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Some Physical Properties of *Corchorus Olitorius* Seed as Function of Moisture Content

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Abstract: Study was conducted on some physical properties of *Corchorus olitorius* seed as a function of moisture content. Bulk density, true density, porosity, angle of repose and coefficient of static friction on five structural surfaces (plywood, mild steel, stainless steel, galvanized steel and glass) were determined using standard methods. Moisture content was varied between 9.86%db and 17.69%db across the properties studied. It was observed that within the aforementioned moisture range, bulk density, true density and porosity decreased from 0.6965 g/cm^3 to 0.6146 g/cm^3, 1.2223 g/cm^3 to 1.1364 g/cm^3 and 38.42% to 35.26% respectively. Angle of repose of *corchorius olitorius* seed increased from 42.79° to 45.34° as the moisture content increases. The coefficient of static friction determined on five structural surfaces showed that coefficient of frictional decreased from 0.7843 to 0.2906 with increase in moisture content for all the contact surfaces. There exist a strong relationship between the properties and moisture content as expressed by the regression model.

Keywords: *Corchorus olitorius* Seed, Bulk density, True density, Coefficient of friction, Moisture content**.**

1. Introduction

Corchorus olitorius is a leafy vegetable largely consumed as food ciusine popuar and culturally acceptable in southern part of Nigeria. It called jute mallow in English while the yoruba called it "Ewedu". The soup is prepared by plucking the leave from the stem and rinse in clean water. A potash is added to a boiling water afterward the *Corchorus olitorius* leaves is added and allow to cook for about 7 minutes. Thereafter, it is mash with a special broom called "ijabe", salt, crayfish and locust beans were then added as condiment to the mash to leave a sensational aroma. Proximate analysis show that *Corchorus olitorius* leave contains protein; 6.00 ± 0.01%, fat; 1.05 ± 0.05%, ash; 1.81 ± 0.01%, crude fiber; 1.47 ± 0.02%, carbohydrate; 1.05 ± 0.04% and energy 34.27 ± 1.89 k/cal/10 g[1]. This low in calories makes it good for body weight loss. Corchorus olitorius is known to contain high levels of iron and folate which are useful for the prevention of anaemia [2]. However, *Corchorus olitorius* like other vegetable are seasonal and are susceptible to high degree of deterioration, handling damage and post-harvest losses within a few days after harvest due to their high moisture content.[[3] and[4]] .

Corchorus olitorius is cultivated by seed and germinates well in medium range soil fertility but best in well-drained fertile loamy soil [5]. Direct broadcasting is the most common planting practice of the seed. Before it could be planted, the seed is treated in hot water due to it high dormancy [6]. Therefore, [7] reported that optimum seed germination, seedling emergence and seedling vigour index were obtained at 120^{0}C for 5 minutes of exposure. At maturity, *Corchorus olitorius* plant produces fruit that encapsules the seed. Traditionally, the seeds are threashed from the dryed pods by packing it in bags and beaten with stick or trampled by animal. The chaff and straw were then removed by winnowing. This operation becomes strainous and labourious due to the large scale indigenous demand for the seed during the planting season. There is dearth of information on some of it engineering properties to provide data for design of specific machine for handling and storage. This work therefore determines some physical and frictional properties of *Corchorus olitorius* seed as a function of moisture content.

2.Materials and methods.

For this study, dried seed of *Corchorus olitorius* were harvested at commercial farm of Federal College of Agriculture, Ibadan, south-western Nigeria. The seed was inspected and manually threashed and windnowed to prevent foreign materials. It was then stored in black polythene bag to prevent moisture movement and later transported to soil laboratory for determination the physical properties. The physical parameters analyzed and methods used according to literature are shown in Table 1.
The desired moisture content was prepared by adding calculated amount of distilled water D [8] to each sample. D is computed from Equation 1:

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$$D = \frac{w_i(m_f - m_i)}{100 - m_f} \qquad (1)$$

Where:

Table 1: Method used for determination of some physical properties of *Corchorus olitorius* seed

Physical properties	Units	Literature
Bulk Density	g/cm^3	[9]
True density	g/cm^3	[10]
Porosity	%	[11]
Coefficient of static friction	Value	[12]
Angle of repose	^{o}	[13]

D – mass of water added (g).
w_i – initial mass of the sample (g).
m_i – initial moisture content of the sample (%d b).
m_f – final moisture content of the sample (%db).

The data obtain from each physical property of the *corchorus olitorious* seed determined was replicated five times and the average recorded and statistically analysed using duncan mutipple range test (DMRT). A regression model was used against moisture content to obtain a relationship between the properties.

