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Physical Properties of Selected Fruits

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Abstract

The study was undertaken to generate information regarding the physical properties of easily available fruit of Punjab so as to enable the research workers to design and develop mechanical handling, grading, drying, processing and storage systems. Sand pear, orange, guava, papaya, peach and ber were selected this purpose. A correlation among various physical properties like weight, volume, specific gravity, surface area, sphericity and roundness was attempted. The common chemical properties like total soluble solids and acidity were also estimated for examining its dependence on the selected physical properties that could act as a guide to the maturity/ripeness of these fruits. The roundness of values for sand pear, orange, guava, papaya, peach and ber were found to vary in the range of 0.39—0.48, 0.38—0.42, 0.28—0.46, 0.42—0.57 and 0.51—0.72 respectively while the sphericity was observed to be in the range of 0.92—0.97, 0.92—0.93, 0.95—0.96, 0.72—0.75 and 0.76—0.79, respectively. The variation in the roundness and sphericity values were due to the different diameters of the fruits.

Key words : Fruits, Roundness, Size, Sphericity, Total soluble solids.

India occupies a prestigious position regarding the production of fruits and vegetables and is next only to China in this regard accounting for about 11% of total output of fruits in the world. However, when it comes to its prosessing or value addition, the position is too dismal to be of any comparison even with many of developing Asian countries. More than 20—25% of total production is lost due to spoilage at various post-harvest stages during various levels of handling. According to CII—Mckinsey report loss of horticulture produce in India is more than the total consumption in UK (1). One of the reasons for this situation is that the fruits and vegetables are handled manually due to the lack of proper infrastructure for it. In order to design and develop various mechanical handling machines for cleaning, grading and separating, knowledge of the various physical properties is essential. With this objective five commonly available fruits in Punjab were selected for determining its physical characteristics and relate it to common chemical parameters of total soluble solids and acidity.

Methods

The study to estimate physical parameters was conducted in the Engineering Properties Laboratory of Department of Processing and Food Engineering, PAU, Ludhiana. Five types of different fruits viz. sand pear, orange, guava, papaya, peach and ber were selected. The fruits were procured from the farm and local market. Different sized fruits were selected for the study. Physical properties estimated during the study included size, sphericity, roundness, surface area, volume, weight and specific gravity while acidity and total soluble were the chemical properties considered (2). The physical parameters of size, surface area and volumes have been measured (3) and calculated using mathematical techniques reported by various researchers (4).

Estimation of the Physical Properties

Size Measurement. A digital vernier caliper was used to measure the size of the fruits. The largest dimension 'a', second largest dimension 'b' perpendicular to 'a' third largest dimension 'c' perpendicular to both 'a' and 'b' were measured. From these measurements, the equivalent diameter was determined as the geometric mean of 'a', 'b' and 'c' (5).

Equivalent diameter of the fruit = $(abc)^{1/3}$

Sphericity. The extent by which objects shape deviate from original (6) sphere was calculated as follows

Sphericity = $[(abc)^{1/3}]/a$

Roundness. The sharpness of corners of the selected horticulture produce was estimated using following formula

Roundness = Σ r/(N*R)

r—Radius of curvature, R—Radius of maximum inscribed circle, N—Total number of corners summed in numerator.

Surface Area. Graphical technique was used to arrive at the estimated values. For this fruits were peeled into strips and spread over a graph paper. The total surface area was calculated by summing up squares covered by strips.

Volume. Water displacement method was adopted for this estimation. A known volume of water was poured into a graduating cylinder. Fruit was immersed in this cylinder and the volume of water displaced was noted.

$$\text{Volume (cc)} = \frac{\text{Weight of displaced water}}{\text{Weight density of water}}$$

Specific Gravity. The specific gravity of the selected fruit was estimated using the following relationship employing electronic balance

$$\text{Specific Gravity} = \frac{\text{Weight in air} \times \text{Specific gravity of water}}{\text{Weight of displaced water}}$$

Gawanda (7) and Oge K and Ugbor EC (8) have also carried out similar studies for estimation of various physical properties of the grains.

Estimation of the Chemical Properties

The common chemical parameters of acidity and total soluble solids (TSS) were estimated using the standard procedures (9). The acidity was worked out in terms of ascorbic acid while hand refractrometer was used for evaluating the TSS.

$$\text{Total acids (\%)} = \frac{\text{Titer (ml)* Normality of alkali* Vol}^{1}\text{ made up *Equivalent wt of acid}}{\text{Volume of sample taken (ml)}^{1}} \times 100$$

*Wt or vol of sample taken

[1]is not employed if juice is taken directly for estimation of acidity.

Results and Discussion

The results to estimate the physical and chemical properties of the selected fruits are discussed below.

