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Effect of moisture content on the physical and frictional properties of clove (*Syzygium aromaticum*) for the design of storage structure and microwave-assisted oil extraction systems

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ABSTRACT

Clove (*Syzygium aromaticum* L.) is a commercially significant aromatic spice cultivated widely in tropical regions and valued for its culinary and medicinal applications. Understanding its engineering properties under varying moisture conditions is essential for the design of efficient handling, processing, and storage systems. This study presents a systematic evaluation of the physical and frictional properties of clove at five moisture contents: 7%, 10%, 13%, 16%, and 19% (wet basis). The average length, width, and thickness of clove buds were measured as 15.96 mm, 5.38 mm, and 3.78 mm, respectively, with corresponding geometric mean diameter (GMD), sphericity, and surface area values of 6.875 mm, 0.430, and 148.41 mm^2. Increasing moisture content resulted in a marked decline in bulk density (872.2-384.4 kg·m^{-3}) and an increase in true density (1090-1250 kg·m^{-3}), leading to higher porosity (19.98-69.24%). The angle of repose increased from 28.29° to 41.18°, while the angle of internal friction increased from 28.50° to 41.00°. Similarly, the angle of external friction increased with moisture content, with angles on plywood rising from 29.61° to 43.55°, and on galvanised steel from 25.93° to 41.05°. The results confirm that moisture content significantly influences both dimensional and frictional characteristics of clove, with direct implications for equipment design, energy requirements, and process optimization in spice processing industries. The presented data serve as a critical reference for engineering applications such as hopper design, conveying systems, and storage facility planning to ensure quality preservation and operational efficiency of clove spice.

Keywords: Clove, Engineering properties, Moisture content, Bulk density, Porosity, Sphericity, Angle of repose, Static friction

INTRODUCTION

Syzygium aromaticum (synonym: *Eugenia caryophyllata*), commonly known as clove, is a medium-sized tree (typically 8-12 meters tall) belonging to the Myrtaceae family and is native to the Maluku Islands of eastern Indonesia. Historically, clove has been a highly prized spice, and its trade played a significant role in shaping the economic landscape of the region for centuries. (Anonymous, 2025a) Clove trees are commonly grown in coastal regions, typically at elevations not exceeding 200 meters above sea level. The commercially valuable part of the tree is the flower bud, which begins to develop around four years after planting. Harvesting is carried out during the bud maturation stage, prior to blooming. This process can be done manually or enhanced through the application of natural phytohormones that release ethylene within the plant tissues, promoting early maturation. (Danthu *et al.,* 2020)

Spices such as clove, oregano, mint, thyme, and cinnamon have long been used not only for flavouring food but also for their preservative and medicinal properties. Their effectiveness is largely attributed to their natural antioxidant and antimicrobial compounds. In recent years, scientific studies have further validated the broad-spectrum biological activities of these spices, including antibacterial, antifungal, antiviral, and anti-carcinogenic effects. Among them, clove has garnered particular interest due to its exceptionally strong antioxidant and antimicrobial potential, distinguishing it from many other spices. (Shan *et al.,* 2005) Eugenol is the primary compound found in clove essential oil, making up approximately 90-95% of its composition. This chemical is largely responsible for the distinct aroma and taste associated with cloves. In fact, eugenol typically constitutes 72-90% of the essential oil derived from cloves, with the remainder consisting of various minor compounds (Kamatou *et al.,* 2012).

Apart from enhancing taste, cloves are valued for their antimicrobial, antioxidant, and anti-inflammatory properties (Verma *et al.,* 2025). Commonly used in whole or ground form, cloves are an integral ingredient in spice blends like garam masala and are also used in pickles, teas, sweets, and baked goods. Major clove-producing countries include Indonesia, Madagascar, Tanzania, and Sri Lanka. Despite its widespread use, understanding the physical and engineering properties of clove, such as moisture content, bulk density, porosity, particle size, angle of repose, and mechanical strength, is essential for designing processing equipment and optimising storage and handling conditions. This study, therefore, focuses on evaluating these properties to support further technological development in clove processing and utilisation.

