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Measurement of physical and frictional properties of aonla fruit

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ABSTRACT : The physical and frictional properties of aonla are important in designing and fabricating equipments and structures for handling, transporting, processing and storage, and also for assessing the quality of aonla. The present research work was carried out to measure some physical and frictional properties of aonla. The average range of polar diameter, equatorial diameter, maximum thickness, weight, bulk density and sphericity over three grades of aonla was found to be 2.97 to 4.10 cm, 3.04 cm to 4.43 cm, 3.05 cm to 4.40 cm, 27.07 g to 46.53 g, 585.52 kg/m^3 to 996.76 kg/m^3 and 100.84% to 105.00 per cent, respectively. The highest rolling angle of 8.3 degree was found on mild steel surface of and lowest of 8.1 degree on both plywood and aluminum surface. The static co-efficient of friction was found to be 0.648, 0.655 and 0.653 for aonla on plywood, mild steel and aluminum respectively. The dynamic co-efficient of friction value was highest on mild steel (0.87) for aonla.

KEY WORDS : Anola, Physical properties, Frictional properties

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Aonla or Indian gooseberry is an indigenous fruit to Indian sub continent. India ranks first in the world with respect to area and production. Area, production and productivity of Aonla was 49.62 ha, 111.10 million tonnes and 2.24 MT/ha, respectively (Anonymous, 2006). Major producing states are Uttar Pradesh, Gujarat, Rajasthan, Maharashtra, Haryana, Mizoram, Tamil Nadu, Andhra Pradesh, Karnataka and Bihar.

The physical and frictional properties of soybean are important to design the equipments and machines for sorting, separation, transportation, processing and storing. Designing of such equipments and machines without taking these into considerations may yield poor results. For this reason the determination and considerations of these properties has an important role. The major physical and frictional properties of biological materials are shape, size, mass, bulk density, true density, porosity, static coefficient of friction against various surfaces etc. (Mohsenin, 1980).

In the recent years many research workers has measured some physical properties of granular biological materials but very limited research work is reported on the measurement of physical and frictional properties of aonla except an attempt of Goyal *et al.*, (2006).

By considering this, the study was undertaken to investigate some physical and frictional properties of aonla. The physical properties studied include polar diameter, equatorial diameter, maximum thickness, weight, bulk density and sphericity etc. Also some frictional properties such as rolling angle and coefficient of static and dynamic friction on various platforms were measured.

METHODOLOGY

Sample preparation :

This research work conducted in Maharashtra, India. The Random samples were drawn from a freshly harvested lot of aonla. Fifteen number of aonla in each three size grades: first (large), second (medium) and third (small) were taken as study samples. Physical and frictional characteristics of each grade were determined in laboratories.

Physical characteristics of aonla:

Linear dimensions:

There are two categories of aonla bulb diameter, polar diameter and equatorial diameter. Polar diameter is the distance between the fruit crown and point of root attachment of the

aonla. Equitorial diameter is the maximum width of the aonla in plan perpendicular to polar diameter (Bhanasawry *et al.*, 2004). Equatorial diameter (De), polar diameter (Dp) and thickness (T) of each fifteen bulbs were measured for each grade using vernier caliper with least count of 0.05 mm.

Bulk density:

The bulk density of sample was computed by the mass of fruit (g) and volume of fruit (cm^3) (Mohsenin, 1980). The mass of individual fruit was determined by using a precise weight balance with accuracy 0.001 g and volume of fruit was computed as length x breadth x thickness of the fruit.

Sphericity:

The fruit shape was expressed in terms of its sphericity. The sphericity index was calculated based on recommendation of Mohsenin (1980).

$$\text{Sphericity (\%)} = \frac{(Dp \times De \times T)^{1/3}}{Dp} \times 100$$

where,

Dp – Polar diameter (cm)

De – Equatorial diameter (cm)

T – Thickness of aonla (cm)

Frictional characteristics of aonla:

It was measured for the plywood, aluminum and mild steel.

