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Full Length Research Paper

Physicochemical characteristics of Jamun fruit

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Jamun fruit (*SYZYGIUM CUMINII* L*)* processing in Pakistan is uncommon or still traditional methods are used during its processing and preservation. It becomes imperative to characterize the fruit cultivars with a view to understand the properties that may affect the design to handle its processing. This study was carried out to present basic principles of physical properties of Jamun fruit in order to facilitate its handling and processing. The morphological parameters includes weight, volume, length, diameter, shape, color, firmness/softness, edible and non-edible contents, specific gravity, juice and seed contents. Two prominent cultivars of Jamun, that is, (V1) improved and (V2) indigenous were analyzed. The improved cultivar was found superior in all parameters analyzed whereas indigenous cultivar was found substandard except seed portion which was more in it. The weight, length, width and volume of V1 was determined as 9.55 g, 3.88 cm, 2.98 cm and 7.60 ml whereas V2 was determined as 6.71 g, 2.73 cm, 2.10 cm, and 5.33 ml respectively. Likewise, edible portion was 69.10% whereas non-edible portion was 30.90% in V1. In case of V2, edible portion was determined as 39.19% whereas non-edible portion was 60.81%. These few parameters indicate that V1 is comparatively better than V2. These research findings would be beneficial references for processors, post harvest practitioners and fruit exporters.

Key words: Jamun fruit, varieties, physical and chemical properties, Sindh, Pakistan.

INTRODUCTION

Physical components of fruits refer to those fruits, whose chemical procedure determination is not almost needed. For determining most of the physical components, intact fruits are used. However, in some cases like determination of juice content, pulp color, inedible part, seed content etc, fruit samples are required to be cut into pieces for onward processing. Jamun fruit is a berry consisting of a single seed surrounded by a flashy pulp and the fruit skin. Jamun fruit are unique in that they constitute a set of properties and characteristics, which distinguish them from all major fruits. Jamun have significance as a stable food as well as an ornamental fruit plant, whilst their use in Jamun products and industrial applications could be increased. According to variety and growth conditions, Jamun fruit vary in shape, size and weight. Usually they are elliptical and ovoid though certain varieties may reach a near round shape.

Agricultural materials and food products have several unique characteristics which set them apart from engineering materials. 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. 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 and aspect ratio which affect the flow ability characteristics of the products. Size and shape determine how many fruits can be placed in shipping containers or plastic bags of a given size. The size such as (length, width, thickness and geometric mean diameter) and shape are also important in designing separating, harvesting and sizing etc. Quality differences in fruits, vegetables, grain and seeds can

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often be detected by differences in density. When fruits and vegetables are transported hydraulically, the design fluid velocities are related to both density and shape. Volumes and surface areas of solids must be known for accurate modeling of heat and mass transfer during cooling and drying. The porosity, which is the percentage of airspace in particulate solids, affects the resistance to air flow through bulk solids. Airflow resistance, in turn, affects the performance of systems designed for force convection drying of bulk solids and aeration systems used to control the temperature of stored bulk solids. Knowledge of frictional properties is needed for the designing of handling equipment. Physical properties can be used when designing and sizing machine components (Stroshine, 1998). Also the information is useful in equipment such as cleaning, sorting, grading and kernel removing. Likewise, moisture content is useful information in the drying or dehydration processes either the whole fruit or its byproducts. Fruit part fraction gives an overall idea about the composition of whole fruit and its seed which affect the yield and quality of the product. The fruit length, width and thickness etc. have also been studied for the purpose of estimating further processing *(*Garnayak et al., 2008; Sirisomboon et al., 2007 and Visvanathan et al., 1996*).*

The importance of these dimensions in determining aperture sizes and other parameters in machine design have been discussed by Mohsenin (1980) and highlighted lately by Omobuwajo et al. (1999).

