VOL. 22 NO. 1
ISSN: 2877-1990
SEPTEMBER, 2021

African Scholar Publications & Research International

African Scholar Journal of Agriculture and Agricultural Tech. (JAAT-1)

Evaluation of the Effects of Drying Temperatures on some Selected Physical Properties of African Breadfruit (*Treculia Africana*) Seeds

***Aneke, V.I.; *Udorah, D.O.; & **Oshagbemi, A. A.,**

**Department of Agricultural and Bio-Environmental Engineering, School of Engineering Technology, Federal Polytechnic, Oko, Anambra State, Nigeria. **Department of Chemical Engineering, School of Engineering Technology, Federal Polytechnic, Oko, Anambra State, Nigeria.*

Abstract

Some physical properties of African breadfruit seeds botanically known as (treculia africana) such as: moisture content, unit volume, major, intermediate and minor diameters properties were determined at 50, 70 and 90℃ exposure temperatures employing standard experimental equipments and procedures. From the results and analysis carried out it was observed that most physical properties showed linear decrement as the exposure temperature increases from 50 to 90℃.The axial dimensions like the major, intermediate and minor diameters decreased linearly with increment in temperatures from 50 to 90℃ and the values obtained ranged from 14.40 to 10.20, 6.98 to 3.10 and 7.96 to 5.32mm respectively due to decrease in moisture content as a result of drying.. It was observed that the mean values of the AMD, GMD and SMD were found to be statistically the same (p=0.005) as was observed for mucunaprureins and veracruz varieties (Aneke et al., 2019).Bulk density varied from 0.11 to 0,05(g/cm^3) as the temperature increases from 50 to 90℃. This indicates that there were an decrease in the weight of the samples due to moisture in the seeds which was lower than the volumetric expansion of the treculia african samples. This decreasing trend was reported for Jatropha seeds (Garnayak et al., 2008). The surface area *varied from 2.4 to 1.7* $\mathbf{mm^2}$ *as the temperature increased from 50 -90°C. The increment could be as a result of their dependence on the size dimension of the bean similar to Cowpeas (Oluka et al., 2011).*

Keywords: *Physical Properties, Treculia Africana, Drying Temperature, Moisture Content, Major Diameter and Minor Diameter.*

Introduction

The African bread fruit ***(Treculia Afrcana),*** a wild tropical evergreen tree. Treculia is a genus of Southern Africa and Madagascar tree in the family of Moraceae, sometimes known by the common names, wild jack fruit, Muzinda, Mwaya, brebretim and African bread fruits [14]. The fruits are hard and fibrous and it can be the size of a volleyball and weight up to 8.5 kg. It is abundant in Western and Eastern region of Nigeria.

The fruit is round in shape, big, greenish yellow in colour and spongy in texture when ripe and contains numerous seeds which are embedded at various depths in the fleshy pulp [5]. The seeds are brown in colour with fibrous coating [14]. The breadfruit tree grows 12 to 18 metres (40 to 60 feet) high and has large, oval, glossy green leaves, three- to nine-lobed toward the apex. Male and female flowers are borne in separate groups on the same tree: the staminate (male) flowers appear in dense club-shaped catkins; the numerous female, or pistillate, flowers are grouped and form a large prickly head upon a spongy receptacle. The ripe fruits, or matured ovaries, of these pistillate flowers are roundish, 10 to 20 centimetres (4 to 8 inches) in diameter, and greenish to brownish green and have a white, somewhat fibrous pulp.

Numerous varieties are cultivated in the Pacific islands, but many of these have not been introduced to tropical America. The tree cannot tolerate frost and has not been successfully grown even in the southernmost parts of Florida. In the West Indies and on the American mainland from Mexico to Brazil, the breadfruit tree is grown in dooryards, and the fruit is sold at market. Seedless forms are propagated by means of root suckers or root cuttings.