MATERIALS AND METHODS

The bulk quantity of clove spice was procured from the local market of Ambedkar Nagar district for the determination of its physical and frictional properties. The experimental investigations were conducted in the laboratory of the Department of Processing and Food Engineering, Mahamaya College of Agricultural Engineering and Technology, Ambedkar Nagar.

Moisture content

The moisture content of clove spice was determined using a digital moisture analyser (Model: LMB-9090, LABWAN). Three samples, each weighing 10 g, were selected for the analysis to ensure accuracy and repeatability of results. Fresh cloves are usually dried until the moisture content reaches 13±1 % for their optimal preservation (Najafian, 2014). If the water content is less than 12 %, cloves will be brittle, while if the water content is more than 14 %, the cloves will be susceptible to microorganisms and can affect the quality of products (Murni *et al.,* 2017). Given physical and frictional properties were measured at different moisture content, such as 10, 12 and 14 percent (d. b.). The samples with the required moisture content were created by adding a calculated amount of distilled water based on the following relationship (Coskun *et al.,* 2005):

$$Q = \frac{Wi(Mf - Mi)}{100 - Mf}$$

Where,

Q = Added water to the clove buds, (kg)

W_i = Initial weight of the clove buds, (kg)

M_i = Initial moisture content of clove buds, (w.b.) %

M_f = Final moisture content of clove buds, (w.b.) %

Measurement of physical properties of the clove spice

The various physical properties measured included length(L), width(W), thickness(T), geometric mean diameter (GMD), surface area, sphericity, bulk density, true density, and porosity. A sample of 100 clove buds was erratically picked, and their three main dimensions (length, width, and thickness) were measured with a digital vernier calliper, achieving an accuracy of 0.02 mm. The mass of 1,000 clove buds was determined by manually counting and weighing different sets of clove buds using a digital balance that has an accuracy of 5 g. The average value of three replications was taken.

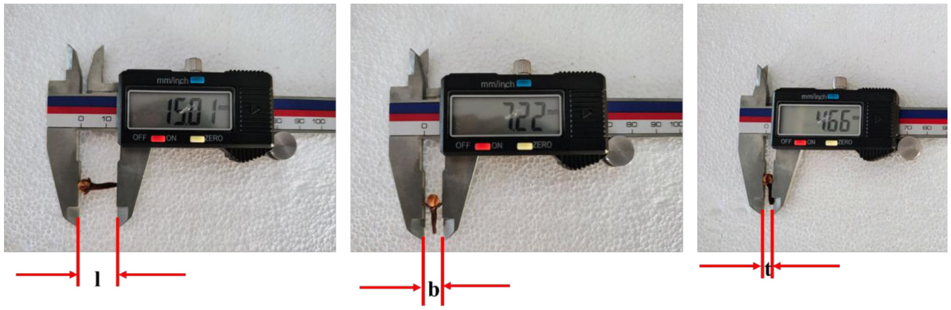


Fig. 1. Axial dimensions of clove buds l (length), b (width) and t (thickness)

Axial dimensions

The dimensions of individual clove buds were measured using a digital Vernier calliper with a measurement range of 0-200 mm and a precision of 0.001 mm. The axial dimensions are denoted as l, b, and t, corresponding to major (length), intermediate (width), and minor diameters (thickness) as shown in Fig. 1.

Bulk density

The bulk density of clove buds was measured by filling a circular container with a volume of 442.4 m^3, without any manual compaction. The mass of the clove buds was then recorded using an electronic weighing scale with a precision of 5 grams. The bulk density was determined using the following formula (Singh *et al.,* 2025):

$$Pb = \frac{W}{V}$$

P_b = Bulk density, kg/m^3, W = Weight of material, kg, V = Volume of the container, m^3

True density

The liquid displacement technique was used to determine the true density of clove buds as shown in Fig. 2. The true density was determined by calculating the ratio of the mass of the clove buds (in kg) to the volume of water displaced (in m^3), using the following formula (Singh *et al.,* 2025):

$$Pt = \frac{W}{V}$$

P_t = True density, kg/m^3, W = Mass of the clove buds, kg, V = Volume of water displaced, m^3