Several other researchers have conducted experiments to find the physical properties of various fruits and crops. Paksoy and Aydin (2004) estimated some physical properties of squash seeds at different moisture content (6.4 to 52.9%). The role of moisture content was also studied. Owolarafe and Shotonde (2004) determined some physical properties for okra fruit at a moisture content of 11.42% (wet basis). Akar and Aydin (2005) evaluated some physical properties of gumbo fruit varieties as functions of moisture content. Karababa (2006) evaluated physical properties of popcorn kernels as a function of kernel moisture content, varying from 8.95 to 17.12% (dry basis). Kashaninejad et al. (2006) determined some physical and aerodynamic properties of pistachio nut and its kernel in order to design processing equipment and facilities. Several physical properties of pistachio nut and its kernel were evaluated as a function of moisture content in the range of 4.10 to 38.10% (wet basis). Topuz et al. (2005) determined and compared several properties of four orange varieties. Jahromi et al. (2007) determined dimensions and projected areas of date (Barhi variety) by image processing technique. Also many studies have been reported on the physical properties of agricultural crops.

There may in fact be a large number of physico-chemical components of Jamun fruits that are worthy to test however, in the present study, only a few but important properties have been evaluated which are more commonly considered for their greater applicability in assessing quality, nutritive value and acceptance to consumers with the objective to determine the physical properties of jamun fruit and consider the appropriate technologies for onward processing.

METHODOLOGY

Jamun fruit was procured for the study from farmer's field near to Sindh Agriculture University, Tandojam, Pakistan. Two common cultivars typically grown in the Sindh climatic condition were selected for the studies which were chosen (V1)-Improved and (V2)-Indigenous. V1 is a newly developed cultivar in the recent years whereas V2 is a wild variety found since many decades. The sample fruits were cleaned manually to remove all foreign materials such as dust, dirt, immature fruits etc. The fruit and seed material was divided into 2 lots each and 20 samples were selected at random from each lot of fruit and seed to obtain samples for conducting the experiment. Hence, measurements of all size and shape indices as well as the fruit mass and seed mass were made thrice. As a whole, a summary of the results of determined physical and chemical parameters of fruit and seeds are collectively shown in Table 1.

Weight

The weight of a selected sample of fruits can however, be determined easily in any standard physical balance. As the Jamun fruit consists of two parts, namely, the outermost part that is edible matter and the inner portion that is the seed fraction (non-edible). The balance was calculated before measuring the fruit weight. The randomly selected representative Jamun fruit samples were placed in a pre-weighed pan then to the digital balance. The mass unit of fruit was determined by means of a digital electronic balance *(*Shimadzu, Japan*)* having an accuracy of 0.0001 to 200 g. The weigh measurements of the two fractions were made thrice to get mean values. To get correct weight it was ensured before use that the balance is properly set, placed and leveled. The weighing was done accurately and the reading was noted carefully.

Volume

The Jamun fruit volume was measured through measuring volume of displaced water directly in measuring cylinder. A measuring cylinder which was properly graduated and transparent was used keeping in mind that the representative sample of fruits could be easily and freely introduced in the cylindrical space. Before use, the measuring cylinder was thoroughly and repeatedly washed with clean running water. The clean water was then poured in it. By doing so all possible care was taken so that no air-bubble could gets trapped in the water poured. In this connection, the water was poured slowly, holding the cylinder in slanting manner. The bubbles made were expelled out by striking the outer wall of the cylinder lightly with finger. Before introducing the sample fruit in the cylinder, the poured water was left to stand for a while and the excess water was taken out by pippetting to such an extent that the water left in the cylinder comes to a known volume and this was carefully noted and this was taken as initial volume of water and denoted as (A). Then the fruit samples were slowly and carefully placed inside the cylinder containing water so that the already measured water could not splash and spill outside the cylinder. When the entire sample fruits were sunk in water, they were left to stand for a while and termed it final volume of water and denoted as (B). The total numbers of fruits were denoted as (N). Hence, the average volume of a fruit was calculated by dividing the differences in volume with

the number of fruits by the following formula:

$$AV = \frac{B - A}{N}$$

Specific gravity

The relative heaviness, measured as specific gravity value is an important character of a fruit. Like other fruits, Jamun fruit's specific gravity value is also considered to be a guiding index to judge their physiological maturity. The specific gravity value is related to season of their development, maturation and ripening. The specific gravity of fruit can also be determined with the help of a hydrometer. However, in the present study, the specific gravity values of Jamun fruit samples were determined by the following formula:

$$\text{Specific gravity value} = \frac{\text{Weight of the fruit}}{\text{Volume of the fruit}}$$

