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Physical properties of Rambutan fruit (*Nephelium iappaceum* L.)

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Abstract
Rambutan (*Nephelium lappaceum* L.) is an exotic plant from Southeast Asian native to the Malaysiane Indonesian region, closely related to fruit species as lychee (*Litchi chinensis Sonn*.) with whom it shares some morphological features except its long, thick, and soft spikes or hairs in its shell; its edible pulp is white, juicy, translucent, subacid-sweet flavored, also similar to litchi. The study was conducted to determine the physical properties of both whole rambutan and peeled rambutan fruits. The Properties determined in the study are length, width, thickness, sphericity, geometric mean diameter, bulk density and angle of repose.

Keywords: Litchi, physical properties, rambutan

1. Introduction
Rambutan (*Nephelium iappaceum* L.) is a fruit grown in tropical countries such as Thailand, Malaysia, Indonesia India and Australia. It grows on a medium sized tree, which is related to the Lychee (*Litchi chinensis Sonn.*). The fruit grows in trees and are hairy, referring to the spikes on the skin of the fruit. The spikes aren't sharp; they are fleshy and pliable. Like the lychee, there is a white flesh of the fruit and a single inedible seed under the rind. Most of the rambutans are red when they are ripe, but in Malaysia, they are yellow in colour [2].
The rambutan fruit is 34-54% pulp, 37-62% of peel, non-edible until now, and 4-9% of seed, consumed as food in some places and possibly suitable for some applications in foods. Rambutans are high in vitamin C, copper, manganese and trace elements of many more other nutrients such as potassium, calcium and iron [7].
It is believed that this plant is native to the Malay Archipelago, from where it spread to Thailand, Burma, Sri Lanka, India, Vietnam, the Philippines, and Indonesia. Later, at the beginning of the 20th century, some varieties of rambutan were introduced in the western hemisphere due to their high development potential in regions with favorable agroclimatic conditions for their cultivation: between 100 and 1000 m of altitude, temperatures of around 28 °C, and blooming during spring and summer [3].
Data about world cultivated area and production of rambutan are scarce, and estimates for the year 2003 show that its cultivation is on more than 200,000 hectares with a production of between 1.5 and 2 million tons each year. However, considering the tendency in many countries for a greater consumption of healthy fruits, it is feasible that to date such figures are widely exceeded. Thailand, Indonesia, and Malaysia are the main producers and exporters of the fruit accounting about 80% of the world production. From the fruit, only the pulp is considered edible, generally consumed fresh, although sometimes it is processed industrially to obtain juices, jams, and jellies, among other products, generally in canned presentations [4].
However, there was little published literature which deals with the determination of physical properties of rambutan fruits. Therefore, this particular research study was to determine the physical properties such as linear dimensions, geometric mean diameter, Sphericity, bulk density, weight, moisture content, angle of repose for whole rambutan and spikes removal rambutan.

2. Materials and Methods
Procurement of raw material
Fresh fruits of rambutan were brought from the local market of Abohar in the state of Punjab, and were washed by water, drained by tissue paper to remove droplets of water present on the surface.

The purpose of washing was not only to remove field soil and surface micro organisms but also to remove fungicides, insecticides and other pesticides from the fruit. The spikes on the fruit were then removed for measurement of properties.

Fig 1: Pictorial view of rambutan fruit: (a) with hair; (b) without hair.

Physical properties of rambutan fruit

Axial dimensions

The principal dimensions of fruits, namely, length, width and thickness were measured with the help of digital vernier calliper as shown in Fig.2 (Mitutoyo absolute AOS digimatic calipers 500, Japan) [5].

Fig 2: Measuring with vernier calipers

Geometric mean diameter

The geometric mean diameter mean diameter of the litchi were calculated by using the following relationships [5].

$$D_g = (a.b.c)^{1/3} \quad (1)$$

Sphericity

Sphericity **(**ϕ) of the fruit was calculated by using the following relationship [5].

$$\phi = \frac{(a.b.c)^{\frac{1}{3}}}{a} \times 100 \quad (2)$$

Where, a = length of fruit (mm); b = width of fruit (mm); c = thickness of fruit (mm); ϕ = sphericity.

Weight

Weight of single fruit and peel was measured by using electronic weighing balance (Mettler Toledo, ME54 Model) as shown in Fig. 3 to accuracy of 0.001 g.

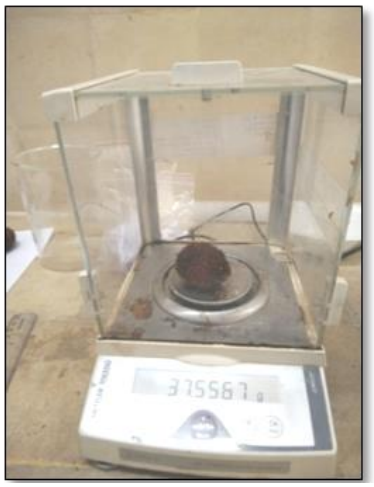

Fig 3: Snapshot showing the weighing of sample using electronic balance.

Bulk density

Bulk density is the ratio of the weight of the sample to the volume occupied by the sample (Eq. (3)), measured with the help of beaker having volume of 500 ml and expressed in kg/m^3.

$$\text{Bulk density} = \frac{\text{Weight of fruit (kg)}}{\text{Volume occupied by the same fruits (m}^3\text{)}} \quad (3)$$

Moisture Content

The initial moisture content of fruit was determined by oven drying the samples at 105 ± 1 °C for 24 h [5]. The moisture content was calculated from the relationship showed in Eq. (4).

$$\text{M. C.} = \frac{W_i - W_f}{W_i} \times 100 \quad (4)$$

Where, M.C. = moisture content wet basis (% w.b.), W_i = initial weight of sample (g), W_f = final weight of sample (g)

Angle of repose

Angle of repose or critical angle of repose is the steepest angle of descent or dip relative to the horizontal plane to which a material can be flown. At this angle, the material on the slope face is on the verge of sliding. The angle of repose can range from 0° to 90 °C.

3. Results and Discussion

Table 1 shows the results that the physical properties of the rambutan fruits which were almost similar to the physical properties of Indian litchi [6].

Table 1: Physical properties of rambutan fruits

Physical properties	Whole fruit	Peeled fruit
Length (mm)	46.259 ± 1.548	36.514 ± 1.566
Width (mm)	35.97 ± 1.685	29.338 ± 1.505
Thickness (mm)	33.612 ± 1.708	27.094 ± 1.980
Geometric mean (mm)	56087.321 ± 6226.245	29182.64 ± 4247.676
Sphericity	1210.935 ± 108.425	797.377 ± 95.580
Bulk density (kg/m^3)	280.00 ± 1.002	514 ± 0.908
Weight (g)	30.650 ± 3.723	18.482 ± 2.624
Moisture content (% w.b)	76.23	75.71
Angle of repose (°)	30.866 ± 0.156	29.766 ± 2.534

Note: Values are represented as mean ± standard deviation.

4. Conclusion

The Rambutan fruit is rich in many vitamins, minerals and beneficial plant compounds. It also contains a good amount of copper, which plays a role in the proper growth and maintenance of various cells, including those of bones, brain and heart. The rambutan peel and seed are thought to be rich sources of nutrients, antioxidants and the fruit is also a source of soluble and insoluble fiber, which can prevent constipation and improve symptoms of certain gut disorders.

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