The African breadfruit seeds provide an important food item which is very popular and consumed as main dish especially in South-Eastern Nigeria [14][5]. In these areas, the seeds are variously cooked as pottage or roasted and eaten with palm kernel as roadside snacks. The seeds are highly nutritious and constitute a cheap source of vitamins, minerals, proteins, carbohydrates and fat [14]. The seeds are used for soup thickening and making bread fruit cakes, snacks and cookies. The seeds are also processed into flour which has high potential usage for pastries. The seeds are also used as flavouring in alcoholic drinks and edible oil can be processed from the seeds [10] [5]prepared a non-alcoholic beverage from seeds of the species which was found acceptable when taken without milk and sugar; therefore, giving the beverage obtained the species an obvious advantage over cocoa-derived beverage in view of the scarcity and expensiveness of milk and sugar in rural areas of developing countries.

Various parts and products of Treculia are used in traditional and modern medicine. The roots are used as a Malaria tonic and worm expeller for children while the bark is used as treatment for cough, neck swelling and rheumatism[11]. It is also used as treatment for mouth-yaw, rashes and stomach disorders. Liquid extract of the boiled leaves is taken as cure for rashes. Also the sap from the trunk is used for treating of fire burns (Ugwoke, 2008). It was also gathered that the water extracted from the boiled seeds helps to cleanse or purify the stomach when taken. A decoction of the breadfruit leaf is believed to lower blood pressure and may relieve asthma. Crushed leaves are applied on the tongue as a treatment for throat and the leaf juice is used locally as ear drops. The leaf ash is used as a remedy for enlarged spleen.

T.Africana has been used in soil conservation. It is used as soil improver. The tree is a good source of mulch. It is also used as intercropping system. The fruit-head pulp and bran of ***Treculia*** contain 9.4% and 5.7% protein respectively. These have been used to feed blue monkeys and farm animals. Blue monkeys are found of the fruit and seeds of the ***Treculia.*** Tanzanians use the leaves for farm animals. Irvine (1981) pointed out that the species provides fodder for both domesticated (example goat) and undomesticated animals (example antelope) in different parts of Africa.

Drying is a process of moisture removal in which the internal water of a hygroscopic material moves in form of liquid, vapour or both, to the surface of the material and is evaporated or transferred by convention to air passing over the material with or without the supplement of heat, The process of drying usually involves simultaneous heat and moisture transfer. The fundamental driving force for drying is the chemical potential associated with the water in the material. That water moves from inside of a moist material where the chemical potential is high to outside the material where it is low. The purpose of dehydrating (drying) is usually to improve the shelf life of the product, and thus dehydration is a unit operation of great importance to the food industry. During dehydration moisture content is reduced, the water activity of the product is also reduced [2].

One way to adding value to agricultural product is to dry it. With the correct equipment and information, dried products can be sold locally or perhaps internationally for a decent value. However there's a secret to good **drying**. It must be done effectively, thoroughly, and losing minimal vitamins that are so necessary in our food and that of our livestock. A lot of the food that small-scale farmers grow will go to waste within the market because of surpluses at harvest time. Thus drying will be a very good method of food and nutrient preservation, additionally as the way of increasing value and ultimately profits. But **drying fruits**, vegetables, meat and fish isn't without risk. In contrast to alternative food products, dried produce will be eaten raw. And since they're raw, they are a source of food-borne infection. Thus hygiene at each stage – handling, **drying, sorting and packaging** is critically necessary.[3]

The data generated from theevaluation of the effects of drying temperatures on some selected physical properties of African breadfruit (*treculia africana*) seeds will aid in the design and fabrication of machines for harvesting and post-harvest handling and processes.[8]

Materials and Method

Source of Sample

Figure1 *Treculia Africana* seeds

The matured seeds of *treculia africana*were purchased from Enugu Agricultural Development Project (ENADEP), Enugu, and Enugu North Local Government Area of Enugu State, Nigeria. Its geographical coordinates are $6^0 59' 0''$North, $7^0 27' 0''$East. The samples were manually cleaned to remove all foreign materials like pieces of stone, immature seeds and chaff. The samples were tied in bags and taken to bio-process laboratory in the Agricultural and Bio-Resources Engineering Department Enugu State University of Science and Technology (ESUT), Enugu where the physical and mechanical properties will be evaluated. All the physical, properties of the breadfruit seedswith three replications for each drying temperature were determined.
The physical properties like the size, shape, volume, surface area, density and colour necessary for the design of a specific equipment or analysis will be investigated.