Overall length

The fruit size, in terms of the two principal axial dimensions, that is length and width was measured using a Vernier-caliper with an accuracy of 0.0 to150 mm (Shanghai, China). The selected batch of Jamun fruit was measured provided that it is of such length as can be suitably held between the jaws of the calipers. By measuring the overall length, care was taken to hold the fruit in correct position, ensured that it's uppermost and the lowermost ends were in contact respectively with two jaws of the instrument.

Maximum width

To measure the width, the diameter of a fruit in its centre is emphasized. In fact, in various fruits the cross sectional diameter is the same as the maximum width; however, this is not the case for all fruits especially in Jamun fruit. Therefore, the Jamun fruit samples were considered the total width measuring the distance from the extreme points at two sides. Hence, the width of Jamun was measured in similar way as its length was measured through the same Vernier caliper.

Fruit shape

Visual observation was made in case of Jamun which is the easiest method and beyond the doubts and practical method to judge the shape of a fruit. However, a standard chart having various types of shapes commonly found in fruits was used to find the accurate shape of Jamun both cultivars, that is (V1) improved and (V2) indigenous.

Firmness/softness

The existence of firmness in Jamun fruit was measured by the following two methods:

Finger prenure/by hand-feeling: This is an easy approach where a person holds the fruit in palm and feels it by giving the desired pressure. No doubt the method is crude but practical and may be applied to have gross ideas especially when relative degree of firmness among different samples of maturation. In order to acquaint much accurate data, a panel of persons was employed instead of one person tester. The judges were M.Sc student and the faculty members of the Institute of Food Sciences and Tech-nology, comprising both male and female. Those were divided into several groups and each group (five members) was asked to test independently by the hand feeling process. The degree of firmness or softness as assessed by each group was expressed by appropriate terms such as very hard, medium had, hard to soft, moderately soft, soft and soft to very soft and extremely soft which was already communicated to the testers before starting the test. The data obtained from each group of tester was considered together and made average to get conclusion.

By pin-drop method: This is also a crude method and may be of use to determine the relative level of softness of fruits. However, this method is applicably used for those fruits which are soft or moderately soft in texture like Jamun. To work, about 5 g sample fruit was attached at the head of a pin. The length of pin was measured 1 cm. The pin having weight at the head was left to drop vertically and freely over the surface of the Jamun fruit from 1 inch height. The length of pin penetrated into the fruit was measured. To interacting effect of air on free drop of the pin was averted by carrying out the test in a closed chamber. On the basis of penetration of pin into the fruit surface, the degree of softness was concluded (Table 1).

Color (visual estimation)

The same panel of judges who were employed to determine firmness was again asked to identify color of Jamun fruit as they were observed and narrated the color under specific terms which was already explained to them before they had started judging. Visual observations were made for determination of color and were compared with the standard color charts. The conclusion was drawn making average of the reports given by the group of judges making a comparison with a standard color dictionary.

