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Effect of moisture content on various engineering properties of Chironji nuts

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Abstract
Chironji kernel (*Buchanania lanzan*) is very important dry fruit. It is used as a substitute of olive and almond oils, and used for indigenous medicines. At present, it is growing under forest condition as an under exploited commodity and it is an income generating produce for the forest dependent tribal communities. Chhattisgarh is the major chironji nut producing state in India. The purpose of present work was to generate data of various varieties of Chironji of Chhattisgarh and study their dependency on moisture content which will be helpful to promote development of machinery for decortication. As such, three samples were collected from the three different forest of Chhattisgarh. Sample A, B and C of chironji nut were collected from village Vishrampuri, Keshkal, and Geedam respectively of the Bastar, Kondagaon and Dantewada district of Chhattisgarh.

The engineering properties were investigated for moisture content in the range 7.21% (db) to 20.09% (db). The average value of sphericity were found to be 0.72 to 0.877, porosity values were in the range 64 to 72.6%, the average value of angle of repose values ranged from 16.64 ^{0}C to 28.53 ^{0}C, the terminal velocity was obtained with values ranging from 11.15 m/s to 20.67 m/s and The average value of Specific heat ranged from 0.2080 cal/g/^{0}C to 0.57 cal/g/^{0}C, coefficient of internal friction was found to be in the range 0.463 – 0.584 and coefficient of external friction was found to be 0.436 – 0.577.

Keywords: Moisture content, various engineering, Chironji nuts

1. Introduction

Chironji or Charoli, (*Buchanania lanzan* Spreng) belongs to the family Anacardiaceae. It is a medium-sized deciduous tree, growing to about 50 ft tall, and subtropical, underutilized and underexploited popular edible nut fruit, eaten raw or roasted and also used in making dessert. It is considered to be native to India and is commonly found in the dry forests of Jharkhand, Madhya Pradesh, Chhattisgarh, Varanasi and Mirzapur districts of Uttar Pradesh. This multipurpose tree provides food, fuel, fodder, timber and medicine to the local community. (Nitrakar, 2014) [7]. Kernel is rich in protein content (34-50%). The fruit of chironji contains a hard nut that on decortication yields kernel containing about 52% oil (Panchabhai, 2012) [8].

Chironji tree is a commercially important tropical plant, makes an important contribution to the tribal economy of Chhattisgarh state. Chironji tree has great medicinal value and used as a drug of the ayurveda and the Unani system of medicine. Chironji is known to have tonic, cardio tonic, and the parts of the plant are used for the treatment of various disorders (Kumar J. *et al.*, 2014) [5].

The collection and sell of nationalized forest produce is done by CG MFP Federation only. Chironji is non-nationalized Non-Wood Forest Produce in Chhattisgarh. Estimated annual trade of Chironji is 5000-10000 MT per year at national level. According to CGMFPF, Chhattisgarh have 51,200 quintal per year production potential of Chironji valued for Rs. 44.29 cores contributing more than 50 per cent of national production (Rajput B. *et al.*, 2018) [9].

Tradional method of decortication of Chironji nut basically has two processing steps de-skinning of nuts followed by shelling of nuts they are rubbed with a stone-slab on a rough stone surface followed by manual separation of kernels. Absence of machinery to decorticate Chironji nuts and further knowledge on processing of extracted kernels is short, tough some decorticators are designed but they are limited to the prototype phase.

The printed literature on the physico-chemical characteristics of Chironji nuts is scarce. Hence, the present study is an attempt in the direction to generate information regarding engineering properties of Chironji nuts of cultivars present in Chhattisgarh state. Keeping the above points in mind the present research work was taken up with the following objectives:

1. Collection of Chironji nuts from the local markets near the forest areas of Chhattisgarh.
2. To study the engineering properties of Chironji nuts and effect of moisture content on various engineering properties of Chironji nuts.

2. Materials and Methods

2.1 Collection of Raw Material

Three samples of chironji nuts we taken for experimentation. Chironji nuts were purchased from a village markets of Vishrampuri of Bastar district, Keshkal of Kondagoan district and Geedam village of Dantewada district, in August 2019. The quantity of chironji nuts procured were 1.5 kg, 1.5 kg and 2.5 kg respectively. The chironji nuts were cleaned manually to remove all foreign matters such as dust, stones and chaff as well as immature infested and broken nuts Plate 1 shows the three samples of chironji.

