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Physical and Engineering Properties of Coconut (*Cocos nucifera* L.) Grown in Malappuram District of Kerala, India

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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ABSTRACT

Coconut (*Cocous nucifera*), also known as the "tree of heaven," is one of the most important marketable crops in tropical countries. Research and commercialization of the technology is needed as to provide an additional source of income and to improve the economic status of the farmers and the country. Some physical and engineering features such as size, weight, sphericity, roundness, volume, and density were researched as part of the steps toward developing processing and handling equipment for coconuts. Major diameter varied from 132.23 mm to 101.45 mm with a mean value of 117.24 mm, the seed volume varied from 713.45 cm^3 to 425.88 cm^3, with an average density of 1.0427 g cm^{-3}. The roundness ranges from 0.4607 to 0.8216 with a mean value of 0.6490 and the sphericity ranges from 0.7304 to 0.9561 with a mean value of 0.8330.

Keywords: Coconut; physical and engineering properties.

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1. INTRODUCTION

One of the most important crops in tropical climates is coconut (*Cocos nucifera*). It is commonly referred to as "kalpavriksha" since it supplies people with more valuable and diverse products [1]. The term "coconut" referred as whole coconut palm. The seeds which said to be a drupe and botanically not a true nut are the only accepted species in the genus *Cocous* [2]. Coconut is grown in more than 90 countries in the world. Total production area of coconut in world is approx. 12 million hectares, with an annual production of 59.98 million tonnes of nuts [3]. Conferring to Food and Agricultural Organization, with a production of 18 million tonnes of coconuts, Indonesia is the one of the largest coconuts producing country followed by Philippines with an annual production of 15.86 million tonnes of coconuts [4].

Coconut is primarily grown near the shore in the Indian states of Kerala, Tamil Nadu, Odisha, West Bengal, Karnataka, Maharashtra, and Pondicherry. In non-traditional states such as Assam, Gujarat, Madhya Pradesh, Rajasthan, Bihar, Tripura, Manipur, and Arunachal Pradesh, coconut growing has been brought to suitable sites [4].

Kerala ranks first in area and production of coconut. Presently, coconut is cultivated in the state in an area of 7.607 lakh ha with annual production of 6.980 billion nuts with an average yield of 9175 nuts/ha [5]. Graphical representation of the area under coconut cultivation in different districts of the Kerala is shown in the Fig. 1.

Coconut is utilised in the production of food, beverages, medicines, natural fibres, fuel, timber, and raw materials for a variety of products. Coconut is also tied to a huge number of small and marginal farmers' socioeconomic lives. To convert the coconut in some useful product post-harvest operation should be done. There are number of post-harvest operations that are accomplished manually or with the help of machine. To develop an appropriate machine physical and engineering property plays an important role [6].

Engineering qualities are important in the design of machines, structures, processes, and controls, as well as in the analysis and determination of a machine's or operation's efficiency, the development of new goods, and the ultimate quality of products [7].

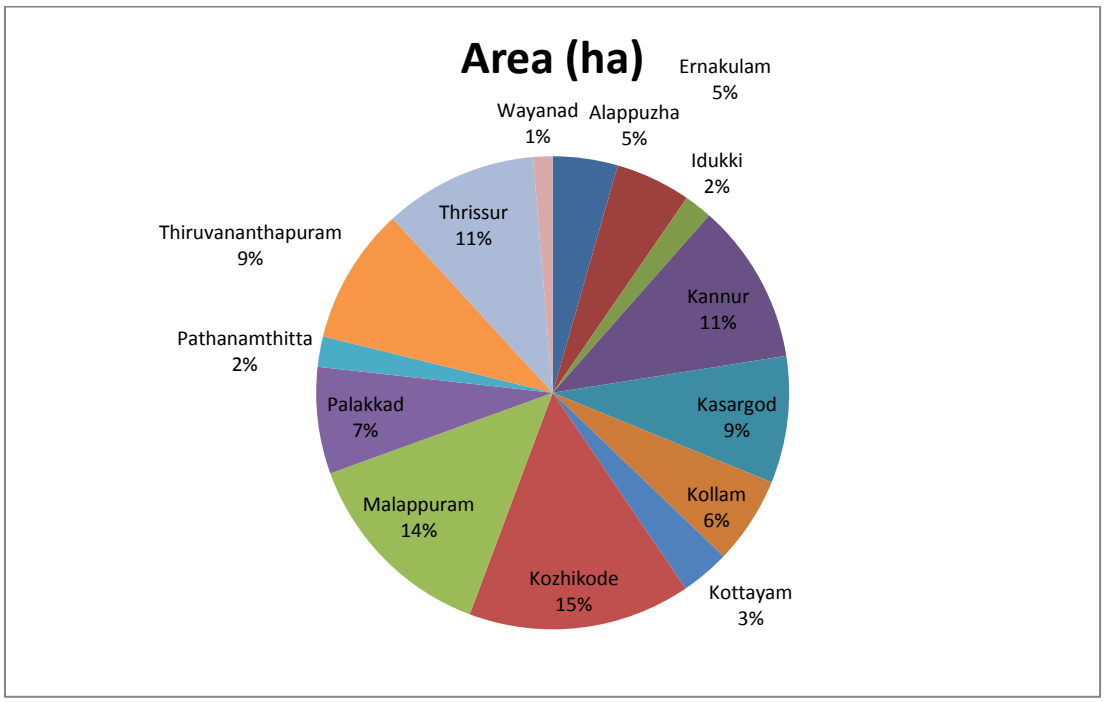

Fig. 1. Area under coconut cultivation in different districts of Kerala
Source: Directorate of Economics and Statistics, Thiruvananthapuram