Percentage consumable matter (pulp)

In this regard, the selected sample of Jamun fruit was first weighed. Fruits were cut to separate the non-consumable part (seed) from the consumable portion (pulp). The remaining consumable matter which adhered to the separated non-consumable part was brought back to the former part by careful scratching. Then the consumable matter was weighed. The percentage of consumable matter was calculated by the following formula:

$$\text{Percent consumable matter} = \frac{\text{Weight of consumable matter (g)}}{\text{Weight of whole fruits (g)}} \times 100$$

Percent non-edible contents (Seed)

Jamun seeds were separated from fruit pulp through a process described in pulp separation technique. The pulp that adhered to the seeds was removed by washing. After washing, the water was wiped out from their surfaces with a piece of cleaned cloth and tissue paper. The seeds were then weighed and calculated asfollow to determine the percentage of seed composition:

$$\text{Percentage seed} = \frac{\text{Weight of seed matter (g)}}{\text{Weight of whole fruits (g)}} \times 100$$

Percent Juice content

After weighing the fruit, the consumable matter from them was completely taken out. A known volume of distilled water was added to that and minced thoroughly in a blender and the blender was run till blending of whole pulp was accomplished. The ground material was filtered through muslin clothe with many folds to separate the pulp pieces out completely. The volume of the filtrate was then measured in measuring cylinder. The percentage of juice in the given sample of Jamun fruit was worked out as follows:

$$\text{Percent Juice} = \frac{\text{Volume of the filtrate (ml) - Volume of distilled water used (ml)}}{\text{Weight of fruit (g)}} \times 100$$

Determination of % moisture

About 10 g of pulp sample was taken in a pre-weighed flat bottomed dish. Both empty dish and fruit sample weights were noted separately. The sample loaded dish was kept in an oven by adjusting its temperature at 100°C. Dish was removed after 4 h, cooled in the desiccators and reweighed. The dish was again placed in the oven for 3 h and was reweighed after cooling. This practice was repeated till the constant reading was obtained. The percentage moisture content was determined by the following formula:

$$\text{Moisture (\%)} = \frac{\text{Weight of (Fresh sample – Sample after drying)}}{\text{Weight of fresh sample}} \times 100$$

Determination of total solids

Total solids were estimated by deducting percentage moisture from 100 as described by James (1995).

% Total solids = 100 - % moisture

Determination of titrable acidity

Titrable acidity was determined according to the method of AOAC (2000). Each sample of the products was treated with 10 N NaOH solution using titration kit. Where 3 to 5 drops of phenolphthalein were used as an indicator. The acidity was determined in terms of lactic acid. The volume of alkali used was noted and calculated using the following formula;

$$\text{\% Titrable acidity} = \frac{\text{Normality of NaOH} \times 0.009}{\text{Weight of sample (g)}} \times 100$$

Determination of TSS

The total soluble solids (TSS) were determined as per method described by Mazumdar and Majumder (2003) using Digital-Bench-Refrectometer. Before use, the instrument was cleaned and adjusted to zero at 20°C using distilled water. An appropriate quantity of each sample was placed on the prism-plate of the refrectometer with the help of a glass rod and folding back the cover. For each sample, the instrument was calibrated by using distilled water. The reading appeared on the screen was directly recorded as total soluble solids.

Determination of pH

For determination of pH (hydrogen ion concentration) in the Jamun fruit, a method of AOAC (2000) was adopted. A digital pH meter was used. Samples solution was taken in the beaker and directly inserted the electrode into the solution. When the first reading was completed, the electrode was wiped with distilled water and dried-up with tissue paper. Hence, as a continue series, all other samples were determined accordingly.