2.2 Sample conditioning

Three varieties of chironji nuts, were used in the experiments. The sample were manually cleaned to remove foreign matter, dust, and dirt. The initial moisture content of the sample was determined using the hot-air oven method. Dried Chironji nuts were conditioned by adding a calculated amount of water, mixing thoroughly, and then sealing in separate polyethylene bags. The amount of distilled water to be added for different moisture contents was calculated using the following formula. (Coskun *et al.,* 2006) [1].

(a)

(b)

(c)

Plate 1: Sample (a) procured from Vishrampuri, sample (b) procured from Keshkal, and sample (c) procured from Geedam.

$$Q = \frac{W_i(M_f - M_i)}{100 - M_f} \quad \ldots\ldots\ldots \quad (1)$$

Where,

Q = mass of water to be added. (g)

W_i = initial mass of chironji nuts. (g)

M_f = desired moisture content. (%db)

M_i = initial moisture content of chironji nuts. (%db)

2.3 Moisture Content

For determination of moisture content of chironji nut, Hot air oven method was used. (KM Sahay and KK Singh, 1994) [10].

$$\text{Moisture content (\% dry basis)} = \frac{weight\ of\ water\ in\ the\ product}{weight\ of\ dry\ matter} \times 100 \cdots\cdots (2)$$

2.4 Engineering properties
2.4.1 Thousand chironji nuts weight
1000 representative number of chironji nuts where taken from each sample and weighed in weighing machine.

2.4.2 Sphericity
The degree of sphericity can be expressed as given formula. (Sahay and Singh 1994) [10]. Length, breadth and height of the kernels were measured using a Vernier caliper.

$$\text{Sphericity} = \left[\frac{l\,b\,t}{l}\right]^{\frac{1}{3}} \quad (3)$$

l = longest intercept, mm
b = longest intercept perpendicular to l, mm
t= longest intercept perpendicular to l and b, mm

2.4.3 Bulk density
100 g nuts was weighed in weighing machine and then chironji nuts was filled in a measuring cylinder to find its volume. Bulk density of chironji nut was determined by following formula (Mohsenin, 1970).) [6].

$$\rho_b = \frac{W(kg)}{V(m^3)} \quad (4)$$

Where
W = weight of chironji nuts. (Kg)
V = Volume occupy by chironji nuts. (m^3)

2.4.4 True density
Toluene was used to find the true volume of chironji nuts. True density was calculated by the formula. (Mohsenin, 1970) [6].

$$\rho_t = \frac{W(kg)}{V_t\,(m^3)} \quad (5)$$

Where
W = weight of chironji nuts (kg)
V_t = true volume (m^3)

2.4.5 Porosity
The porosity was computed by the following formula. (Mohsenin, 1970) [6]

$$\text{Porosity} = 1 - \frac{bulk\ density}{true\ density} \times 100 \quad (6)$$

2.4.6 Angle of repose
Angle of repose is calculated by following formula. (Mohsenin, 1970) [6]

$$\emptyset = \tan^{-1}\frac{H}{R} \quad (7)$$

Where
H = Height of the cone.
R = Radius of the cone.
ϕ = Angle of repose.

2.4.7 Coefficient of friction
The coefficient of state friction of chironji was determined on GI sheet, Experimental setup consisted of an friction table, frictionless cord, hollow cylinder, pan and fractional weights Coefficient of external friction was determined by sliding the chironji nuts against GI sheet. Coefficient of internal friction was determined by sliding the chironji nuts against layer of chironji nuts. It was calculated using the following formula. (Mohsenin, 1970) [6]

$$\text{Coefficient of external friction (f)} = \frac{F}{W} \ \ldots\ldots\ldots (8)$$

Where
F = coefficient of external friction.
F = weight of pan + fractional weight (g)
W = weight of hollow cylinder + weight of chironji nuts. (g)