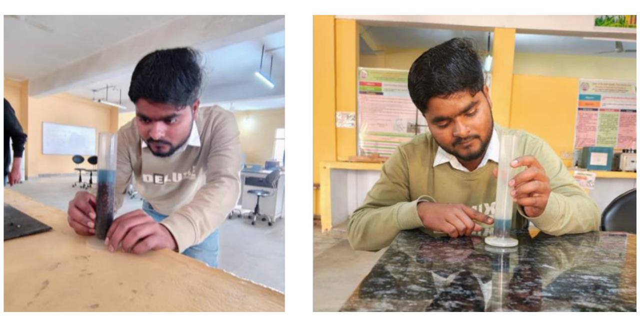


Fig. 2. Liquid displacement technique to determine true density of clove buds Porosity

The porosity was determined from the measured values of bulk density and true density using the given relationship (Mohsenin, 1986):

$$\varepsilon = \left(\frac{Pt - Pb}{Pb}\right) \times 10$$

ε = Porosity, %, P_b - Bulk density, kg/m^3, P_t - True density, kg/m^3

Geometric mean diameter (GMD)

A vernier calliper with a minimum count of 0.02 mm was used to measure the three principal dimensions: major diameter (length), minor diameter (thickness), and intermediate diameter (width). The equivalent diameter of clove buds sample is another name for the geometric mean diameter (GMD). The following formulae were used to calculate the geometric mean diameter (GMD) and sphericity (Mohsenin, 1986):

$$GMD = (LWT)^{1/3}$$

L= Length, mm, W= Width, mm, T= Thickness, mm

Sphericity, (Φ)

In relation to a sphere of the same volume, the sphericity is a measure of shape character. In order to determine the sphericity, the following formula was used, if the diameter of the circumscribed sphere matched the biggest intercept (a) of the tri-axial ellipsoid and that the solid's volume matched that of the ellipsoid with intercepts a, b, and c:

$$\Phi = \frac{(LWT)^{1/3}}{L}$$

Φ = Sphericity, L= Length, mm, W= Width, mm, T= Thickness, mm

Surface area

The following formula was used to determine the surface area

$S = \pi Dg^2$

Dg or GMD = Geometric Mean Diameters, mm, S = Surface Area, mm^2

Measurement of the frictional properties of the clove spice

Angle of Repose

The angle of repose of clove buds is obtained through an angle of repose apparatus. The value of the angle of repose is affected by various factors, including clove buds shape and size distribution, moisture content, and surface friction (Al-Hashemi *et al.,* 2018). The clove buds are poured through a funnel and placed on a base sheet, forming a cone as shown in Fig. 3. When the predetermined height or the predetermined width of the base is reached, the pouring of clove buds is stopped. In this scenario, the angle between the sloping side of the cone formed by the clove buds and the horizontal plane is measured as the angle of repose. During the measurement process, the height of the funnel increases slowly and steadily with the help of an adjustable nut, gradually reducing the impact of the falling clove buds on the measurement results. The angle of repose was calculated as:

$$\alpha = \tan^{-1} \frac{2H}{D}$$

Where,

α = angle of repose

H = height of clove bud's cone, cm

D = diameter of base of clove bud's cone, cm

Fig. 3. Measurement of the angle of repose of clove buds

Angle of External Friction

The angle of external friction was determined using a table provided with changeable surfaces, as per the method suggested by Richard, 1954 and Singh *et al.,* (2025). The experimental setup is shown in Fig. 4. A box of size 90 mm × 90 mm × 90 mm was tied by a cord passing over a pulley, and a pan was attached to this cord. Subsequently, the box was filled with sample material, and again weights were added to cause sliding of the box. Weights were added to the pan until the box started to slide on the desired surface (GI sheet and plywood). These weights (P) were also noted. The coefficient of external friction was calculated as:

$$\mu e = \frac{P - (w \sin \theta)}{w \cos \theta}$$

Fig. 4. Measurement of the angle of external friction of clove buds

Where,

μe = coefficient of the external friction

P = weight in pan

w = weight of clove buds in box

θ = angle of tabletop

Angle of external friction (θ) = $\tan^{-1}\mu_e$

The experiment was performed on two surfaces: plywood and galvanised iron sheet.