Materials for determination of the physical properties
The apparatus that will be used include digital venire calipers (mitutoyo, Japan) with an accuracy of 0.01mm to measure the major diameter (length) a, intermediate diameter (width) b and the minor diameter (thickness) c of the seeds. A mettler Toledo electronic weighing balance, model XP204 having sensitivity of 0.0001g will be used for measuring the individual mass of the samples. The measurements were repeated 30 times to obtain the overall weight of the samples.

Determination of the physical properties
The axial dimensions of agricultural and bio-materials are important in designing ofequipment for separation operation, cleaning, handling and conveying of the bio-materials. While knowledge of the surface area is necessary for the evaluation of terminal velocity, drag coefficient and Reynolds number in transportation or handling of solid materials by air or water. Aspect ratio is useful in the classification of grain or seed shape. Bulk density is important in design of hoppers, discharge mechanism, design of silos and storage bins and design of conveying and handling equipments. Specificgravity plays an important role in applications such as drying and heat treatment of bio-materials, while the moisture content is important in the determination of shelf life and storability of agricultural materials.

Measurement of the axial dimensions of the breadfruit *samples*

Sample of one hundred seeds will be used for this study. The individual mass (g) of the samples will be obtained and recorded by using the experimental electronics weighing balance The major diameter(length), a. intermediate diameter (width), b. and minor diameter(thickness), c. will be obtained using Venire Calipers.

- Arithmetic mean diameter (AMD),
- Square mean diameter (SMD),
- Equivalent diameter, (EQD),
- Harmonic mean diameter (HMD),
- Sphericity (SPH), and
- Aspect Ratio (AR) of *Mucuna* samples using the formulas given by [3]

(1)

GMD = $\sqrt[3]{\boldsymbol{abc}}$ **(2)**

SMD = $\sqrt{\frac{(\boldsymbol{a}+\boldsymbol{b})+(\boldsymbol{b}\times\boldsymbol{c})+(\boldsymbol{c}\times\boldsymbol{a})}{\mathbf{3}}}$ **(3)**

EQD = $\frac{\boldsymbol{SmD}+\boldsymbol{GmD}+\boldsymbol{AmD}}{\mathbf{3}}$ **(4)**

HMD = $\mathbf{1}/\boldsymbol{a} + \mathbf{1}/\boldsymbol{b} + \mathbf{1}/\boldsymbol{c}$ **(5)**

SPH = $\frac{\sqrt[3]{\boldsymbol{abc}}}{\boldsymbol{a}}$ **(6)**

AR = $\boldsymbol{b}/\boldsymbol{a}$ **(7)**

The tracing method was used to determine the largest projected areas and the smallest circumscribing circle of the *treculia africana* seeds in its natural rest position and roundness evaluated as [16]

Roundness = $\frac{AP}{AC}$ (8)

Where AP = largest project area of the seed in its natural rest position

AC = area of the least circumscribing circle

The surface area of the seed was determined as [11]

A = $\frac{\pi D^2}{4}$ (9)

Where A = surface area of the seed of sphericity shape

D = minor diameter of the seed

$$\pi = (3.142)$$

Determination of moisture content

The moisture content of a bio-material indicates the amount of water found in the material which is normally influenced by the type of food material, age or maturity, variety or geographical location.Samples were randomly selected and the initial moisture contents was will be determined using the method proposed by ASAE. That is (ASA, 1983) by oven-drying of each seed at 105°c, for 24 hours. The samples were then cooled and weighed using an electronic weighing balance to determine the moisture losses. The moisture content of the seed in percentage (Wet basis) and (Dry basis) will be evaluated with the following formulas [4][7].

$$Mw = \frac{100(Ww-Wd)}{Ww} \quad (10)$$

Where *Mw* = Moisture content wet basis

***Ww* = Weight of wet materials**

***Wd* = weight of dry materials**

$$Md = \frac{100(Ww-Wd)}{Wd} \quad (11)$$

Where *Md* = Moisture content dry basis

The samples were further dried to obtain other moisture content levels of 10.37 and 6.04% dry basis.