Machines have been designed and fabricated for crops and more works are still going on to improve on the design of such machines [8]. This paper presents the determination of some physical and engineering properties of coconut which helps in the design and development of dehusking operation, coconut splitting machine, coconut water collector and similar types of machine associated with coconut.

2. MATERIALS AND METHODS

2.1 Experimental Procedure

The coconuts used for this research work were obtained from the farmers of the Tavanur Panchayat, since it is readily available throughout the year. They were manually cleaned after random selections. This was done to diminish the errors in the results. A total number of 50 coconuts were used after randomly selected for the physical and engineering properties test such as size, shape, weight, volume, density, sphericity and roundness, etc. The following procedures used to determine the physical and engineering properties of coconut.

(a) Colour and Appearance of the coconut

Direct visual examination of the coconut was used to determine its colour and look. When ripe, the colour changes from green to brown, with a light brown fibrous husk, a firm brown shell, and a huge hollow seed with pale greasy edible flesh.

(b) Roundness

Roundness is a measure of the sharpness of the solid material. The most accepted methods for determining the roundness of irregular particle are given below,

$$\text{Roundness} = \frac{\text{Largest projected area of the particle when it is in natural rest position, Ap}}{\text{Area of smallest circumscribing circle, Ac}}$$

for Fig. 2 (a) (1)

$$\text{Roundness ratio} = \frac{\text{Radius of curvature,r of the sharpest corner}}{\text{Mean radius of the particle, R}}$$

for Fig. 2 (b) (2)

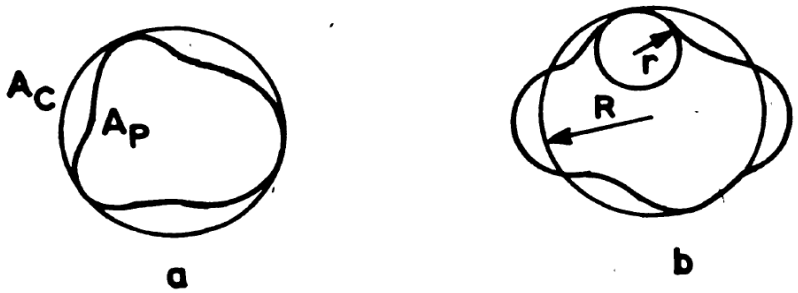

Fig. 2. Diagram for roundness and roundness ratio of a particle

(c) Sphericity

The diameter of a sphere of the same volume as the particle and the diameter of the smallest circumscribing sphere, or the maximum diameter of the particle, is known as sphericity [9]. This parameter shows the shape character of the particle relative to the sphere having same volume. If D_e is the diameter of a sphere having same volume as that of the particle and D_c is the diameter of the smallest circumscribing sphere, then the sphericity can be expressed as under,

$$\text{Sphericity} = \frac{De}{Dc} \quad (3)$$

The sphericity can also be expressed as;

$$\text{Sphericity} = \frac{D_i}{D_c} \quad (4)$$

Where,

D_i = diameter of the largest inscribing circle
D_c = diameter of the smallest circumscribing circle

The D_i and D_c are shown in Fig. 3.

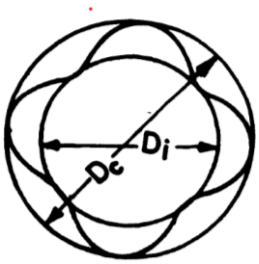

Fig. 3. Diagram of smallest circumscribing and largest inscribing circles of a particle

(d) Volume

Using a measuring beaker and the water displacement method, the volume of randomly picked seeds was calculated. The difference between the final volume water displaced and the initial volume gives the volume of the coconut.

Plate. 1 Volume determination of coconut by water displacement method

(e) Density

The density of any material may be expressed as below,

$$\text{Density} = \frac{Weight\ of\ the\ material, kg}{Volume\ of\ the\ material, m^3} \quad (5)$$

Coconuts were chosen on random basis. The samples were first weighed to ascertain their mass, and then the volume of each sample was calculated by immersing it in water and measuring the volume of water displaced with a measuring beaker. The readings were taken immediately the seeds were immersed into the beaker. The ratio of each mass of the sample obtained from the volume gives the density.