Angle of Internal Friction

The angle of internal friction was determined using the method suggested by Richard, 1954 and Singh *et al.,* (2025). The experimental setup is depicted in Fig. 5. A layer of clove buds was placed on an inclined base to measure the friction between clove buds-to-clove bud's surfaces. The weight of the clove bud's sample and the box, which was sized 90 mm × 90 mm × 90 mm, was placed on the inclined base. Subsequently, the box was filled with the sample material and tied with a cord passing over a pulley attached to a pan. The box was then pulled upward slowly until the lower surface of the box left a layer of clove buds on the inclined base. The weights (P) required to cause the sliding of the box were noted. The angle of internal friction was calculated as follows:

$$\mu i = \frac{P - (w \sin \theta)}{w \cos \theta}$$

Where,

μ_i = coefficient of the internal friction

P = weight in pan

w = weight of clove buds in box

θ = angle of tabletop

Angle of internal friction (θ) = $\tan^{-1}\mu_i$

Fig. 5. Measurement of the angle of internal friction of clove buds

Statistical analysis

The experimental data were analysed using one-factor analysis of variance (ANOVA) in Design-Expert (DOE) 13.0 (30-day trial version) software under a user-defined model to assess the effect of moisture content on the measured properties. Mean comparisons were carried out at a 5% level of significance.

RESULTS AND DISCUSSION

The mean values and corresponding standard deviations for the major physical and frictional properties of clove buds at different moisture contents are presented in Table 1. These properties include geometric characteristics such as geometric mean diameter, sphericity, and surface area; bulk characteristics like bulk density, true density, and porosity; and frictional characteristics including the angle of repose and the angles of internal and external friction on different surfaces (plywood and G.I. sheet).

Bulk Density (kg/m³)

Bulk density decreased from 872.40 ± 12.50 kg/m³ (7%) to 384.80 ± 10.01 kg/m³ (19%), indicating expansion of clove buds with increasing moisture content. The reduction suggests that volume increases faster than mass due to swelling, resulting in lower packing efficiency. Similar decreasing trends have been reported in spice materials where moisture causes volumetric expansion and increased inter-particle voids. This behaviour agrees with findings reported for black pepper and other spices, where bulk density decreased at higher moisture levels (Meghwal and Goswami 2011; Buhari *et al.,* 2025). The consistent decline in values confirms the strong influence of moisture on bulk handling properties.

True Density (kg/m³)

True density increased gradually from 1090.00 ± 5.00 kg/m³ at 7% to 1250.00 ± 5.00 kg/m³ at 19% moisture content. This increase reflects the absorption of water into the internal structure of clove buds, which raises their mass per unit volume. The steady rise indicates that moisture fills internal pores and reduces air spaces within the material. Unlike bulk density, this parameter focuses only on the solid portion. The significant differences across moisture levels confirm structural changes in the material. This property is useful for understanding material composition and processing behaviour.

Table 1. Effect of moisture content on physical and frictional properties of clove buds (mean±SD, n = 3)

Property	7 %	10 %	13 %	16 %	19 %
Bulk density (kg/m³)	872.40±12.50[a]	838.03±12.53[b]	642.40±12.50[c]	545.30±10.01[d]	384.80±10.01[e]
True density (kg/m³)	1090.00±5.00[a]	1100.00±5.00[a]	1110.00±5.00[b]	1170.00±5.00[c]	1250.00±5.00[d]
Porosity (%)	20.03±0.45[a]	23.67±0.35[b]	32.07±0.40[c]	42.15±0.35[d]	69.25±0.45[e]
Geometric mean diameter (mm)	5.69±0.03[a]	5.77±0.03[a]	6.31±0.04[b]	6.44±0.04[c]	6.88±0.04[d]
Sphericity	0.39±0.00[a]	0.40±0.00[b]	0.42±0.00[c]	0.43±0.00[d]	0.43±0.00[d]
Surface area (mm²)	101.67±0.85[a]	104.35±0.75[a]	125.23±1.15[b]	130.11±0.90[c]	148.47±1.30[d]
Angle of repose (°)	28.33±0.45[a]	32.24±0.75[b]	36.26±0.75[c]	38.50±0.50[d]	41.23±0.75[e]
Angle of internal friction (°)	28.50±0.30[a]	31.80±0.40[b]	34.41±0.60[c]	38.20±0.50[d]	41.00±0.50[e]
Angle of external friction (Plywood) (°)	29.57±0.45[a]	32.81±0.70[b]	35.67±0.65[c]	38.60±0.50[d]	43.52±0.50[e]
Angle of external friction (G.I. Sheet) (°)	25.91±0.30[a]	30.06±0.45[b]	36.38±0.60[c]	38.64±0.45[d]	41.05±0.55[e]

Notes: Values are means of three replicates±standard deviation.
Means followed by different superscript letters (a-e) within a row differ significantly ($p < 0.05$) according to Tukey's HSD test.