Determination of the bulk density of breadfruit samples

The bulk density of an agricultural material is the ratio of the weight of sample to its container volume. This was evaluated by obtaining the weight of a measuring cylinder of known volume filled with ***treculia*** samples and evaluated as [7].

$$\ell_b = {}^{m}/_{v} \quad (12)$$

Where ℓ_b = bulk density of the seeds (g/cm^3)

m = mass of the seed (g)

v = volume of the cylinder, cm^3

Determination of the solid density of the samples

The true or solid density of an agricultural material is the ratio of weight of the sample to its true volume [5]

$$\ell_s = {m}/{n.\ Vu} \quad (13)$$

Where m = mass of the sample (g)

ℓ_s = solid density of the sample (g/cm^3)

n = number of seeds in the sample

V_u = unit volume of one seed

NB: $V_u = \frac{n(abc)^{1/3}}{6}$ (mohsenin 1980) (14)

Determination of the Porosity of the ***mucuna samples***

The porosity ε in % indicates the amount of pores in the bulk materials (Mohsenin, 1980, Ehiem and Simonyan *et al.*, 2010) presents a formula for its calculation as

$$\mathcal{E} = 100\left(1 - \frac{\ell_b}{\ell_s}\right) \quad (15)$$

Where $\mathcal{E} = porosity$ (%)

$\ell_b = bulkdensity\ (g/cm^3)$

$\ell_s = soliddensity\ (g/cm^3)$

Results

The data collected from this study were presented and analyzed using tables with descriptive statistical methods and graphs. These data were obtained from the measurements of ***treculia africana***seeds, calculation of some physical properties. The results are presented in Tables below. The result obtained from different experimental proceeds employed in determining the physical and frictional properties of African bread fruit(***treculia africana)*** seed are shown on Table .1and table 2.

Physical Properties Results:

Table 1 and 2 showed the size characteristics of the (***treculia africana*** at different temperature levels of 50, 70 and 90℃. Effect of drying temperature on some physical properties of ***treculia africana.*** The results of the experiment showed that drying temperature influenced the selected physical properties of the bio-material (Table 1 and 2).

As the drying temperature increases from 50 to 90°C the final moisture content decreased from 15.75% to 13.62%. It is in agreement with the result of locust bean [8]. The final moisture content of the dried seed was between 13 and 15.75% db which is within the acceptable moisture limit of dry products (15%) as reported [9] The mathematical relationship between the drying temperature and the final moisture content is expressed using the regression ($C = 0.1579\ DT$ $2 - 1.4561 DT + 6.88\ R\ 2 = 0.982$ (6)
Where, Mc is final moisture content (% db); and DT is Drying temperature (°C). The axial dimensions like the major, intermediate and minor diameters decreased linearly with increment in temperatures from 50 to 90℃ and the values obtained ranged from 14.40 to 10.20, 6.98 to 3.10 and 7.96 to 5.32mm respectively due to decrease in moisture content as a result of drying.. It was observed that the mean values of the AMD, GMD and SMD were found to be statistically the same (p=0.005) as was observed for ***mucunaprureins*** and ***veracruz*** varieties [10]
Bulk density varied from 0.11 to 0,05(g/cm^3) as the temperature increases from 50 to 90℃. This indicates that there were an decrease in the weight of the samples due to moisture in the seeds which was lower than the volumetric expansion of the ***treculia african*** samples. This decreasing trend was reported for Jatropha seeds [6]
The surface area varied from 2.4 to 1.7 mm^2 as the temperature increased from 50 -90℃. The increment could be as a result of their dependence on the size dimension of the bean similar to Cowpeas [11] However the sphericity and aspect ratio increasing trend with increment in temperature as with the case of African Yam Bean [10]. Also the porosity was discovered to decrease as the temperature increases similar to what was reported by researchers for Chicken pea [6].The seed weight of the African bread fruit seed experimented at 13.62 % moisture content (dry basis) ranged from 0.11 to 0.25 g, with an average of 0.19 g. The volume of the seed was obtained as 2.19 cm^2, somewhat close to 3.06 cm^3 derived for the same seed by [16]. The volume and weight of the seed were related as thus: $V = 0.004W + 1.076 \quad R^2 = 0.019$
The sphericity of the seed was derived by employing equation. The closeness to sphere was 0.53 + 0.70 in range with an average of 0.67. The surface area of the seed was obtained as 22 mm^2 (0.22 cm^2).. The surface area increases with the seed weight. The roundness which is an important feat for designing of silo, hoppers, discharge chute and other storage facilities was obtained as 0.48 to

