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Determination of Physical Properties of Aonla Fruit (*Embilica officinali's)*

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ABSTRACT

Aonla is one of the most important and vitamin C rich fruit. The moisture content of aonla cultivar viz., Chakaiya and NA-7 were 80.5% and 78.5% respectively. Determining the physical characteristics of Aonla fruits are very important to optimize the design parameters of food processing equipment. The mean values of size, sphericity, aspect ratio, surface area, volume, density, pulp to seed ratio of cultivars Chakaiya and NA-7 were 36.33 mm and 32.95 mm; 95.8% and 94.7%; 90.84% and 88.23% ; 4249.9 mm^2 and 3601.8 mm^2; 28.95 cm^3 and 22.56 cm^3; 1.06 g/cc and 1.07 g/cc; 21.14 and 15.77 respectively. Based on sphericity value the shape of fruit was classified as spheroid to oblate. The mean values of seed radial diameters of Chakaiya and NA-7 were 13.46 mm and 13.54 mm respectively. The mean seed weight for Chakaiya and NA-7 were 1.40 g and 1.45g respectively. It was observed that the maximum cutting force required for cutting the Chakaiya variety along the stem end side was 8.4 to 9.9 kgf. While, the force required for cutting the NA-7 variety along the stem end side was estimated to be 8.6 to 11.8 kgf.

Key words : Aonla fruit, Aspect ratio, Physical properties, Sphericity.

Indian goose berry (*Emblica officinali's*) popularly known as Aonla is one of the precious gift of nature to the man, and considered as *"wonder fruit for health"*, because of its inherent qualities. These fruits are widely used in pharmaceutical and food industries due to high medicinal and nutrient properties. Aonla an edible fruit indigenous to tropical India, has extensive adaptability to grow in diverse climatic and soil conditions. It has been grown and known in India for last more than 3500 years. It belongs to family *Euphorbiaceous*. The main varieties of aonla are Chakaiya, NA-7, Banarasi, Hathijhool, Bansi red, Pink-tinged etc. Among the varieties of Amla Var: Chakaiya, was used for development of value added products (Poonam *et al.,* 2009). In India, Aonla is grown in an extent of about 50,000 ha with a total production of around 2 lakh metric tonnes. The yield per tree range from 100 to 300 kg/year (Goyal *et al.,* 2008).

Aonla is a richest source of vitamin C and it also contains tannin, pectin, gallic acid, proteins, fibres and minerals such as iron, calcium, and phosphorus besides vitamins A and B. Aonla fruit contains more than 80% of water and also it contained about three times as much protein and 160 times as much ascorbic acid as apples (Barthakur and Arnold 1991). Aonla is used in medicines to treat diseases such as diabetes, skin diseases, leprosy, and jaundice. Its strong antioxidant properties protect heart, lungs, brain and skin diseases (Goyal *et al.,* 2008 and Khan 2009).

Excellent nutritive and therapeutic values of the fruit offer great potential for processing it into quality products. Recently a number of processed products of aonla such as aonla pulp, RTS (ready to serve), Nector, Squash, Candy, Supary, Pickle, Juice, Shreds, dried Powder, etc. are prepared from aonla fruits to improve their acceptability and exploit nutritional qualities.

The aim of this research was to investigate that the physical properties of Chakaiya and NA-7 variety of aonla in order to achieve a complete profile of these attributes.

MATERIALS AND METHODS

Procurement of raw materials

Fresh, good, healthy and matured aonla fruits of cultivars Chakaiya and NA-7 were procured from the local market of Bapatla. Whole, healthy and uninjured fruits were selected for this study. Fruits were washed with potable water to remove adherent dirt and immediately wiped with muslin cloth and stored at room temperature.

Determination of physical properties of aonla fruits

Determining the physical characteristics of aonla fruits are very important to optimize the design parameters of food processing equipment.

The physical properties of aonla fruit such as Size, Geometric Mean Diameter, Sphericity, Aspect ratio, Surface Area, Volume, Density and also pulp to seed ratio, cutting force, seed diameter and weight were determined by using the following methods.