Table 2. Analysis of variance (ANOVA) for the properties of Clove buds

Properties	Sum of Squares	Mean Squares	Degree of freedom	F-Value	Significance
Bulk density (kg/m³)	497856.79	124464. 19	4	928.76	<0.0001*
True density (kg/m³)	53760.00	13440.00	4	537.60	<0.0001*
Porosity (%)	4666.58	1166.64	4	7146.51	<0.0001*
Geometric mean diameter (mm)	2.91	0.7282	4	621.35	<0.0001*
Sphericity	0.0040	0.0010	4	168.71	<0.0001*
Surface area (mm²)	4505.17	1126.29	4	1101.28	<0.0001*
Angle of repose (°)	311.97	155.98	4	368.93	<0.0001*
Angle of internal friction (°)	296.58	74.15	4	333.82	<0.0001*
Angle of external friction (Plywood) (°)	344.60	86.15	4	266.16	<0.0001*
Angle of external friction (G.I. Sheet) (°)	471.23	117.81	4	508.20	<0.0001*

Note: *=Significance at 5% level ($P<0.05$)

Porosity (%)

Porosity increased markedly from 20.03 ± 0.45% at 7% to 69.25 ± 0.45% at 19% moisture content. This sharp rise is due to the combined effect of decreasing bulk density and increasing true density. As clove buds swell, they create larger void spaces between particles. The increase is gradual but becomes more pronounced at higher moisture levels. High porosity indicates greater air space within the bulk sample. This has important implications for aeration, drying efficiency, and storage stability.

Geometric Mean Diameter (mm)

The geometric mean diameter increased from 5.69 ± 0.03 mm at 7% to 6.88 ± 0.04 mm at 19% moisture content. This shows that clove buds expand in size as they absorb moisture. The increase is relatively small at lower moisture levels but becomes more noticeable beyond 10%. This indicates uniform swelling in all dimensions. The statistical variation confirms that size changes are significant. This parameter is important for equipment design such as graders and separators.

Sphericity

Sphericity increased slightly from 0.39 ± 0.00 at 7% to 0.43 ± 0.00 at 19% moisture content. The gradual increase suggests that the shape of clove buds becomes slightly more regular with moisture absorption. However, the change is minimal compared to other properties. At higher moisture levels (16% and 19%), the values remain nearly constant, indicating stabilization in shape. This shows that moisture affects size more than shape. Sphericity plays a role in flow and aerodynamic behaviour.

Surface Area (mm²)

Surface area increased from 101.67 ± 0.85 mm² at 7% to 148.47 ± 1.30 mm² at 19% moisture content. This increase corresponds directly with the increase in size of the clove buds. As the dimensions expand, the exposed surface area also increases. The rise is gradual but significant across moisture levels. Larger surface area enhances interaction with surrounding air during drying or processing. This property is important in heat and mass transfer operations.

Angle of Repose (°)