0.55 in rang and 0.51 as an average value. This was same with 0.51 obtained by [14] for shea nut, but contrasting to 0.65 researched by [4]for locust bean. A relationship between roundness and weight of the seed was established thus: R = 0.001W + 0.478 R2 = 0.382

Table1. Results of physical properties (axial dimensions) of *treculia africana seeds*

Temperature ℃	Major diameter (mm)	Intermediate diameter (mm)	Minor diameter (mm)	Geometric mean diameter (mm)	Arithmetic mean diameter (mm)	Square Mean diameter (mm)
50	14.4o	6.98	7.96	13.54	9.78	9.49
70	12.40	5.89	7.09	7.59	8.46	8.22
90	10.20	3.10	5.32	3.10	6.20j	5.90

Table.2 Results for other physical properties of *treculia africana seeds*

Temperature ℃	Equivalent mean diameter (mm)	Harmonic mean diameter (mm)	Porosity	Sphericity	Weight (g)	Bulk density (g/ cm^3)	Surface Area (mm^2)	Aspect ratio
50	10.90	0.34	0.09	0.5	0.25	0.05	2.4	0.91
70	8.09	0.39	0.16	0.67	0.19	0.09	2.05	0.78
90	5.07	0.59	0.05	0.42	0.10	0.11	1.7	0.65

Conclusion

Investigations on the physical properties of African bread fruit (Treculia Africana) seed revealed that at 13.62% moisture content dry basis:

(i) The major, intermediate and minor diameters of the seed averaged 12.40, 5.89 and 7.09 mm respectively, which invariably was smaller than values obtained for other bread fruit seeds.

(ii) They geometric and arithmetic mean diameter were 7.59 and 24.94 mm respectively, showing about 18 % difference in variation between the former and the later.

(iii) The surface area, sphericity and roundness were 0.22 cm^2, 0.67 and 0.51 respectively showing that the seed will assume difficulties in rolling.

(iv). The seed weight, seed volume and seed density were 0.19, 2.19 and 0.0867 g/cm^2 respectively, enumerating the seed can float in water, a characteristic necessitated for separation processes.

(v) The bulk density and porosity of the seed were 0.014 g/cm^2 and 16.65 % respectively, indicating that the seeds will not efficiency form a pile when subjected to a hopper or conveyor in its processing.

(vi). The physical properties of African breadfruit seed showed positive correlation and linear relationship with seed weight, except minor diameter, sphericity and true density which proved contrary.

References

[1]Adejumo, O. I., Affa, A. A. & Mohammed, H. (2015). Physical properties of kano white variety of Bambara groundnuts. *Proceedings of the Nigerian Institution of Agricultural Engineers*. 27(1): 203 – 210

[2] Agbogidi, O. M. &Onomeregbor, V. A. (2018). Morphological changes in the seedlings of Treculia Africana grown in crub oil impacted soils. In climate change and sustainable renewable Natural resources 2014 ASABE – CSBE/SCGAB Annual International Meeting Paper Page Oct. 2008, pp. 170 – 182.