2.4.8 Terminal velocity
The terminal velocity of chironji nuts were found using seed blower and moving vane anemometer.

2.4.9 Specific heat
Experimental setup for determination of specific heat consists of a thermos flask fitted with a thermometer. Principle of method of mixtures is employed for calculation of specific heat of chironji nuts. It is calculated by following formula.

$$Q = mc_p\,\Delta T \ \ldots\ldots\ldots \quad (9)$$

Where
Q = heat, cal
m = mass. (g)
c_p = specific heat (cal/g/°C)
ΔT = change in temperature. (°C)

3. Results and Discussions

Plate 2: Tribal market in Vishrampuri

The engineering properties were determined for the three samples individually at different moisture content of 9.21% (db), 13.28% (db), 17.64% (db) and 20.09% (db) for sample A, for sample B engineering properties were found at 7.21% (db), 12.95%(db), 17.64% (db), 20.09% (db) and for sample C the moisture content value were found at 9.26% (db), 13.28% (db), 15.46% (db), 20.09% (db) respectively.

3.1 Sphericity
The average value of Sphericity ranged from 0.79 to 0.867 for sample A, from 0.772 to 0.877 for Sample B and for sample C it ranged from 0.801 to 0.856

If seen deeply one can conclude that the value for sphericity increased with the increase in moisture content. Deshpande *et al*. (1993) [2] reported that nut became more spherical with increase in moisture content.

The relationship between Sphericity and moisture content can be represented by the following equation:

Sample A: Y=0.6652x + 73.307 (R^2 = 0.9648)…… (10)

Sample B: Y= 0.7182x + 72.137 (R^2 = 0.9070)…………. (11)

Sample C: Y=0.5366x + 75.278 (R^2 = 0.9001)………… (12)

Where, y = Sphericity and; x = moisture content of chironji.

3.2 Porosity

Porosity values were obtained in the range 67.15 to 64.7% for sample A, from 66.83 to 64% Sample B and 72.6 to 68.48% for sample C.

The relationship between Porosity and moisture content can be computed by the following equation:

Sample A: =-0.2484x +69.654 (R^2 = 0.9262)……… (13)

Sample B: Y= -0.2278x + 68.687 (R^2 = 0.9586)……… (14)

Sample C: Y=-0.0855x + 69.191(R^2 =0.0489)……… (15)

Where, y = porosity and; x = moisture content of chironji.

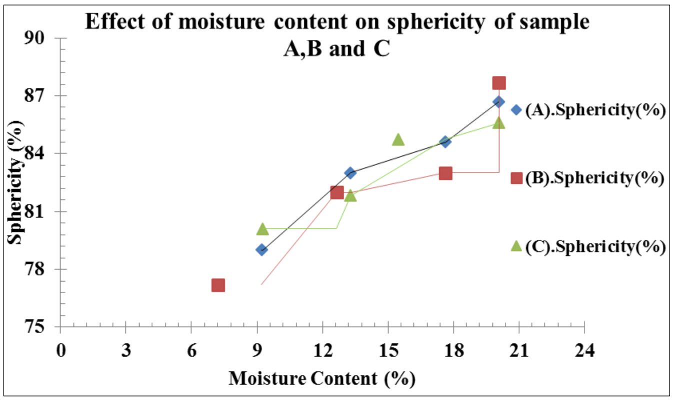

Fig 2: Effect of moisture content on sphericity of chironji nuts of Sample A, B and C

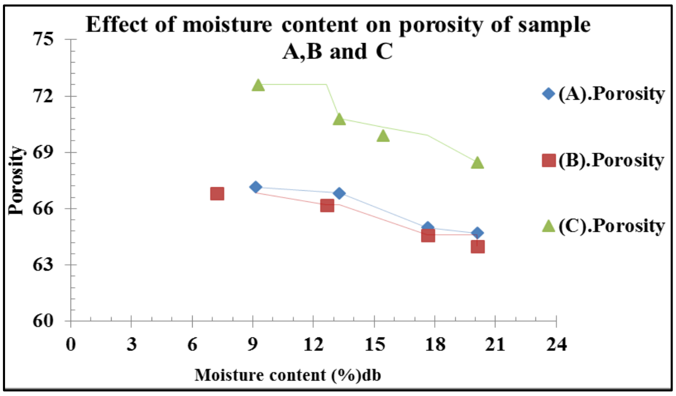

Fig 3: Effect of moisture content on porosity of chironji nuts on Sample A, B and C

3.3 Angle of repose

The average value of Angle of repose values ranged from 16.64^0 to 19.23^0 for sample A, 16.64^0 to 19.19^0 sample B and 22.6^0 to 28.53^0 sample C respectively. Angle of repose increased with the increase in moisture content.