RESULTS AND DISCUSSION

According to shape index, the Jamun fruit of V1 was concluded to be “elliptical” whereas V2 was imagined “ovoid/round shape”. However, the color of V1 was recorded “reddish-purple” whereas V2 was “blackish-purple” (Table 1). The study of the shape as a physical feature of a fruit has its importance to determine whether it conforms to the standard and any deviation that may result due to interacting factors like environment, biotic agencies or application of agro-inputs to the trees bearing that fruit. Fruits belonged to a species or a variety of it has some characteristic shape of their own although variations within some limit are not considered to be an uncommon feature. The fruits commonly consumable to the human beings are found to have number of shapes (Omobuwajo et al., 1999). The selected samples of Jamun fruit were examined to determined its softness hence, V1 was ranked as “soft-to-very-soft “and V2 were “moderately-soft” in firmness (Table 1). Owolarafe and Shotonde (2004) described that firmness of a healthy fruit is linked to the degree of its physiological maturation. With progress of development, maturation and ripening either in the pre-harvest or in the post harvest condition; the fruit undergo gradual softness to a greater or a lesser extent depending on species, varieties, environment and the use of agro inputs. Chemically, the changeover from firm to soft condition of a fruit is largely due to enzymatic conversion of pectic-compounds present in them as component of cell walls. These complex polysaccharides, which are long-chain polymers of galacturonate mono-mers gradually transform from water-insoluble to the more and more soluble forms, that is, from protopectin to pectic acid in the fruits as they undergo development, maturation and ripening. Due to this solubilization process of pectic polymers, the fruits attain more and more softness (Stroshin, 1998).

Size of Jamun fruit cultivars found varied from 3.88 to 2.73 cm in length and 2.98 to 2.10 cm in geometric mean diameter/width in V1 and V2 respectively. The overall weight of Jamun fruit was observed 9.55 and 6.75 g for V1 and V2 respectively (Table 1). An important qualitative character of a fruit is the length that it measures. For fruits of some species including Jamun, maturity for harvest is also judged in considering the length attained by them. In the market, the consumers are even found to select out relatively long sized fruits especially for those of Jamun despite the fact it is not certain whether a

Table1. Determination of physicochemical characteristics of Jamun fruit cultivars of Sindh (mean measurements/values).

S/No.	Parameter	Improved (V1)	Indigenous (V2)
01	Shape index	Elliptical	Ovoid/round
02	Color	Reddish-purple	Blackish-purple
03	Firmness/softness	Soft to very soft	Moderately soft
04	Weight of fruit (gm)	9.55±0.685	6.71±0.520
05	Length of fruit (cm)	3.88±0.224	2.73±0.174
06	Width/diameter (cm)	2.98±0.361	2.10±0.202
07	Volume of fruit (ml)	7.60±0.361	5.33±0.176
08	Specific gravity (value)	1.26±0.120	1.25±0.048
09	Edible matter/pulp (%)	6.6 g (69.10±6.240)	2.63 g (39.19±0.416)
10	Non-edible matter/seed (%)	2.95 g (30.90±0.327)	4.08 g (60.81±0.485)
11	Length of seed (cm)	0.49±0.047	1.60±0.058
12	Width/diameter of seed	0.21±0.033	0.70±0.025
13	Juice (%)	2.11 ml (32±1.155)	0.99 ml (38±1.155)
14	Total Soluble Solids (TSS) deg Brix	13.75±0.501	15.82±0.505
15	Titrable acidity (%)	1.26±0.031	1.58±0.021
16	pH (value)	3.87±0.010	3.77±0.010
17	Moisture content in fruit (%)	81.32±0.203	80.14±0.087
18	Moisture content in seed (%)	13.31±0.262	12.34±0.021

longer fruit have any impact on its quality. Kashaninejad et al. *(*2006), Bart-Plange and Baryeh (2003) in their studies pointed out that width of a fruit, that is, how much it has grown across is a measure which is perhaps of greater importance than the lengthwise growth of it, in order to judge its normal and healthy growth. In some countries, the maturity for harvest of many fruits is also assessed by observing their girth-wise growth. For example, in the fruit of Jamun, width is some times considered to determine their harvest-maturity condition. The practice lies in testing whether the fruit passes or not through a ring of desired diameter. If the fruit passes out, it is considered not to have fully grown till then for which it is left to grow further instead of harvesting at that stage. Keramat et al. (2007) describe that determination of weight of fruit samples needs no emphasis in any analytical study on fruits. A part from estimating yield of a tree, weight of a fruit is considered to be an important factor in judging its compactness, maturity, juice content, levels of chemical constituents. The weight of fruit also determines its acceptance to consumers and thereby the market price of it.