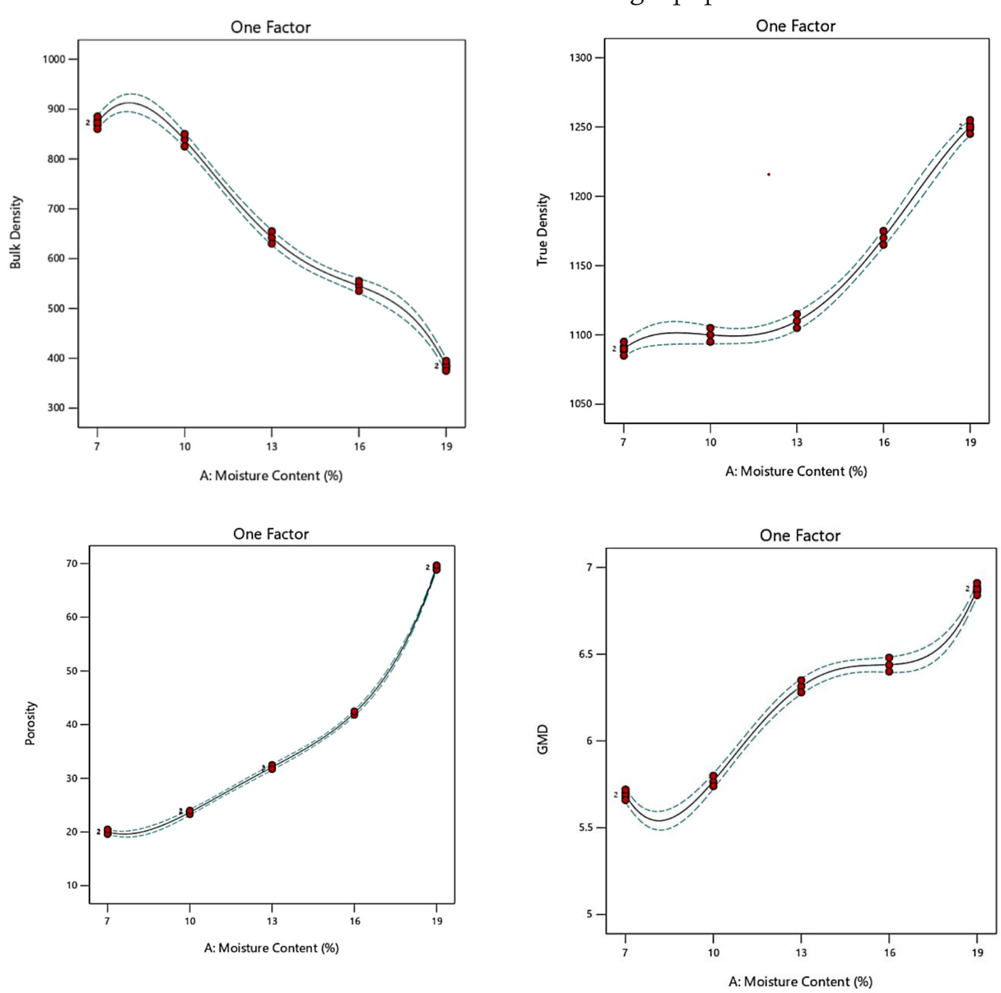
The angle of repose increased from 28.33 ± 0.45° at 7% to 41.23 ± 0.75° at 19% moisture content. This indicates a reduction in flowability of clove buds at higher moisture levels. Increased moisture causes particles to stick together due to cohesive forces. As a result, the material forms steeper piles. The steady increase shows strong dependence on moisture. This parameter is essential for designing storage bins and hoppers.

Angle of Internal Friction (°)

The angle of internal friction increased from 28.50 ± 0.30° at 7% to 41.00 ± 0.50° at 19% moisture content. This reflects increased resistance to movement between particles. Higher moisture enhances adhesion and interlocking among clove buds. The increase is consistent across all moisture levels. This indicates stronger internal bonding within the bulk material. It is an important parameter for analysing stress and pressure in storage systems.

Angle of External Friction (Plywood) (°)

The angle of external friction on plywood increased from 29.57 ± 0.45° at 7% to 43.52 ± 0.50° at 19% moisture content. This shows that resistance between clove buds and the plywood surface increases with moisture. The presence of moisture makes the surface interaction more adhesive. The increase is gradual and statistically significant. This indicates that surface type influences friction behaviour. It is important to select materials for handling equipment.