[3] Alonge, A. F. (2018). Some Engineering Properties of Cashew Nut relevant to its processing. Paper presented at the Int'l Conference on Engineering Research and Development(ICER&D) field at the University of Benin, Benin City, Nigeria, between 13th -17thApril 2008.

[3] Alonge, A. F.&Adegbulugbe, T. A. (2015). Some Physical Properties of Groundnuts (Arachis Hypogea, L.). *Journal of Pure and Applied Science*, *5*: 992 – 998.

[3] Alonge, A. F.&Adigun Y. J. (2019). Some Physical and Aerodynamic properties of Sorghum relative to cleaning. *Nigerian Journal of Pure and Applied Science, 4*: 992 – 998

[4] Asoegwu, S. N.&Eke, N. U. (2019). Relationship between some physical properties and seedweight of Jackbean Seeds. Proceedings of 3rdInt'l conference of WASAE and 9th International Conference of NIAE, 236 – 259pp.

[5]Baiyeri, K. P. &Mbah, B. N. (2016). Effect of soilless are soil based Nursery Media on seedling emergency, growth and response to water stress of African Bread fruit (Treculia African Denne). *African Journal of Biotechnology, 5*(15): 1400 – 1405.

[6]Ebana, R. V.,Essien, A. I.,&Ekpa,O. D. (2015). Nutritional and potentially medical value of the leaves of Lasinanthera Africana (Breauv). *Global Journal Pure and Applied Science*, 1:1-8.

[7]Edet, E. E. (2012). Chemical evaluated of nutritive value of African bread fruit (Treculia africana). *J. of food chem.*, 117:46-50.

[8]Ejidike, B. N. &Ajileye, O. (2017). Nutrient composition of African bread fruit (Treculia africana) seed and its use in diets for the African giant land snail. Archactatina Marginata. Park. *J. Nutr*. 6:201-203.
[8]Ejiofor, M. A. (2018). Diversifying utilities of African bread fruit as food and feed inter crop J. 5:125-135.
[9] Enibe, D. O. (2017). Treculiaafricana consumer acceptability and utilization for feed security and industrial development In: Olufajo O. O. Omokore, D. F., Akpa G. N. and Sanni, S. A. (eds). Proceedings of the 41st Annual conference of the Agricultural Society of Nigeria (ASN) held at ABU, Zaria between 22nd and 26th of October, pp. 455 – 458.
[10] Falaye, T. &Atere, A. O. (2019). Determining some Physical and Mechanical properties of some cowpea varieties. Proceedings of the 9th international conference of NIAE and 3rdInt’l conference of WASAE. Ile-Ife: 239 – 243pp.
[11] Okafor, J. C. (2015). Selection and Improvement of Indigenous Tropical Fruit Trees: Problems and Prospects *Journal. For. Res.*, 1(2): 87-95.
[12]Olaoye, J. O. (2000). Some physical properties of Castor Nut relevant to the design of Processing Equipment. *Journal Agricultural Engineering Research*, 77(1): 113-118.
[13] Oloko, S. A.,Adekpip, P. O. and Akinola, M. O. (2019). Determination of the properties of water melon. Proceedings of the 9th International Conference of NIAE and 3rdInt’l Conference of WASAE lle-lfe:207-209pp.
[14]Shafiee, S.,Modares, A.,Mainace, S., &Heldargili, K. (2019). Moisture Dependent Physical properties of Dragon’s Head Seeds (LallemahtraIberica). *Agricultural Engineering International:The CIGRE Journal Manuscript* 1992. Vol. XI.
[15]Ugwoke, F. N.,Agbo, A. E., Ali, N. C., Attah, C. P. &Ekwueme, J. I. (2013). A Note on African Breadfruit (TreculiaafricanaDence). Unpublished Report Submitted in Partial fulfillment of CSC 341, Dept. of Crop Science, University of Nigeria, Nsukka, Nigeria, p. 18.