3. RESULTS AND DISCUSSIONS

The result obtained after determining some physical and engineering properties of coconuts are presented in Table 1. The size of the coconut was determined by measuring major axes, intermediate axis and minor axis. The selected seeds were carefully handled in order to measure their three principle dimensions using vernier calliper with an accuracy of 0.02 mm; which are major, minor and intermediate diameters respectively. The principle dimensions. Major, minor and intermediate diameters were measured for fifty coconuts. The value of major diameter ranges from 101.45 mm to 132.33 mm with a mean of 117.24 mm and standard deviation of 9.00. The value of minor diameter ranges from 87.51 mm to107.29 mm with a mean of 97.09 mm and standard deviation of 5.57. The value of intermediate diameter ranges from 85.468 mm to 101.07 mm with a mean of 93.29 mm and standard deviation of 4.59. It was observed that the intermediate, minor diameters and the major diameters all have varying mean value and standard deviation.

The major diameter has the highest value of mean and standard deviation of 117.24 and 9.00 cm respectively. This indicates that the value of this diameter has the largest spread about the mean and hence the highest variability compared with the other diameters.

The weight of the coconut ranges from 370.01 g to 781.69 g with a mean value of 579.99 g. and standard deviation of 104.56 as shown in Table 1. The volume ranges from 425.8861 cm^3 to 713.4501 cm^3 with a mean value of volume of 556.2091 cm^3 and standard deviation of 64.0713 as shown in table 1. The density of the coconuts ranges from 0.7999 g cm^{-3} to 1.3028 g cm^{-3} with mean value of 1.0427 g cm^{-3} and standard deviation of 0.1434 as shown in Table 1.

The roundness ranges from 0.4607 to 0.8216 with a mean value of 0.6490 and standard deviation of 0.1024 as shown in Table 1. The sphericity ranges from 0.7304 to 0.9561 with a mean value of 0.8330 and standard deviation of 0.0461 as shown in Table 1. This value indicates that the shape of the coconut approximates that of spheroid because the mean sphericity value is 0.8330 with a very little deviation among the coconuts.

Table 1. Statistical analysis of physical and engineering properties of the matured coconut

Property	Mean	Maximum	Minimum	Standard Deviation
Major Diameter (mm)	117.24	132.33	101.45	9.00
Minor Diameter (mm)	97.09	107.29	87.51	5.57
Intermediate Diameter (mm)	93.29	101.07	85.68	4.59
Roundness	0.6490	0.8216	0.4607	0.1024
Sphericity	0.8330	0.9561	0.7304	0.0461
Weight (g)	579.99	781.69	370.01	104.56
Volume (cm^3)	556.2091	713.4504	425.8861	64.0713
Density (g cm^{-3})	1.0427	1.3028	0.7999	0.1434

4. CONCLUSIONS

The various investigations on some physical and engineering properties of coconut. The major diameter of the coconut was obtained 101.45 mm to 132.33 mm and the mean value was 117.24 mm. The minor diameter ranges between 87.51 mm to 107.29 mm with mean of 97.09 mm. The intermediate diameter of the coconut ranges between 85.68 mm to 101.07 mm with the mean value of 93.29 mm. The shape of the coconut was found to be approximately as that of a ovoid or ellipsoid. The mean value of roundness of the coconut was found to be 0.6490 with a standard deviation of 0.1024. The mean value of the sphericity of the coconut was found to be 0.8330 with a standard deviation of 0.0461.The weight of the coconut ranges between 370.01 g to 781.69 g with a mean value of 579.99 g and standard deviation was found to be 104.56 g .The average volume of the coconut was found to about 556.2091 cm^3 with a standard deviation of 64.0713 cm^3.The average density of the coconut was found to be about 1.0427 g cm^{-3} with a standard deviation of 0.1434 g cm^{-3}.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Sumy Sebastain, Abesh Reghuvaran, Geena MG, Divya Patel, Sinjula CS, Satheeshkumar R. Coir pith, wealth from waste. India inter. Coir Fair, Print Ex Press, Cochin. 2016;87.
2. World Wildlife Fund. Petenes Mangroves. Encyclopedia of Earth. Washington DC: National Council for Science and the Environment; 2010.
3. Rodrigues GS, Martins CR, de Barros I. Sustainability assessment of ecological intensification practices in coconut production. Agricultural Systems. 2018; 165:71-84.
4. Raghavi MD, Surender S, Kalidas K. Review on area, production and productivity of Coconut in India Int. J. Res. Business Manag. 2019;7(1):1-6.
5. Preethi VP, Thomas KJ, Kuruvila A. Performance of coconut in India: A trend analysis. Journal of Tropical Agriculture. 2019;56(2).
6. Pandiselvam R, Manikantan MR, Kothakota A, Rajesh GK, Beegum S, Ramesh SV, Niral V, Hebbar KB. Engineering properties of five varieties of coconuts (*Cocos nucifera* L.) for efficient husk separation. Journal of Natural Fibers; 2018.
7. Mohsenin NN. Physical properties of plant and animal materials. Gordon and each Science Publisher, New York. 1970;498.
8. Bui H, Sebaibi N, Boutouil M, Levacher D. Determination and review of physical and mechanical properties of raw and treated coconut fibers for their recycling in construction materials. Fibers. 2020;8(6): 37.
9. Sahay KM, Singh KK. Unit operations of agricultural processing. Vikas Publishing House Private Limited, New Delhi, India. 1994;558.

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