3.Result and Discussion

Table 2 shows the physical properties *corchorus olitorious* seed at moisture content 9.86, 11.67, 13.68, 15.68, 17.69 %db respectively.

(i) Bulk Density

The bulk density of *corchorus olitorious* seeds decreases with increase in moisture content (Table 2). A decrease from 0.6965 g/cm^3 to 0.6146 g/cm^3 was observed in the moisture content range of 9.86 to 17.69% db. The decrease in bulk density at high moisture content could be explained in terms of an increase in mass due to moisture gain in the sample lower than the accompanying volumetric expansion of the seeds [14]. While the later increase could be because of the combined effect of void space and volumetric expansion of seed at that moisture content. [15] for moringa *oleifera* seed and [16] for Safflower, have reported similar trend in bulk density. The statistical analysis shows that not all bulk density of the seed between the moisture range are significant different from each other at P ≤ 0.05 according to DMRT. A polynomial relationship described the bulk density *(ρ_B)* dependence of moisture *(MC)* as shown below:

$$\rho_B = -0.003MC^3 + 0.0339MC^2 - 0.001303MC + 0.7942 \quad (R^2 = 0.9482)$$

The bulk density of seeds is useful in the design of silos and storage structures.

(i) True Density

The true density decreases from 1.2223 to 1.1364 g/cm^3 (Table 2) as the moisture content increases from 9.86 %db to 17.69%db . Statistical analysis shows no significant difference between the moisture content and true density at p≤0.05 according to Duncan multiple range test (DMRT. Cell structure, volume and mass increase characteristics of seeds as moisture content increases as observed for green wheat [17] and wheat [18]. The true density *(ρ_T)* dependence of moisture (*MC*) was described by a polynomial equation as follows:

$$\rho_T = 0.002MC^3 - 0.0029MC^2 - 0.0103MC + 1.2342 \ (R^2 = 0.9832)$$

True density greater than 1g/cm^3 indicates that the seed is heavier than water hence will sink in water. The true density is useful in the design of cleaning and separation machines and also in computing product yield.

(ii) Porosity

Table 2 shows a non-linear increase in porosity of the seed as the moisture content increases. However, there was no significant difference (p≤0.05) in the mean porosity across the moisture range. Porosity depends on the bulk and true densities the magnitude of variation in porosity depends on these factors only. A similar trend of increase in porosity with increase in moisture content was observed for Faba bean[19] , and sweet corn [20]. The variation in porosity *(P)* with respect to varying moisture content *(MC)* can be represented by polynomial equation.

$$P = 0.3347MC^3 - 3.6321MC^2 + 12.055MC + 34.098 \ (R^2 = 0.9652)$$

Porosity has practical applications in the design of aeration systems during storage. It is also needed by the design of planter metering device.

(iii) Angle of Repose

The mean angle of repose *corchorus olitorius* seed was found to increase from 23.26° to 32.09° in the moisture range of 9.86 – 17.69% db. This increasing trend of angle of repose with moisture content occurs because surface layer of moisture surrounding the particle hold the aggregate of seeds together by the surface tension. Statistical analysis shows that not all angle of repose variation with moisture content are significantly different from each other at p≤0.05 according to DMRT. These results were similar to those reported by [21], for high quality maize and [22] for guna seed. The values of the angle of repose *(β)* for *corchorus olitorius* seed show the following linear relationship with moisture content *(MC):*

$$\beta = 2.1422MC + 21.051 \quad (R^2 = 0.9922)$$

The angle of repose is useful in the design of agricultural machine hopper and conveying equipment such as belt conveyor.

(iv) Coefficient of Static Friction

The mean coefficients of static friction of *corchorus olitorius* seed on five surfaces (plywood, glass, mild steel, galvanized steel and stainless steel) against moisture content in the range of 9.86 – 17.69% db are presented in Table 2. It was observed that the coefficients of static friction decreased with increase in moisture content for all contact surfaces. The reason for the decreased frictional coefficients at higher moisture content may be owing to the fact that the surface of the seeds got smoother at higher moisture content and the sliding characteristic of the seeds improved. At all moisture content, the maximum friction was offered by plywood,

followed by galvanized steel and mild steel, while minimum was observed at glass and stainless steel. The least static coefficient of friction may be owing to smoother and more polished surface of the glass compared to the other materials used. Plywood also offered the maximum friction for Chai seed and barley ([23], [24]). The relationships between coefficient of static friction *(μ)* and the moisture content *(MC)* on plywood (μ_{pw}), glass (μ_g), mild steel (μ_{ms}), galvanized steel (μ_{gs}) and stainless steel (μ_{ss}) can be represented by the following linear equations:

