

Engineering Properties of Pomegranate Fruits and Arils

Malwade V.V., D.T. Bornare, Patil S.R.

Department of Agricultural Engineering, Maharashtra Institute of Technology, Aurangabad,
Maharashtra, India

email: vaibhav.malwade57@gmail.com, deepakbornare@gmail.com

Abstract : Pomegranate (*Punica granatum*) is very useful and important pharmacological fruit belongs to family Lythraceae. It is an important fruit crop of arid and semiarid regions of the world. The determination of engineering property of pomegranate fruit and arils is important for equipment design. Some physical properties like geometric mean diameter, sphericity, surface area, volume, bulk density, porosity, hardness, etc. were determined. The average length, width and thickness of pomegranate fruit are 65.9mm, 68.5mm and 67.1mm respectively. The geometric mean diameter, sphericity, surface area and volume are 64.39mm, 0.97, 13.02mm² and 138.82 cm³ respectively. Bulk density for pomegranate fruit and arils were 0.524 and 0.555 respectively. Some textural properties like hardness (N), Deformation (mm), % deformation at hardness and Springiness (mm) were calculated by using texture analyzer. The hardness of whole pomegranate compression test is 4.13N and the hardness of aril in TPA was cycle i) 10.01 N and cycle ii) 8.77 N and in compression test hardness is 4.55N. Whereas Deformation of whole pomegranate in TPA and compression was 1.98 mm and 4.60 mm and Deformation of aril in TPA and compression was 1.98 mm and 2.00 mm respectively.

Keywords: Arils, Sphericity, Hardness, Deformation, TPA, Compression, etc

Introduction

Pomegranate fruit plays an important role in our daily life. Botanical name of pomegranate fruit is *Punica granatum*, which belongs to family *Lythraceae*. It is a small tree around 6-8 meters in height. Pomegranate fruit is native to Caucasus, the Himalayas in North Pakistan and Northern India. The physical shape of pomegranate fruit is spherical and size varies from 2.5-5 inch. Inside fruit there are numbers of arils present which are fleshy and darkish red in colour. The seeds are present inside the arils. The peel is well known for its astringent property. Pomegranate tree has lance shaped leathery leaf which is green in colour. Flower of pomegranate consist of 5-8 petals which is yellowish red in colour. (Manan Shah *et al.*, 2011)

Determination of physical and mechanical properties of pomegranate fruit plays important role for machine design and also for handling and storage. Some properties include geometric mean diameter, sphericity, surface area, volume, bulk density, etc. Dimensional property (length, width and thickness) is most important physical property. Particularly fruit shape gives idea for sorting operation and sizing. Fruit skin color is attribute which decides consumer's behaviour and increase acceptability. Fruit volume is also important. So,

to increase work efficiency and reduce product loss these properties play major role. (V Dhineshkumar *et al.*, 2015)

Material and Methods

Determination of physical and textural properties of pomegranate fruit plays an important role for design and development of machine. For determination of properties purchase fresh 100 pomegranate fruits of Bhagva variety from local market of Aurangabad.

Length (L), Width (W), Thickness (T) is determined using vernier caliper (Mitutoyo, Japan) with error of ± 0.02 mm and 100 replications were performed. Length, width and thickness measurement of pomegranate fruit gives basic idea about design parts like hopper size, Feeder size, outlet for arils design parts like size of sieve aperture and some other parts. Sphericity is useful for quantifying shape of fruits and arils, surface area and volume useful for storage, transport and handling purposes. Bulk density was calculated from the mass of fruit divided by the volume containing mass. It is expressed in kg/m³.

Length, width, thickness

The pomegranate fruit and arils size were determined by measuring the dimension of the fruit Length (L), Width (W) and Thickness (T) of 100 fruits by using vernier caliper with error of ± 0.02 mm.

Moisture content

The moisture content of pomegranate aril was measured by oven dry method. Initially the sample with the known weight was kept in oven at 105 °C for twenty four hours. The sample was cooled in desiccators and weighed using an electronic weighing balance. The moisture content of sample was calculated by following formula. (R. Riyahi *et al.* 2015)

$$M.C. (\%) = \frac{w_i - w_f}{w_i} \times 100$$

Where,

M.C. = moisture content, %

w_i = initial weight ,

w_f = final weight

Weight of pomegranate fruit

The randomly pomegranate samples were selected and weighted on electronic weighing balance. Total 100 samples were taken and their observations were noted. Mean of total 100 pomegranates were taken.