The whole fruit specific gravity value was found to 1.25 in V1 and 1.26 in V2. Garnayak et al. (2008), Sirisomboon et al*. (*2007) and Visvanathan et al. (1996) agreed to say that volume of fruit is another important factor like that of its weight in determining quality. In the market, the consumers are also found to have a preference to select the large sized ones for many fruit including Jamun. And accordingly the price of those fruits goes higher with size. Results showed that volume varied from 5.60 to 5.33 ml in V1 and V2 respectively. To what proportion the human consumable matter is actually present in a fruit is, in fact, of practical concern to a food scientist. This varies greatly according to species, varieties under them, rootstocks used, edapho-climatic conditions of growing, agro inputs applied and so on. Thus, to a fruit scientist, the yield as human consumable matter of a fruit crop per tree or per unit area of plantation is of actual concern than the total yield of fruit. The edible matter (pulp) in V1 and V2 was 69.10% (6.6 g) and 39.19% (2.63 g) respectively. Whereas non-edible portion (seed) was 30.19% (2.95 g) in V1 and 60.81% (4.08 g) in V2 was determined. Dutta et al. (1988) stated that presence of seeds in a fruit is considered a merit or demerit. Seeds are valued at least in some fruits for certain purposes like Jamum 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 byproducts etc. Also the juice percent was obtained as 32 and 38% in V1 and V2 respectively.

The chemical properties of Jamun fruit cultivars were also analyzed. Accordingly, the average dry-basis moisture content of whole Jamun fruit was found 81.32 and 80.14% in V1 and V2. Whereas, the moisture content in seeds were found 13.31 and 12.34% in V1 and V2 respectively. TSS varied as 13.75 and 15.82% in refractory index for V1 and V2 respectively (Table 1). These results are in agreement with many other researchers on Jamun aqueous extract as described in detail by Dahot et al. (1986, 1989). By describing the role of chemical

constituents including moisture content, many researchers carried out experiments on various fruits and crops. Paksoy and Aydin (2004) estimated squash seeds at different moisture content (6.4 to 52.9%). Owolarafe and Shotonde (2004) determined moisture content of Okra fruit at 11.42% along with some other physical characteristics. Akar and Aydin (2005) evaluated some physical properties of gumbo fruit varieties. Karababa (2006) evaluated physical properties of popcorn kernels. Kashaninejad et al. (2006) determined some physical and aerodynamic properties of pistachio nut and its kernel.

The pH and acidity for V1 and V2 was found 3.87 and 3.77, 1.26 and 1.58% respectively. The pH values revealed that fresh extract of Jamun fruit is highly acidic and may be responsible for astringency in taste. Noomrio and Dahot. (1996) authenticated the same view point on pH of Jamun fruit. The other researchers reported that the pH value of Jamun fruit pulp is higher than other fruits like Carisa carindas 2.9 (Hasnain and Ali, 1990). Hasnain and Ali (1990) further reported that lower pH of sample is favorable for higher shelf life. Total solids are measure of the amount of material dissolved in water. This material can include carbonate, bicarbonate, chloride, sulfate, phosphate, nitrate, calcium, magnesium, sodium, organic ions, and other ions (American Public Health Association, 1998). Thus these properties may be useful in order to separate fruit and seed, processing, design equipment and facilities.

CONCLUSION

The aim of this study was to investigate the physical properties of Eugenia Jambolana fruits and seeds grown in Sindh, Pakistan. The parameters studied include size, shape, color, fruit part fraction (edible and non-edible), geometric mean diameter, specific gravity, percentage juice ratio, volume, moisture content, TSS, pH and acidity etc. The physical properties of Jamun fruit were evaluated in order to optimize better the designing of tools, equipment and machines and facilitate the overall mechanism for their processing, preservation and commercialization.

RECOMMENDATION

The present study was specific on few parameters and cultivars for physicochemical determinations of Jamun fruit grown only in Sindh region, however, the Jamun cultivars of other regions may be evaluated further with additional parameters.

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