$$\mu_{pw} = -0.0367MC + 0.824 \ (R^2 = 0.9978)$$
$$\mu_g = -0.0209MC + 0.4896 \ (R^2 = 0.9952)$$
$$\mu_{ms} = -0.0368MC + 0.5575 \ (R^2 = 0.9945)$$
$$\mu_{gs} = -0.0341MC + 0.6305 \ (R^2 = 0.9903)$$
$$\mu_{ss} = -0.0294MC + 0.441 \ (R^2 = 0.9953)$$

The data on frictional properties will be useful in hopper design for gravity flow since the angle of inclination of the hopper walls should be greater than the angle of repose to ensure continuous flow of the material. The coefficient of friction on material surface is important in selecting appropriate materials for different units of machinery especially the components requiring flow of the seeds. The design of the container for storage such as silo and for loading and unloading during handling such as hopper is dependent on the knowledge of the friction properties

4.Conclusions

The following conclusions were drawn from the study on some physical properties of *Corchorus olitorius* seed as a function of moisture content.

(i).The bulk density decreased from 0.6965 g/cm^3 to 0.6146 kg/m^3 with the increase in moisture content from 9.86% to 17.69% db.

(ii). The true density decreased from 1.2223 g/m^3 to 1.1364 g/m^3 as the moisture level increased from 9.86% to 17.69% db.

(iii). The porosity increase from 42.79% to 45.34% for the moisture range of 9.86% to 17.69% db.

The angle of repose increased from 23.26° to 32.09° for the moisture range of 9.86% to 17.69% db.

(iv). The coefficient of static friction on plywood (0.7843 to 0.6401), glass (0.4685 to 0.3839) mild steel (0.5186 to 0.3683), galvanised steel (0.6011 to 0.4663) and stainless steel (0.4081 to 0.2906) decrease as the moisture content increases.

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Table 2: Physical properties of *Corchorus olitorius* seed as affected by moisture content

		Moisture content (%db)				
Properties of Seed	**N**	**9.86**	**11.67**	**13.68**	**15.68**	**17.69**
Bulk Density (g/cm^3)	5	0.6965^{c*}	0.6376^{b}	0.6376^{a}	0.6146^{a}	0.6146^{a}
True Density (g/cm^3)	5	1.2223^{a}	1.994^{a}	1.1891^{a}	1.1553^{a}	1.1364^{a}
Porosity (%)	5	42.79^{a}	46.63^{a}	46.21^{a}	45.89^{a}	45.34^{a}
Coefficient of static friction on various surfaces						
Ply wood	5	0.7843^{d}	0.7537^{d}	0.7106^{c}	0.6747^{b}	0.6401^{a}
Glass	5	0.4685^{d}	0.4456^{cd}	0.4307^{bc}	0.4061^{ab}	0.3839^{a}
Mild Steel	5	0.5186^{d}	0.4835^{c}	0.4495^{b}	0.4164^{b}	0.3683^{a}
Galvanize steel	5	0.6011^{d}	0.5591^{c}	0.5272^{b}	0.4878^{a}	0.4663^{a}
Stainless Steel	5	0.4081^{d}	0.3839^{d}	0.3562^{c}	0.3251^{b}	0.2906^{a}
Angle of Repose (^{o})	5	23.26^{a}	25.56^{ab}	27.15^{b}	29.32^{bc}	32.09^{c}

**group means with the same letters are not significantly different at 0.05 level of significant using DMRT.*

References

[1] Raji Akeem Olayemi1, Akinoso Rahman. "Thermal properties of some selected Nigerian soups." Agricultural Sciences Vol.4, No.5B, pp. 96-99 doi:10.4236/as.2013.45B018. 2013

[2]. Steyn NP, Olivier J, Winter P, Burger S, Nesamvuni S A "Survey of wild, green, leafy vegetables and their potential in combating micronutrient deficiencies in ruralpopulations". South African Journal of Science 97 pp 276-279. 2001.

[3] Raji, A. O and Oriola, K . O. "Packaging and handling methods as source of mechanical damage to tomatoe in transit." Journal of Engineering and applied science. 2(9) pp1450-1454, 2007.

[4] Ilori, T.A., Raji, A.O. and Kilanko,O. O. "Some physical properties of selected vegetables." Journal of Agricultural and Veteritary Sciences. 2 pp 101-109, 2010.

