jamun fruit, true density was determined by the water displacement method (Abdullah, 2011). The true density was calculated using following equation:

$$\text{True density (g/cm}^3) = \frac{\text{mass of individual fruit (g)}}{\text{volume of individual fruit (cm}^3) \quad \ldots (8)$$

2.12 Porosity

Porosity is a vital physical property that characterizes the amount of air space in a bulk. It is needed in modeling and design of various heat and mass transfer processes. It is defined as the volume fraction of air in the bulk sample and is calculated by the following equation:

$$\varepsilon = \frac{(\rho_t - \rho_b)}{\rho_b} \times 100 \quad \ldots (9)$$

Where,
- $\varepsilon$ is porosity (%), $\rho_t$ is true density (g/cm$^3$) and $\rho_b$ is bulk density (g/cm$^3$).

2.13 Angle of Repose

The angle of repose was determined by standard circular platform method as given by Mohsenin (1980). The angle of repose was calculated by using the formula:
\[ \Phi = \tan^{-1}\left(\frac{2h}{d}\right) \]  
(10)

Where,

- \(\Phi\) is angle of repose in degree,
- \(h\) is height of pile, mm and
- \(d\) is diameter of disc, mm.

2.14 Colour of Fruits

Colour of Jamun fruit was determined by Minolta chromameter (CR-400) in terms of \(L\), \(a\), \(b\) value.

3. Result and Discussion

3.1 Moisture Content

The moisture content of Jamun fruit was found to be 71.11 % (wb).

3.2 Weight of Fruit

The weights of corresponding 50 fruits were recorded with the help of electronic balance with least count 0.01 g. The maximum and minimum weight of fruit was found to be 6.35 and 3.09 g, respectively (Table 1). The average weight of fruits was found to be 4.73 g with standard deviation 0.814.

3.3 Axial Dimension

The three principal of axes (length, breadth, and thickness) of fruit were measured with the help of vernier caliper (Table 1). The maximum and minimum value of length, breadth, and thickness of fruit were found to be 26.61, 23.69, 22.34 and 18.79, 15.9, 14.96, respectively. The average length, breadth, and thickness of fruits were found to be 21.84, 18.27, 17.88 mm with standard deviation 1.706, 1.731, 1.692, respectively.

3.4 Geometric Mean Diameter

The geometric mean diameter of Jamun fruits was determined from the measurement of its axial dimensions i.e. length, width and thickness and results are summarized in (Table 1). The observed geometric mean diameter of fruits was varied in the range of 16.6 to 24.07 mm. The average geometric mean diameter of fruits was found to be 19.18 mm with standard deviation 1.55.

3.5 Arithmetic Mean Diameter

Arithmetic mean diameter of Jamun fruits was calculated from its axial dimensions. The maximum and minimum value of arithmetic mean diameter of fruit was found to be 24.41 and 16.71, respectively (Table 1). An average value of arithmetic mean diameter was found to be 19.33 mm with standard deviation 1.54.

3.6 Sphericity

The sphericity of Jamun fruits was determined with the help of mathematical equation no. 3 summarized results are given in (Table 2). The maximum and minimum value of sphericity of fruit was found to be 0.95 and 0.81, respectively. This property may be used for the design of fruit grader. The average sphericity of Jamun fruit was found to be 0.88 with 0.041 standard deviation.

3.7 Surface Area

The surface area of Jamun was calculated with the help of mathematical equation no. 4 and results are summarized in (Table 2). The maximum and minimum value of the surface area of Jamun fruits was found to be 181.92 mm² and 86.5 mm², respectively. The average surface area of Jamun fruit was found to be 116.22 mm² with 19.59 mm² standard deviation.

3.8 Pulp and Seed Content, %

The pulp content of Jamun fruits was calculated by using mathematical equation no. 5 and result is summarized in Table 2. The edible matter (pulp) was 68.4 % whereas non-edible portion (seed) was 25.79 %. Dutta et al. (1988) stated that presence of seeds in a fruit is considered a merit or demerit. Seed are valued at least in some fruits for certain purpose like Jamun fruit. Experimental evidence provides proof to the fact that the seedless Jamun fruits tend to be less sweet than the seeded fruits. Hence, Jamun seeds can be used for many purposes i.e medicinal, nutritional and food by-product etc.

3.9 Bulk Density

The maximum and minimum value of the bulk density of Jamun fruits was found to be 0.507 g/cm³ and 0.464 g/cm³, respectively. The average bulk density was found to be 0.4892 g/cm³ with 0.017 g/cm³ standard deviation (Table 3).

3.10 True Density

The maximum and minimum values of the true density of Jamun fruits were found to be 1.25 g/cm³ and 0.833 g/cm³, respectively. The average true density was found to be 1.062 g/cm³ with 0.175 g/cm³ standard deviation (Table 3).