Rolling angle:

To determine the rolling angle, the aonia was kept at the centre of the corking surface. Choricental platform was used to prevent topping over (top upwards). The platform was inclined until Anola begins to roll. When the rolling of anola was started, the position of platform was noted by protractor and for the next test platform was brought to the initial horizontal position.

Co-efficient of static friction:

To measure the coefficient of static friction, frame made with a rectangular wooden were placed on the surface. The frame was filled with fruits. The table was tilted slowly (manually) until movement of the whole fruit mass and hence the angle was measured.

Co-efficient of dynamic friction:

Co-efficient of dynamic friction is the ratio of the force required to slide the bulb over a surface divided by the normal force pressing the bulb against the surface.The frame was filled with fruits. The observations of weight of fruits and force required to pull that frame was taken and co-efficient of dynamic friction was calculated.

RESULTS AND DISCUSSION

The results of the present study as well as relevant discussion have been summarized under following heads:

Physical and frictional properties of aonla:

Depending upon the size, aonla were divided into following three grades,

Grade I- above 40 mm,

Grade II-between 40 to 36 mm,

Grade III-below 36 mm.

Table 1 shows that polar diameter of aonla was in range of 2.97 cm to 4.10 cm, whereas equatorial diameter was in range of 3.04 cm to 4.43 cm over the three grades. The maximum thickness value was in the range of 3.05 cm to 4.40 cm whereas, weight of aonla in the range of 27.07 g to 46.53 g. The bulk density and sphericity of aonla were in the range of 585.52 kg/m^3 to 996.76 kg/m^3 and 100.84 per cent to 105.00 per cent, respectively. The results are in agreement with Goyal *et al.* (2006) and Bhanasawry *et al.* (2004).

The frictional properties of aonla on three different surfaces (plywood, aluminum, mild steel) are presented in Table

Table 1: Physical properties of Aonla

Sr. No.	Particulars	Large (G-I)	Medium (G-II)	Small (G-III)
1.	Polar diameter (cm)	4.10 ± 0.21	3.69 ± 0.11	2.97 ± 0.31
2.	Equatorial diameter (cm)	4.43 ± 0.22	3.74 ± 0.13	3.04 ± 0.33
3.	Thickness (cm)	4.40 ± 0.22	3.73 ± 0.12	3.05 ± 0.30
4.	Weight (g)	46.53 ± 3.81	34.73 ± 1.98	27.07 ± 4.27
5.	Bulk density (kg/m^3)	585.52 ± 60.39	675.70 ± 44.80	996.76 ± 166.32
6.	Sphericity (%)	105.00 ± 3.19	100.84 ± 1.15	101.77 ± 1.08

Table 2 : Frictional properties of aonla

Sr. No.	Particulars	Plywood	Mild steel	Aluminum
1.	Rolling angle (degree)	8.1 ± 1.55	8.3 ± 1.30	8.1 ± 1.33
2.	Static co-efficient of friction	0.648 ± 0.02	0.655 ± 0.028	0.653 ± 0.024
3.	Dynamic co-efficient of friction	0.84 ± 0.04	0.87 ± 0.02	0.86 ± 0.014

2. The highest rolling angle of 8.3 degree was found on mild steel surface while it was found to be 8.1 degree on both plywood and aluminum surface, respctively. The static co-efficient of friction was found to be 0.648, 0.655 and 0.653 for aonla on plywood, mild steel and aluminum, respectively. The dynamic co-efficient of friction was highest as 0.87 on mild steel whereas lowest as 0.84 on plywood.

Conclusions:

The average range of polar diameter, equatorial diameter, maximum thickness, weight, bulk density and sphericity over three grades of aonla was found to be 2.97 to 4.10 cm, 3.04 cm to 4.43 cm, 3.05 cm to 4.40 cm, 27.07 g to 46.53 g, 585.52 kg/m^3 to 996.76 kg/m^3 and 100.84 per cent to 105.00 per cent, respectively.

The rolling angle was found to be maximum of 8.3 degrees on mild steel whereas minimum of 8.1 degrees on plywood and aluminium. The coefficient of static and dynamic friction was found to be maximum on mild steel as 0.655 and 0.87 respectively.

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