Moisture content

Moisture content of the fruit was determined by using hot air woven method. In this method initially, the known weight of fruit sample was taken and kept in a woven for 1 to 3 h at 130°C (AOAC, 1990). After drying, the sample was removed from oven and cooled. After cooling, final weight of the sample was taken and the moisture content on wet basis was determined by the following formula.

$$\text{Moisture content (\%)} = \frac{\text{Initial weight} - \text{Final weight}}{\text{Initial weight}} * 100$$

Size

Size is the measure of physical dimension of the object. Measurements of the three major perpendicular dimensions of the fruit were carried out with a digital vernier caliper to an accuracy of 0.01 mm. Dimension 'L' is the length or (axial diameter), '*W*' is the width or (radial diameter) perpendicular to '*L*' and '*T*' is the thickness or (transverse diameter) perpendicular to 'L' and '*W*'..

The Geometric mean diameter (Dg) of the fruit was calculated by using the following relationship (Mohsenin, 1980). It was found using the following equation.

The Geometric mean diameter (mm) $D_g = (LWT)^{1/3}$

Sphericity

The sphericity is the geometric mean diameter of the fruit to major diameter of the fruit (Mohsenin, 1980).It was found using the following equation.

$$\text{Sphericity (\%)} = \frac{(LWT)^{\frac{1}{3}}}{L}$$

Aspect ratio

It is the term used to express the shape of a material. The aspect ratio of the geometric shape is the ratio between sizes in different dimensions. i.e. Length to Width. The aspect ratio (R_a) was obtained using following relationship.

$$\text{Aspect ratio (\%), Ra} = \frac{L}{W}$$

Surface area

Surface area (S) was calculated using the equation as given below

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

Where,

S = Surface area (mm^2)

Dg = Geometrical mean diameter (mm)

Volume

The fruit volume was calculated by the water displacement method. The fruit weighed on the scale in air then forced into the water and weight of displaced water was noted.

$$\text{Volume } (m^3) = \frac{\text{Weight of displaced water (Kg)}}{\text{Weight density of water } \left(\frac{Kg}{m^3}\right)}$$

Density

The density of the individual fruits were determined by following equation

$$\text{Density } \left(\frac{Kg}{m^3}\right) = \frac{\text{Weight of fruit in air}}{\text{Volume of fruit}}$$

Pulp to seed ratio

Pulp to seed ratio is the ratio of weight of the pulp and seed in a fruit. The seed to pulp ratio gives an idea about the amount of pulp present in the fruit.

$$\text{Pulp to seed ratio (w/w)} = \frac{\text{Weight of pulp}}{\text{Weight of seed}}$$

Cutting force

Table 1. Physical properties of aonla fruits (Var: Chakaiya).

S.no.	Attribute	No. of Fruits	Replications	Mean of 25 fruits	Standard deviation	Maximum value	Minimum value	Range
1.	Axial diameter (mm)	25	3	37.86	1.24	40.54	35.49	5.05
2.	Radial diameter (mm)	25	3	34.41	1.53	38.49	31.72	6.77
3.	Transverse diameter (mm)	25	3	36.83	1.28	39.09	34.71	4.38
4.	Geometric mean diameter (mm)	25	3	36.33	1.14	38.88	34.55	4.33
5.	Sphericity (%)	25	3	95.8	1.94	99.40	92.10	7.30
6.	Aspect ratio (%)	25	3	90.84	4.03	98.73	83.39	15.34
7.	Surface area(mm^2)	25	3	4249.90	264.05	4749.50	3750.30	999.20
8.	Weight (g)	25	3	30.84	2.85	36.27	26.85	9.42

Table 2. Physical properties of aonla fruits (Var: NA-7).

S.no.	Attribute	No. of Fruits	Replications	Mean of 20 fruits	Standard deviation	Maximum value	Minimum value	Range
1.	Axial diameter (mm)	25	3	30.86	1.36	34.36	28.23	6.13
2.	Radial diameter (mm)	25	3	34.95	1.13	37.71	33.69	4.02
3.	Transverse diameter (mm)	25	3	33.34	1.02	36.11	31.65	4.46
4.	Geometric mean diameter (mm)	25	3	32.95	1.03	36.03	31.53	4.50
5.	Sphericity (%)	25	3	94.70	1.56	97.10	91.10	6.00
6.	Aspect ratio (%)	25	3	88.23	3.61	94.44	81.63	12.81
7.	Surface area(mm^2)	25	3	3601.80	214.48	4079.10	3124.50	954.60
8.	Weight (g)	25	3	24.32	1.63	27.23	20.22	7.01

The Cutting force required to cut the fruit at different orientation was carried out by using a TA.XT2 Texture Analyzer (Texture technologies corp., UK, Model TA.XT2, version 05.16 equipped with 5-kg load cell). The analyzer was connected to a computer and data was recorded via a software program called Texture Expert (XT.RA). The total experiment was carried out by compression tests that generates plot of force (grams) vs. time (sec). A 25 mm diameter perplex cylinder probe was used to measure cutting force required for deseeding of aonla fruit. The cutting force was measured from a graphical representation generated through computer test.