3.11 Porosity

The maximum and minimum value of porosity of Jamun fruits was found to be 60.65 % and 41.05 %, respectively. The average porosity of Jamun fruit was found to be 1.062 g/cm³ with 0.175 g/cm³ standard -
Table 1: Variation in weight, axial dimensions, size, and arithmetic mean diameter Jamun fruits

<table>
<thead>
<tr>
<th>Particular</th>
<th>Weight of Fruit, g</th>
<th>Axial dimensions, mm</th>
<th>Geometric mean diameter, mm</th>
<th>Arithmetic mean diameter, mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. Of observation</td>
<td>25</td>
<td>50</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>Max</td>
<td>6.35</td>
<td>26.61</td>
<td>23.69</td>
<td>22.34</td>
</tr>
<tr>
<td>Min</td>
<td>3.09</td>
<td>18.79</td>
<td>15.9</td>
<td>14.96</td>
</tr>
<tr>
<td>Avg</td>
<td>4.73</td>
<td>21.84</td>
<td>18.27</td>
<td>17.88</td>
</tr>
<tr>
<td>SD</td>
<td>0.814</td>
<td>1.706</td>
<td>1.731</td>
<td>1.692</td>
</tr>
<tr>
<td>Var</td>
<td>0.663</td>
<td>2.912</td>
<td>2.996</td>
<td>2.863</td>
</tr>
<tr>
<td>SEM</td>
<td>0.163</td>
<td>0.314</td>
<td>0.346</td>
<td>0.338</td>
</tr>
<tr>
<td>CV, %</td>
<td>17.82</td>
<td>7.813</td>
<td>9.474</td>
<td>9.458</td>
</tr>
</tbody>
</table>

Table 2: Variation in sphericity, surface area, pulp and seed content of Jamun fruits

<table>
<thead>
<tr>
<th>Particulars</th>
<th>Sphericity</th>
<th>Surface Area, mm²</th>
<th>Pulp Content, %</th>
<th>Seed Content, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of observation</td>
<td>25</td>
<td>25</td>
<td>25</td>
<td>25</td>
</tr>
<tr>
<td>Max</td>
<td>0.95</td>
<td>181.92</td>
<td>80.27</td>
<td>38.44</td>
</tr>
<tr>
<td>Min</td>
<td>0.81</td>
<td>86.5</td>
<td>53.15</td>
<td>17.32</td>
</tr>
<tr>
<td>Avg</td>
<td>0.88</td>
<td>116.2</td>
<td>68.4</td>
<td>25.79</td>
</tr>
<tr>
<td>SD</td>
<td>0.041</td>
<td>19.59</td>
<td>6.43</td>
<td>5.24</td>
</tr>
<tr>
<td>Var</td>
<td>0.002</td>
<td>383.9</td>
<td>41.34</td>
<td>27.4</td>
</tr>
<tr>
<td>SEM</td>
<td>0.008</td>
<td>3.919</td>
<td>0.013</td>
<td>1.313</td>
</tr>
<tr>
<td>CV</td>
<td>4.706</td>
<td>16.86</td>
<td>9.39</td>
<td>20.32</td>
</tr>
</tbody>
</table>

Table 3: Bulk density, true density, porosity and angle of repose of Jamun fruit

<table>
<thead>
<tr>
<th>Particulars</th>
<th>Bulk density, g/cm³</th>
<th>True density, g/cm³</th>
<th>Porosity, %</th>
<th>Angle of Repose, deg</th>
<th>Colour</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of observation</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Max</td>
<td>0.507</td>
<td>1.25</td>
<td>60.65</td>
<td>41.87</td>
<td>26.94</td>
</tr>
<tr>
<td>Min</td>
<td>0.464</td>
<td>0.833</td>
<td>41.05</td>
<td>39.61</td>
<td>20.18</td>
</tr>
<tr>
<td>Avg</td>
<td>0.4892</td>
<td>1.062</td>
<td>52.99</td>
<td>40.61</td>
<td>24.548</td>
</tr>
<tr>
<td>SD</td>
<td>0.017</td>
<td>0.175</td>
<td>8.042</td>
<td>1.033</td>
<td>1.464</td>
</tr>
<tr>
<td>Var</td>
<td>0.000</td>
<td>0.031</td>
<td>64.68</td>
<td>1.067</td>
<td>2.709</td>
</tr>
<tr>
<td>SEM</td>
<td>0.008</td>
<td>0.078</td>
<td>3.597</td>
<td>0.462</td>
<td>0.301</td>
</tr>
<tr>
<td>CV</td>
<td>3.498</td>
<td>16.454</td>
<td>15.17</td>
<td>2.543</td>
<td>6.705</td>
</tr>
</tbody>
</table>

3.10 True Density
The maximum and minimum value of the true density of Jamun fruits was found to be 1.25 g/cm³ and 0.833 g/cm³, respectively. The average true density was found to be 1.062 g/cm³ with 0.175 g/cm³ standard deviation (Table 3).

3.11 Porosity
The maximum and minimum values of porosity of Jamun fruits were found to be 60.65 % and 41.05 %, respectively. The average porosity of Jamun fruit was found to be 52.99 % with 8.042 % standard deviation (Table 3).

3.12 Angle of Repose

3.13 Colour of Fruits
Colour of Jamun fruits was measured in terms of L, a, b value with help of chromameter (CR-400) (Table 3). The maximum and minimum color value in terms of L, a, b of Jamun fruits was found to be 26.94, 5.12, 0.71 and 20.18, -0.02, -0.5, respectively. The average value of L, a and b was found to be 24.548,
1.429 and 0.431, respectively with standard deviation 1.646, 1.217, 0.224, respectively.

4. Conclusions

The study showed considerable variation in some physical properties of Jamun fruit. These properties can be useful for designing and fabricating for handling, transporting, processing and storage and also for assessing the behavior of the product.

References