Kumar (2014) [5] also obtained an increasing trend for variation of angle of repose with moisture content. According to experiments carried out by him, the angle of repose ranged from 28.10^0 to 32.90^0 whereas, in this experimant it ranged from 16.64^0 to 28.53^0.

The relationship between Angle of repose and moisture content can be computed by the following equation:

Sample A: Y= 0.2665x + 14.079 (R^2 = 0.9321)……… (16)

Sample B: Y=0.1899x + 15.789 (R^2 = 0.7434)………. (17)

Sample C: Y=0.5787x + 16.358 (R^2 = 0.8754)……… (18)

Where, y = Angle of repose and; x = moisture content of chironji.

3.4 Terminal Velocity

The Terminal Velocity was obtained with values ranging from 11.15 m/s to 18.24 m/s for sample A, 12.03 m/s to 18.1 m/s sample B and 12.14 m/s to 20.67 m/s sample C. respectively was obtained. A gradual increase in Terminal Velocity with increase in moisture content can be witnessed. This is because with increase in moisture content, there is an increase in weight due to which a high velocity of jet of air is required to bring the nuts to fluidized state.

The relationship between Terminal Velocity and moisture content can be computed by the following equation:

Sample A: Y=0.3774x +9.4900 (R^2 = 0.8122)………. (19)

Sample B: Y= 0.8194x + 5.0853 (R^2 = 0.9059)………. (20)

Sample C: Y=0.6559x + 4.6560 (R^2 = 0.9695)………. (21)

Where, y = Terminal Velocity and; x = moisture content of chironji.

3.5 Specific heat

The average value of Specific heat ranged from 0.2080 cal/g/^{0}C to 0.7705 cal/g/^{0}C for sample A, 0.237 cal/g/^{0}C to 0.555 cal/g/^{0}C sample B and values for sample C 0.2780 cal/g/^{0}C to 0.5616 cal/g/^{0}C respectively.

Similar studies were carried out by Mortaza *et al.* (2008) on berberis fruit, the value of specific heat increased 1.9653 kJ/kg °C to 3.2811 kJ/kg °C, while the moisture increased from 19.3% - 74.3%.

The relationship between Specific heat and moisture content can be computed by the following equation:

Sample A: Y=0.0432x - 0.2600 (R^2 = 0.6561)……… (22)

Sample B: Y= 0.0213x - 0.0389 (R^2 = 0.0389) ……… (23)

Sample C: Y=0.0283x - 0.0030 (R^2 = 0.9377) ………… (24)

Where, y = Specific heat and; x = moisture content of chironji.

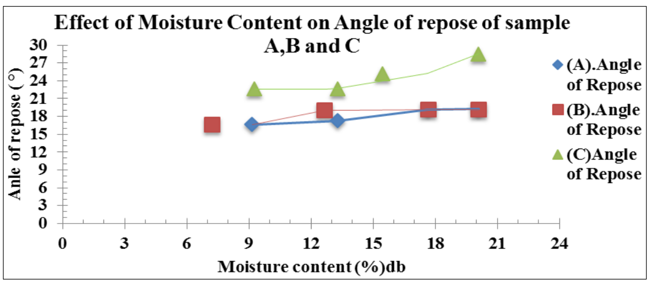

Fig 4: Effect of moisture content on angle of repose of chironji nuts on Sample A, B and C