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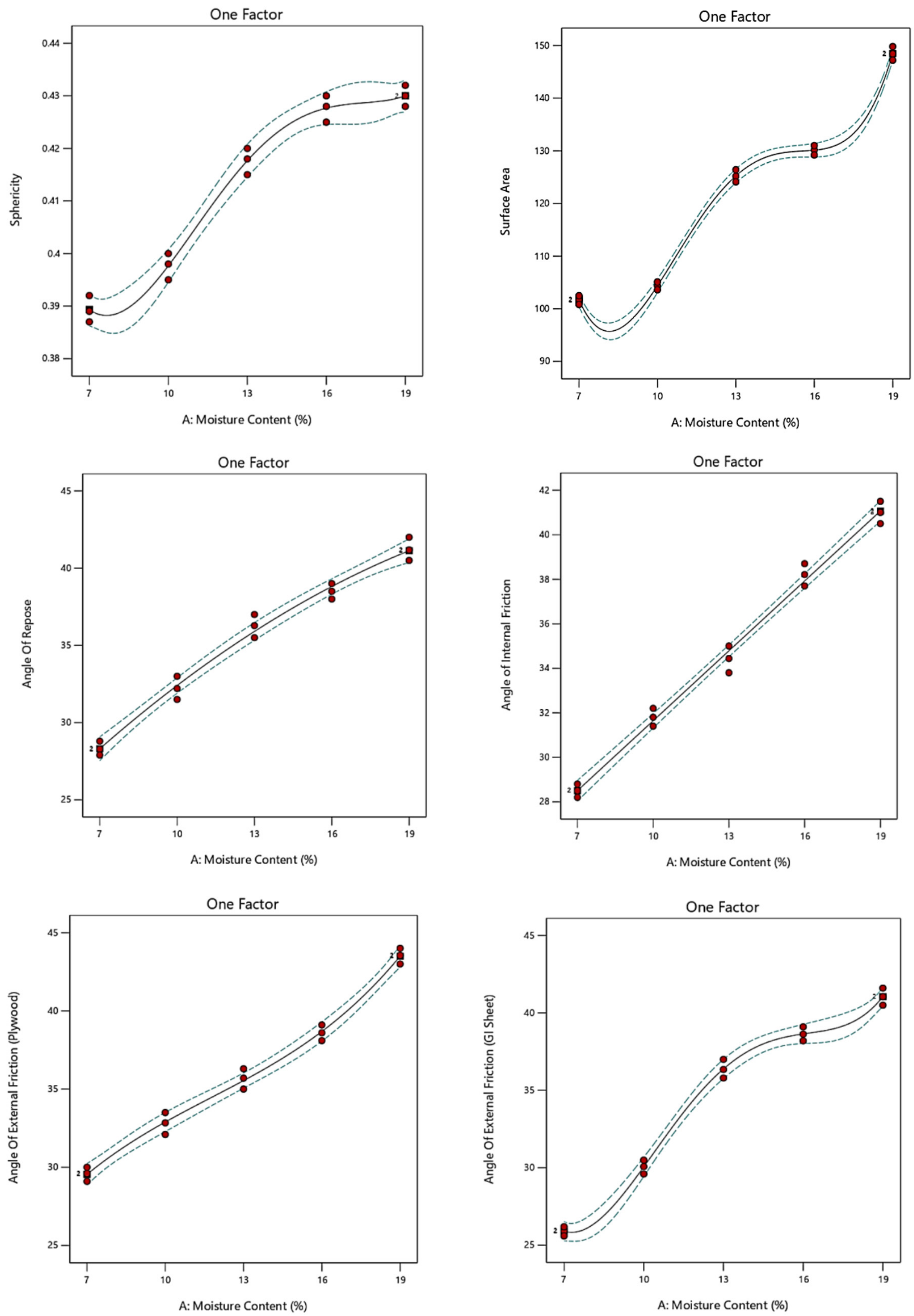

Fig. 6. Effect of moisture content on various Engineering Properties of Clove buds

Angle of External Friction (G.I. Sheet) (°)

The angle of external friction on G.I. sheet increased from 25.91 ± 0.30° at 7% to 41.05 ± 0.55° at 19% moisture content. Although values are lower compared to plywood, the same increasing trend is observed. This suggests that smoother surfaces offer less resistance but are still affected by moisture. The increase confirms that moisture enhances adhesion regardless of surface type. The variation across moisture levels is consistent and significant. This property is useful in the design of chutes and conveyors.