RESULTS AND DISCUSSIONS

Moisture content

Moisture content of fruits as determined by hot air oven method, was found as 80.5% and 78.5% respectively for Chakaiya and NA-7 varieties. The moisture contents reported by (Goyal *et. al.,* 2007) were 74.6% and 69.46% respectively

Table 3. Results obtained from Mass, Volume, Density and Pulp to seed ratio of two varities of aonla fruits.

Variety	No. of fruits	Size of fruit	Individual weight of fruits (g)	Volume of individual fruits ($cm^{3)}$	Density g/cc	Pulp to seed ratio (w/w)
Chakaiya	25	Maximum	36.27	33.77	1.07	23.18
	25	Minimum	26.85	29.50	0.91	19.65
	25	Mean	30.84	28.95	1.06	21.14
NA-7	25	Maximum	27.23	24.73	1.10	16.56
	25	Minimum	20.22	18.42	1.09	13.97
	25	Mean	24.32	22.56	1.07	15.77

Table 4. Aonla seed diameter and weight of the Chakaiya Variety.

S.NO	Attribute	No. of fruits	Replications	Mean	Standard deviation	Maximum	Minimum	Range
1.	Axial diameter (mm)	25	3	12.65	0.25	13.12	12.25	0.87
2.	Radial diameter (mm)	25	3	13.46	0.21	13.80	13.08	0.72
3.	Weight (g)	25	3	1.40	0.12	1.60	1.30	0.30

Table 5. Aonla seed diameter and weight of the NA-7 Variety.

S.NO	Attribute	No. of fruits	Replications	Mean	Standard deviation	Maximum	Minimum	Range
1.	Axial diameter (mm)	25	3	12.73	0.40	13.33	12.23	1.12
2.	Radial diameter (mm)	25	3	13.54	0.25	13.85	13.09	0.76
3.	Weight (g)	25	3	1.45	0.11	1.55	1.35	0.20

for Chakaiya and NA-7 varieties. The reason for high moisture content might be due to high relative humidity levels and soil conditions at coastal areas of Andhra Pradesh

Size

The physical properties of Chakaiya and NA-7 cultivars of aonla fruits were summarized in the Table 1 and 2.

The geometric mean diameter of Chakaiya and NA-7 observed were 36.33 mm and 32.95 mm respectively. The deviation of the size was more in NA-7 (4.50) as compared to Chakaiya (4.33). The reason might be due varietal difference. Similar results were found by (Goyal *et al.,* 2007) 36.0 mm for Chakaiya and 34.4 mm for NA-7 cultivars. Based on geometric mean diameter, the size of fruit of Chakaiya variety was 36.33 mm and it was 32.95 mm for NA-7.

Sphericity

The sphericity of Chakaiya and NA-7 cultivars were found as 95.8% and 94.70% respectively. Based on sphericity value, the shape of fruit was classified as spheroid to oblate, as the sphericity was more than 90%.

Aspect ratio

Fig 1. Showing force requirement of Chakaiya fruit from its stem end side.