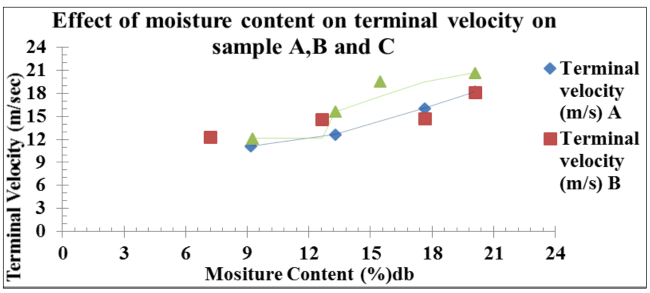

Fig 5: Effect of moisture content on terminal velocity of chironji nuts on Sample A, B and C

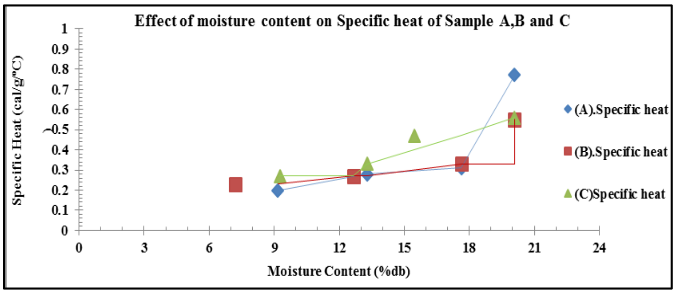

Fig 6: Effect of moisture content on specific heat of chironji nuts on Sample A, B and C

3.6 Coefficient of friction

3.6.1 Coefficient of friction (internal)

The average coefficient of friction values ranged from 0.511 to 0.584 for sample A, 0.511 to 0.559 sample B and values for sample C 0.463 to 0.527, within moisture range of 9.21(% db) to 20.09 (%db) for sample A, 7.21(% db) to 20.09(% db) sample B and 9.26(% db) to 20.09% (db) sample C respectively.

Kumar *et al.*,(2014) [5], carried out experiments on moisture dependent physical properties of chironji nuts the results obtained were in the range 0.550 to 0.654 within the moisture range 6.60% (db) to 11.07% (db) whereas, on our experiment it ranged from 0.511 to 0.559 with in moisture content 7.21%(db) to 20.09% (db).

The relationship between Coefficient of friction (internal) and moisture content can be computed by the following equation:

Sample A: Y=0.0072x + 0.4464 (R^2 = 0.9657) …… (16)

Sample B: Y= 0.0038x + 0.4879 (R^2 = 0.9417) …… (17)

Sample C: Y=0.0061x + 0.4035 (R^2 = 0.9754) …… (18)

Where, y = Coefficient of friction and; x = moisture content of chironji.

3.6.2 Coefficient of friction (external)

The average values of coefficient of friction ranged from 0.53 to 0.577 for sample A, 0.508 to 0.577 sample B and values for sample C 0.436 to 0.546,within moisture range of 9.21% (db) to 20.09%(db) for sample A, 7.21% (db) to 20.09% (db) sample B and 9.26% (db) to 20.09% (db) sample C respectively.

Kumar *et al.*, (2014) [5] reported similar results obtained in the range 0.501 to 0.531 within the moisture range 6.60% (db) to 11.07% (db).

The relationship between Coefficient of friction (internal) and moisture content can be computed by the following equation:

Sample A: Y=0.0037x + 0.4917 (R^2 = 0.7545) ……… (19)

Sample B: Y= 0.0053x + 0.4639 (R^2 = 0.9295) ……… (20)

Sample C: Y=0.0110x + 0.3343 (R^2 = 0.8469) ……… (21)

Where, y = Coefficient of friction and; x = moisture content of chironji.

It was observed that the static coefficient of external friction for chironji nut increased with increase in moisture content on the G.I. sheet surface. In all the samples coefficient of external friction increased. It was observed that the moisture effects the material surface owing to the increased adhesion between the nut and the surface at higher moisture value. It is also possible that the chironji nut become rougher on its surface as the moisture content increases making the coefficient of friction go up.

Similar observation have been reported by Aviara *et al.* (1999) for guna seed. Dutta *et al.* (1998) [3] for gram, Gupta and Das (1997) [4] for sunflower that coefficient of external friction increased with increase in moisture content.