[5]. Madakadze, R. M., Kodzanayi, T and Mugumwa, R. "Effect of plant spacing and harvesting frequency on Corchorus olitorious Leaf and Seed Yeilds." African crop science conference proceedings Vol 8 pp 279-282, 2007.

[6] Schippers R, Maundu P, Imbuni M and Obiero H. "How to grow and use Jew's Mallow." Horticultural Development Services, Baarn, The Netherlands. pp 10. 2002.

[7].Denton, O. A, Oyekale, K. O., Nwangburuka, C. C., Daramola, D. S., Adeyeye, J. A.,Olukayode, O. O. Influence of High Dry Heat Temperature on Seed Germination, Seedling Emergence and Seedling Vigour of three Cultivars

of Corchorus olitorious Seeds. American Journal of Research Communication, 2013, 1(5): 98-114, 2007
[8] Bhise S., Kaura, A. and Manikantan, M.R. "Moisture dependent physical Properties of sunflower (Psh 569). International Journal of Engineering and Science." 2(8) pp 23-27, 2013.
[9] Omobuwajo TO, Sanni LA, Balami YA. "Physical properties of Sorrel (Hibiscus sabdariffa) seeds." J. Food Eng. 45(1) pp37-41, 2000.
[10] Ilori, T.A., Raji, A. O. and Dauda, T.O. "Evaluation of Some Physical and Thermal Properties of Thevetia Peruviana As Affected By Days of Havest". International Journal of Scientific and Engineering Research. 4(1) pp1-8, 2013.
[11] Tunde-Akintunde, T.Y. and Akintunde, B.O. "Effect of Moisture Content and Variety of Selected Properties of Beniseed." Agricutural Engineering International: The CIGR E-Journal Manuscript FPO7021, Volume IX. (2007).
[12] Ilori, T.A., Oradugba, O.B. and A. O. Raji. "Physical properties of Mexican sunflower seed".International Agrophysics. 25 pp 299-302, 2011.
[13] Sahoo, P. K. and Srivastava, A.P. "Physical properties of okra seeds". Biosystem Engineering. 83(4) pp 441-448. ,2002.
[14] Pradhan, R.C., S.N. Naik, N. Bhatnagar, and S.K. Swain. "Moisture-dependent physical properties of Karanja (Pongamia pinnata) kernel." Industrial Crops and Products, 28(2), pp 155-161, 2008.
[15]. Adejumo, B. A and Abayomi, D. A Effect of Moisture Content on some Physical Properties of Moringa Oleifera seed. IOSR Journal of Agriculture and veterinary science. 1(5) pp 12-21, 2012.
[16] Baumler E, Cuniberti A, Nolasco SM, Riccobene IC Moisture dependent physical and compression properties of safflower seed. Journal of Food Engineering. 72 pp134-140, 2006.
[17] Al Mahasneh, M. A., & Rababah, T. M. "Effect of moisture content on some physical properties of green wheat". Journal of Food Engineering. 79(4) pp 1467-1473, 2007.
[18] Tabatabaeefar, A. "Moisture-dependent physical properties of wheat." International Agrophysics 17(4) pp 207-212, 2003.
[19] Altuntas, E. and Yildiz, M. "Effect of moisture content on some physical and mechanical properties of faba bean (Vicia faba L.) grains." Journal of Food Engineering 78 pp 174–183, 2007.
[20] Karababa E. and Coşkuner Y. "Moisture content dependent physical properties of dry sweet corn kernels. International Journal of Food Property." 10 pp 549-560, 2007.
[21] Sobukola, O. P., Kajihausa, O. E., Onwuka, V. I. and Esan, T. A. "Physical properties of high quality maize (Swam 1 variety) seeds (Zea mays) as affected by moisture levels." African Journal of Food Science 7(1) pp. 1-8, 2013.
[22] Aviara, N. A., Gwandzang, M. I., and Haque, M. A. "Physical properties of guna seeds." Journal of Agricultural Engineering Research 73(2) pp 105-111, 1999.
[23] Ixtaina, V. Y., Nolasco, S. M. and Tomás, M. C. "Physical properties of Chia (SalviahispanicaL.) seeds". Industrial Crops and Products 28(3) pp 286-293, 2008.
[24] Sologubik, C. A., Campañone, L. A., Pagano, A. M., & Gely, M. C. "Effect of moisture content on some physical properties of barley". Industrial Crops and Products 43, pp 762-767, 2013.

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