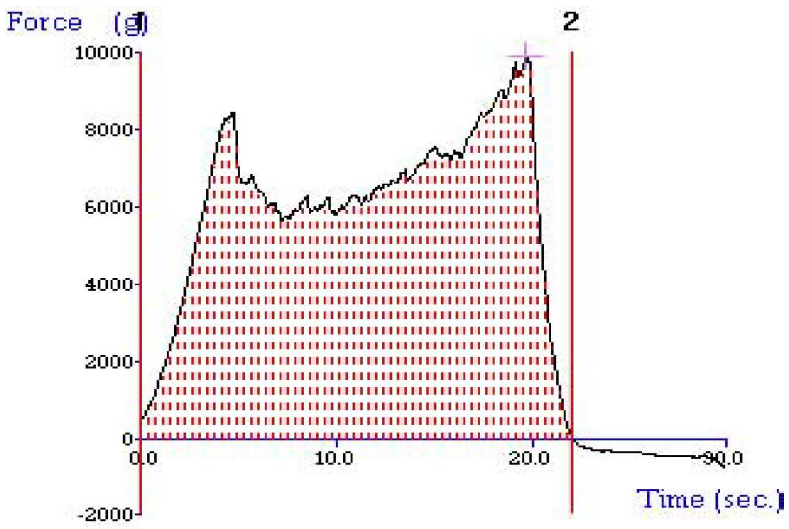
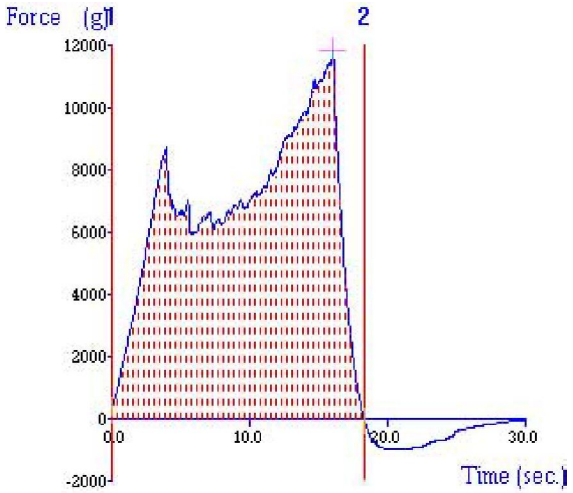


Fig 2. Showing force requirement of NA-7 fruit from its stem end side.



High aspect ratio of fruits indicates its rolling or sliding property on flat surfaces. The mean aspect ratio observed were 90.84% and 88.23% respectively, for Chakaiya and NA-7 varieties.

Surface area

The surface area of Chakaiya and NA-7 was found 4749.50 mm² and 4079.10 mm². It was observed that the surface area for Chakaiya was higher, as compared to NA-7. The higher surface area could be due to the larger size of the fruit. The similar results were reported by (Ganachari *et al*., 2010) 4821.0 mm² for Chakaiya and 3825.0 mm² for NA-7 cultivars.

Volume and density

The volume and density values are presented in Table 3. It was observed that, the volume for both the cultivars Chakaiya and NA-7 were 28.95 cm^3 and 22.56 cm^3 respectively. Chakaiya fruits had higher volume as compare to NA-7 which may be due to variation in size of fruits.

The density of the fruit was found as 1.06 g/cc for Chakaiya and 1.07 g/cc for NA-7 varieties.

Pulp to seed ratio

The pulp to seed ratio on weight basis was found as 21.14 for Chakaiya variety followed by 15.77 NA-7 varieties. The reason for difference in pulp to seed ratio may be due to the difference in the verities and the regional variation in soil and climate and also size difference. The mean, maximum and minimum values were presented in Table 3.

Force required for deseeding the aonla fruits

The force required for deseeding the aonla fruits were determined by the texture analyzer as described in the previous section. It was observed from the figure 1 that the maximum force required for deseeding the aonla fruit of Chakaiya variety along the stem end side was varied from 8.4 to 9.9 kgf. Similarly, the force required for deseeding the NA-7 variety along the stem end side was 8.6 to 11.8 kgf.

Physical properties of Aonla seed

The Aonla seed diameter and weight for the design of the deseeding machinery were determined and presented in the Table 4 and 5. These values were found as 13.46 mm and 13.54 mm respectively for Chakaiya and NA-7 varieties.

The weight recorded was 1.40 g respectively for Chakaiya and 1.45 g for NA-7 cultivar.

CONCLUSIONS

From the results of various experiments conducted for determination of physical properties, the following conclusions were drawn. The moisture content of aonla cultivars, Chakaiya and NA-7 were 80.5% and 78.5% respectively. The values of size, sphericity, aspect ratio, surface area, volume, density, pulp to seed ratio of cultivars Chakaiya and NA-7 were 36.33 mm and 32.95 mm; 95.8% and 94.7%; 90.84% and 88.23% ; 4249.9 mm^2 and 3601.8 mm^2; 28.95 cm^3 and 22.56 cm^3; 1.06 g/cc and 1.07 g/cc; 21.14 and 15.77 respectively. Based on sphericity value the shape of fruit was classified as spheroid to oblate. The values of seed diameters of Chakaiya and NA-7 were 13.46 mm and 13.54 mm respectively. The seed weight for Chakaiya and NA-7 were 1.4g and 1.45g respectively. It was observed that the maximum deseeding force required for cutting the Chakaiya variety along the stem end side was 8.4 to 9.9 kgf. The force required for deseeding the NA-7 variety along the stem side was 8.6 to 11.8 kgf.

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