CONCLUSION

This study comprehensively examined how moisture content (7–19%) influences the physical and frictional properties of clove buds and the resulting implications for handling, processing, and equipment design. The Bulk density decreased markedly from 872 to 384 kg/m³ as moisture content increased. Similarly, True density (1090–1250 kg/m³), porosity (20–69%), geometric mean diameter (5.69–6.88 mm), sphericity (0.39–0.43), and surface area (102–148 mm²) all increased with rising moisture levels. The angle of repose, internal friction, and external friction on both plywood and galvanised iron surfaces also increased, indicating reduced flowability and greater interparticle cohesion at higher moisture contents. Overall, the findings highlight the strong effect of moisture on the structural, dimensional, and flow behaviour of clove buds. These data provide a useful basis for designing and optimising storage, conveying, and processing systems to improve handling efficiency and reduce operational challenges associated with changes in moisture content.

REFERENCES

Al-Hashemi, H.M.B. and Al-Amoudi, O.S.B. (2018). A review on the angle of repose of granular materials. *Powder Technology 330*, 397-417.

Anonymous, (2025a). A website .https://thottamfarmfresh.com/what-are-cloves-how-useorganiccloves/?srsltid=AfmBOooaNh8ZIzBNI_9U2Rgg3PaNK38suD5tDGY0A6uGm1ua5cUyqq0- is visited on date 12/04/2025.

Buhari, F.A., Julius, M.O., Akingbade, T.O., Aremu, E.A., Soji-Adekunle, A.R. and Elutu, M.A. (2025). Physico-mechanical properties of clove seeds across moisture content levels. *FUOYE Journal of Engineering and Technology 10*(2), 185–192.

Coskun, M., Yalcin, I. and Ozarslan, C. (2005). Physical properties of sweet corn seed (Zeamayssaccharata Sturt.). *Journal of Food Engineering 74*, 523-528.

Danthu, P., Simanjuntak, R., Fawbush, F., Tsy, J.L.P., Razafimamonjison, G., Abdillahi, M.M., Jahiel, M. and Penot, E. (2020). The clove tree and its products (clove bud, clove oil, eugenol): prosperous today but what of tomorrow's restrictions? *Fruits*, *75*(5), 224-242.

Kamatou, G.P., Vermaak, I. and Viljoen A.M. (2012). Eugenol—from the remote Maluku Islands to the international market place: a review of a remarkable and versatile molecule. *Molecules 17*(6): 6953-6981.

Meghwal, M. and Goswami, T.K. (2011). Effect of moisture content on physical properties of black pepper. *Journal of Agricultural Engineering*, *48*(2), 8, 1-11.

Mohsenin, N.N. (1986) Physical Properties of Plant and Animal Materials. Second edn. Gordon and Breach Science Publishers, New York.

Murni, V.W., Saepudin, E., Cahyana, A.H., Rahayu, D.U.C., Hastuti, L.T. and Haib, J. (2017). Effect of oven drying and storage on essential oil composition of clove (Syzygium aromaticum) from Toli-Toli. In *AIP Conference Proceedings 1862*(1),1-7.

Najafian, S. (2014). Storage conditions affect the essential oil composition of cultivated Balm Mint Herb (Lamiaceae) in Iran. *Industrial Crops and Products 52*, 575-581.

Richard, W.D. (1954). Friction coefficient of some agricultural material. *Agricultural Engineers 35*(6): 411-414.

Shan, B, Cai, Y.Z., Sun, M. and Corke, H. (2005). Antioxidant capacity of 26 spice extracts and characterization of their phenolic constituents. *Journal of Agricultural and Food Chemistry 53*(20): 7749-7759.

Singh, S., Singh, V.K., Mishra, P.K., Kumar, M., Chaudhary V., Verma S. and Singh P. (2025). Efficacy of Moisture Content on Frictional Properties of Food Grains. *Journal of Scientific Research and Reports*. *31*(6), 412-421. https://doi.org/10.9734/jsrr/2025/v31i63139.

Singh, V.K., Verma, S., Chaudhary, V., Singh, V.K., Shivam, S.K.S., Shukla, A. and Yadav, A. (2025). Moisture-Dependent Some Physical Properties of Selected Food Grains. *Environment and Ecology*, *43*(1A), 282-288.

Verma, S., Singh, V.K., Chaudhary, V., Shahi, N.C., Mishra, P.K., and Singh, S.K. (2025). Clove (Syzygium aromaticum): A Champion Spice with Therapeutic and Industrial Potential. *European Journal of Nutrition and Food Safety 17*(5), 119-126.