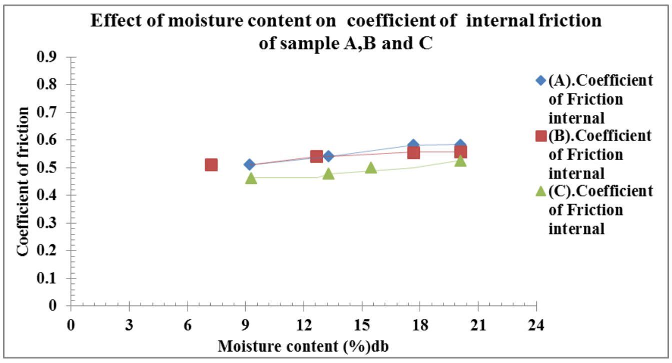

Fig 7: Effect of moisture content on coefficient of friction (internal) of chironji nuts on Sample A, B and C

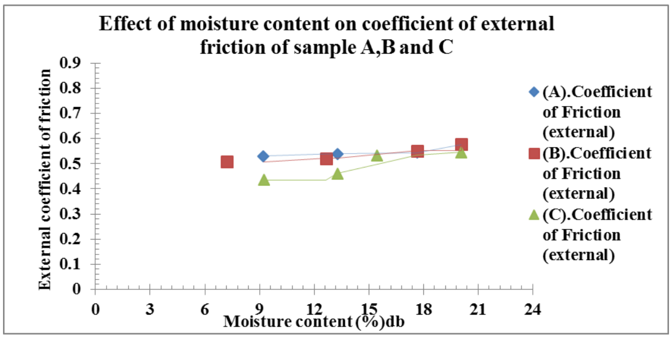

Fig 8: Effect of moisture content on coefficient of friction (external) of chironji nuts on Sample A, B and C

4. Specific conclusions drawn from the studies are

1. The various properties like length, width, thickness, equivalent diameter, and sphericity, and bulk density, angle of repose, terminal velocity, and specific heat are increased with the increase in moisture content.
2. True density is the property which first increase and then decreases with the increase in moisture content.
3. Porosity is the property which decreases with the increase in the moisture level.

5. Reference

1. Coskun MB, Yalcm I, Özarslan C. Physical properties of sweet corn seed (Zea mays saccharata Sturt.) J Food Eng. 2006; 74(4):523-528.
2. Deshpande SD, Bal S, Ojha TP. Physical properties of soybean. J Agric. Eng. Res. 1993; 56:89-98.
3. Dutta SK, Nema VK, Bhardwaj RK. Physical properties of gram. J Agric. Eng. Res. 1988; 39:259-268.
4. Gupta RK, Das SK. Physical properties of sunflower seeds. J Agric. Eng. Res. 1997; 66:1-8.
5. Kumar Jitendra, Prabhakar PK, Srivastav PP, Bhowmick PK. Physical characterization of Chironji (*Buchanania lanzan*) nut and kernels. Food Science Research of Journal. 2014; 5(2):148-153.
6. Mohsenin NN. Physical Properties of Plant and Animal Materials. Gordon & Breach Science Publishers, New York, 1970.
7. Niratkar CD, Sailaja. Preliminary Photochemical Screening and Evaluation of Antimicrobial Activity of *Buchanania lanzan* (Chironji) from Chhattisgarh. World Journal of Pharmaceutical Research. 2014 3(9):514-522.
8. Panchabhai VK. Studies on storage of Chironji (*Buchanania lanzan* Spreng.) Kernels in Different Packaging Materials. (Unpublished M. Tech Thesis submitted to Indira Gandhi Krishi Vishwavidyalaya,

Raipur), 2018.
9. Rajput BSD, Gupta S, Kumar K, Singh C, Tiwari *Buchanania lanzan* Spreng (Chironji): A vulnerable multipurpose tree species in Vindhyan region. Journal of Pharmacognosy and Phytochemistry. 2018; 7(5):833-836.
10. Sahay KM, Singh KK. Unit operations of agricultural processing. Vikas Pub. House Pvt. Ltd, New Delhi, 1998.
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