Physical Properties of the Fruits

The physical properties viz. size surface area, weight, volume and specific gravity of the selected fruits obtained from the market at the same level of maturity are presented (Table 1). The equivalent diameter of pear, orange, guava, peach is found to vary in the range of 4.8—7.5 cm whereas in papaya, it lies in the range of 12.5—14 cm while the smallest fruit of ber possesses.equivalent diameter in the range of 3—4 cm. The spherecity of fruits like pear, orange and guava worked out to be more than 0.9 (90%). So these fruits can be considered as spherical in shape for practical purpose. This observation has many practical application in food engineering as many of the parameters like diffusivity of moisture during drying and dehydration, mechanism of heat penetration during heating and cooling and design of package for trans-

Table 1. Physical and chemical characteristics of selected fruits. The values presented are average of different sized fruits.

Type of fruit	Weight (g)	Spheri-city	Round-ness	Equivalent Diameter (cm)	Specific gravity	Surface area (cm)	Volume (cm^3)	Acidity (%)
Sand pear	130.4	0.94	0.42	6.03	0.98	94.5	131.7	0.05
Orange	189.6	0.92	0.40	6.88	0.99	151	190.4	0.68
Guava	168.8	0.95	0.34	6.60	0.95	126	175.9	0.07
Papaya	1048.1	0.73	0.50	12.9	0.75	546	1390.2	0.18
Peach	78.7	0.90	0.52	4.74	0.84	70	77.80	0.12
Ber	24.3	0.78	0.62	3.5	0.97	34.2	20.41	0.12

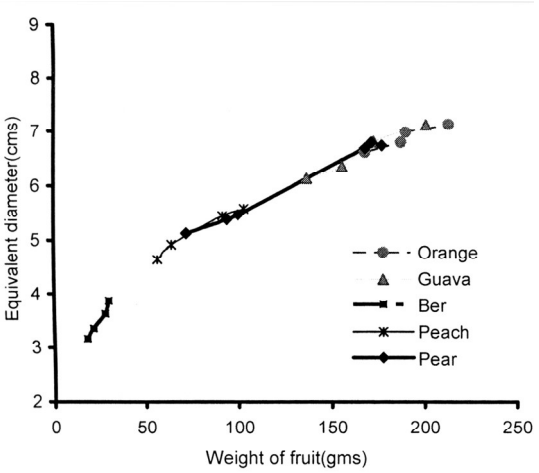

Figure 1. Relationship between equivalent diameter (cm) and weight (gm) of selected fruits.

portation is influenced by it. The papaya, peach and ber are spherical to the extent of 0.45 to 0.80. Figure 1 shows the relationship between the equivalent diameter and the weight of fruits. With the exception of papaya, all the fruit have linear relationship i.e. as the diameter of the fruit increases; its weight is increased proportionally. The fruits of pear, orange and guava have more or less similar specific gravity in the range of 0.9—1.2 while the papaya, peach and ber possess lower specific gravity with papaya accounting for the least value of 0.7—0.8.

The regnession relationships of fruits for diameter and weight are given below.

Orange : $Y = 0.0114X + 4.72$ ($R^2 = 0.90$)
Guava : $Y = 0.0159X + 3.96$ ($R^2 = 0.97$)
Ber : $Y = 0.055X + 2.16$ ($R^2 = 0.97$)
Peach : $Y = 0.019X + 3.59$ ($R^2 = 0.97$)
Pear : $Y = 0.017X + 3.85$ ($R^2 = 0.99$)
Papaya : $Y = 0.002X + 10.75$ ($R^2 = 0.83$)

Physico-Chemical Characteristics of Selected Fruits

The chemical parameters of total soluble solids (TSS) and acidity (%) are related to be physical parameter of size (equivalent diameter) for the fruits at same level of maturity. Figure 2 explains this relationship. With the exception of oranges, there is general increase in total soluble solids with the increase in

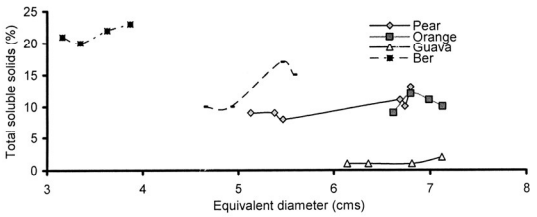

Figure 2. Relationship between equivalent diameter (cm) and total soluble solids of selected fruits.

the size of fruit. TSS for fully matured pear, orange, guava, papaya, peach and ber ranged between 7—14%, 8—12%, 1—3%, 6—12%, 8–16% and 18—24%, respectively.

The acidity of fruits was tested to be less than 1 for all the types fruits selected with oranges having the maximum among them. Table 1 lists the various physical and common chemical properties of these fruits. This information is important for the processor who can select the fruits for the processing purpose by just looking at the common physical attributes of the fruit at the time of purchasing.

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