Geometric mean diameter

Geometric mean diameter of average of 100 pomegranates (length, width, thickness) fruit and arils were calculated by using formula-

$$D_g = (LWT)^{1/3}$$

(V Dhineshkumar *et al.* 2015)

Where,

D_g = Geometric Mean Diameter,

L = Length,

W = Width,
 T = Thickness

Sphericity of fruit

It is the direct measurement of Geometric Mean Diameter divided by length of fruit and denoted by Φ . Calculation of sphericity was carried out using the following formula (V Dhineshkumar et.al. 2015)

$$\Phi = \frac{D_g}{L}$$

Surface area

Surface area of fruits were calculated by using formula (V Dhineshkumar et.al. 2015)

$$S = \pi (D_g)^2$$

Where,

$$\pi=3.14$$

Volume

Volume of pomegranate fruit were calculated by using formula- (V Dhineshkumar et.al. 2015)

$$V = \frac{\pi}{6} (D_g)^3$$

Bulk density

Bulk density is the mass of fruit per volume of fruit. It is expressed in kg/m³. Calculation of bulk density was carried out using the following formula - (V Dhineshkumar et.al. 2015)

$$\rho_b = \frac{M}{V}$$

Where,

ρ_b = Bulk density

M = Mass

V = Volume

| Sample | Pomegranate whole | Pomegranate aril | Pomegranate aril |
|--------------------------|-------------------|------------------|------------------|
| Test type | Compression | TPA | Compression |
| Probe used | TA4/100; D | TA 39 | TA4/100; D |
| Hardness (N) | 4.13 | 10.01 8.77 | 4.55 |
| Deformation (mm) | 4.60 | 1.98 | 2.00 |
| %Deformation at hardness | 5.10 | -- | 3.50 |
| Springiness (mm) | -- | 0.62 | -- |

2.1 Textural properties

Textural properties of fruit are measured by using CT-3 Texture analyzer in which TA39 and TA4/100 probes were used. Properties measured like Hardness, Deformation, and % deformation at hardness, Springiness and tests like TPA (Textural profile analysis) and compression were calculated.

RESULTS AND DISCUSSION

Length (L), Width(W) and Thickness(T) were calculated respectively by Mitutoyo Vernier Calliper with error of ± 0.02 mm. This was done for 100 Fruits and arils and the average of this was taken for further calculations. The moisture content of arils was calculated by taking sample in Hot Air oven and the result on Wb was 86.7 %.

Average length, width and thickness of fruit were 65.9 mm, 68.5mm and 67.1 mm respectively. Average weight of pomegranate fruit is 165 gm and average no. of arils per fruit is 375. Geometric mean diameter, Sphericity, Surface area, volume and Bulk density of pomegranate fruit were 64.39, 0.97, 13.02, 139.62 and 0.524 respectively. Whereas Geometric mean diameter, Sphericity, Surface area, volume and Bulk density of pomegranate arils were 7.16, 0.77, 0.16, 0.19 and 0.555 respectively. The result of physical properties of pomegranate fruit and arils were given in Table 1

Table 1 physical properties of pomegranate fruit and arils

| Sr. No. | Physical properties | Pomegranate Fruit | Pomegranate Arils |
|---------|---|-------------------|-------------------|
| 1. | Length (L), mm | 65.9 \pm 3.67 | 9.2 \pm 0.73 |
| 2. | Width (W), mm | 68.5 \pm 2.43 | 7.2 \pm 0.56 |
| 3. | Thickness (T), mm | 67.1 \pm 3.22 | 5.9 \pm 0.54 |
| 4. | Geometric mean diameter (D _g), mm | 64.39 \pm 2.82 | 7.16 \pm 0.40 |
| 5. | Sphericity, Φ | 0.97 | 0.77 |
| 6. | Surface area(S), mm ² | 13.02 | 0.16 |
| 7. | Volume (V) cm ³ | 139.62 | 0.19 |
| 8. | Bulk Density (ρ_b), kg/m ³ | 0.524 | 0.555 |

3.1 Textural properties of pomegranate fruit and arils

The textural properties of whole pomegranate and aril were determined on CT-3 texture analyzer. The hardness of full pomegranate in TPA was cycle i) 17.33 N and cycle ii) 16.5 N and in compression test hardness was 4.13N respectively and The hardness of aril in TPA was cycle was i) 10.01 N and cycle ii) 8.77 N and in compression test hardness was 4.55N respectively. Whereas Deformation of whole pomegranate in TPA and compression was 1.98 mm and 4.60 mm and Deformation of aril in TPA and compression was 1.98 mm and 2.00 mm respectively. Springiness of full pomegranate and aril were 1.48 mm and 0.62 mm respectively. The results of Textural properties of pomegranate fruit and arils were given in Table 2

Table 2 Textural properties of pomegranate fruit and arils

CONCLUSION

1. Studying engineering properties of pomegranate fruit and arils is one of the important aspects for machine designing point of view.
2. Compression test for aril revealed that its delicate and slightest force can remove juice from aril.
3. The dimensions of fruit and arils can be utilized for designing size of

hopper, feeder, Sieve apertures for aril separation etc.

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