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DETERMINATION OF PHYSICAL PROPERTIES OF JATROPHA SEED FOR OPTIMUM PROCESSING.

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ABSTRACT
This research was conducted to investigate the physical properties of Jatropha seed. The seed length, width, thickness, geometric mean diameter, sphericity, surface area, bulk density, true density were investigated using standard methods and equations. The result obtained was 14.7, 20.0, and 23.60 mm for small, medium and large seed of major, intermediate and minor diameter respectively, the geometric mean diameter was found to increase with increase in size. The true density and bulk density were found to be 0.90, 0.80 and 1.20g/cm3, 2.40, 2.70, and 3.0g/cm3 respectively. Sphericity and Surface area were found to be 54.0 %, 66.0 % and 73.0 %, and 1309.8 mm2, 959.1 mm2, and 157.0 mm2 for small, medium and large seed respectively. The results obtained will provide a data base for designing equipment for handling, processing and development of new products of the seeds. The Jatropha seed is spheroid in shape based on the result obtained. Further studies is recommended for flow properties of jatropha that will aid in the material handling.

Keyword: *Jatropha seed, physical properties, sphericity, density, surface area*

Introduction
Jatropha is a seed bearing plant and produces 1-2kg of seed per plant per year when the plant is 2-3years old. The production amount may increase with increasing age of the plant. Jatropha curcas is known in Nigeria by

various local names as “butuje,” “Lapapa”, “Ologbo”, in Hausa, Yoruba and Igbo (Ayambimpe et al., 2009).

Different vegetable oils are in use in various countries for biodiesel production. United States is an exporter of edible oils hence it uses soybeans for bio-diesel production. Rapeseed oil is in use in European countries for bio-diesel production whereas tropical countries such as Malaysia use coconut oil and palm oil for same purpose (Sharma and Singh, 2007). India, however is a net importer of edible oil, hence the emphasis is on non-edible oils from plants such as Jatropha (jatropha curcas L), Karanja (pogamia pinnata L), Simarouba (simarouba glauca L), which could be utilized as a source for production of oil.

Efforts are being made to explore for alternative sources of energy that is technically feasible, economically competitive, environmentally acceptable and readily available (Srivastava and Prasad, 2000)

The use of physical properties in crop production, handling, processing and storage is important especially when it comes to fabricating the machine for planting, harvesting processing and storage of many agricultural produce. During harvesting, transportation and industrial handling, it is desirable to have a strong product, one which will not suffer any damage when impacts (mechanical harvesting) or static compressive forces (bulk storage) are applied. During mastication and size reduction processing, it is desirable to have a weak product one that will disintegrate in the proper manner when forces are applied (Peleg and Bagley, 1983). Seeds and grains often suffer mechanical damage which may be external or internal injuries in form of distortion, cracks, internal bruising etc. It affects the quality of the materials. Damage to seeds and grains could affect their milling quality, result in greater losses in sifting and lower the germination capacity and seedling development. Even small cracks in seed coat may allow bacteria to enter the seed where it destroy the food reserve and hinder food supply before a plant is established.

In Jatropha seeds and cotton seed according to mohsenin (1986), rupture of the seed coat permit a rise in free fatty acid content which result in low germination and reduce high quality oil refine during processing. Physical damage of oil-bearing seeds such as Jatropha during the production, processing, and handling operations tends to cause build-up oil bearing fragment in critical areas of mechanical equipment. This may result in clogging with further increase in seeds damage, kernel losses and damage levels have been found to be greatly influenced by the crop physical and mechanical properties.

The traditional approach to the design of the agricultural machineries for this primary production processing has been the basic of machine design principle along with some knowledge of the cultural operation.

Several researchers have investigated the physical and mechanical properties considered relevant to the design of suitable equipment for their processing.

The physical properties of oil seeds are important in assessing the behavior of the product quality (Kashaninejad et al., 2006).

Physical properties are essential to design equipment for decortications, drying, cleaning, grading, and oil extraction. Moisture content is useful information in the drying process. The size (such as length, breath, thickness, arithmetic mean diameter) and geometric mean diameter and shape are important in designing of separating, harvesting, sizing grading and grinding machines. The product shape can be determined in terms of its sphericity and aspect ratio which affect the flow ability characteristics of the product. Bulk density, true density and 1000- units mass are use in determining the size of the storage bin and also affect structures. Porosity (calculated from bulk density and true density) surface area affected the resistant to airflow through bulk material bed and data on them are necessary in designing in the drying process.

Recently, Jatropha has gained much attention as potential source of bio-fuel (Openshaw, 2000). Besides fuel production, Jatropha also have potential application such as lubricant. For paint and varnish industries (Adetoye et al 2010), soaps, cosmetic products and other chemicals. The cake obtained after removing the oil can be used as a fermentation substrate as an organic fertilizer (Singh, et al 2008) as feed stuck for biogas production (Staubmann, et al 1997) or as reinforcing filler for biodegradable polymers (Diebel, et al 2012) in addition, non-toxic varieties pressed cake can be used as animal feed as it is rich in protein (Devappa et al, 2012).

Research Objectives

The objectives of the study is to determine some physical properties of Jatropha seed such as size, shape, true density, bulk density, , porosity, and 1000 seed weight.

Materials and Methods

Test materials

Jatropha seeds were gotten from the Federal Polytechnic Staff Quarter Bauchi, which were selected for the study. Some of the seeds were freshly gotten from fruits while some were already dried. The seeds were graded into the required sizes of small, medium and large.

Procedure for determining the physical properties

Size

Sample of 5 seeds each from all the size grades which included small, medium and large were randomly picked from the bulk sample. Measurement of the three diameters of seeds was carried out. The size was determined by the use of digital Vernier caliper with an accuracy of $\pm$ 0.01mm, the dimensions were the major, intermediate and minor diameter, and the values obtained from the measurement were used in calculating the size of the seeds. The mean, standard deviation and coefficient of variation were also determined for all small, medium and large grades. Shape and Sphericity

Sample of 5 seeds from each three fractions were taken, geometrical dimensions namely length, width and breath of J.curcas seeds were measured with a digital vernier caliper with an accuracy of $\pm$ 0.01mm.

The sphericity (Ø) of the seeds was calculated based on the isoperimetric property of sphere. Sphericity has been used mostly to describe particular shape. The shape of Jatropha seed was judge or considered to be best described by sphericity. Hence the values obtained for the three 3 major dimensions were used in determination of sphericity. Equation below was used in calculating sphericity. The mean, standard deviation and coefficient of variation were also obtained.

$$\text{Sphericity} = \frac{gemetric\ mean\ diameter}{major\ diameter} = \frac{(abc)^{\frac{1}{3}}}{a}$$

Determination of bulk and true density

Measuring cylinder of 2000ml was used, a measuring rule was used at the height of 20cm and the same height into the cylinder. The weight of the cylinder before introducing the Jatropha seeds was 1.1kg. The three categories of large, medium, and small seeds were poured into the cylinder and the weight recorded using a measuring scale.

To determine the true density, a cylinder of known volume of 2000ml was used. The cylinder was filled with water to 1000ml mark and measured each of the seed and the readings were recorded. The values were calculated using equation below

$$\ell = \frac{M}{V}$$

Where M is the mass in kg

V is volume in cm3 and

ℓ is density in kg/m3.

1000 Seeds weight determination

100 seeds were randomly picked and weighed using a weighing scale. The 100 seeds weight were multiply by 10 giving the 1000 seeds weight.

Results and Discussion

The physical properties of the Jatropha seed after the experiment were summarized in Table 1 below.

Table 1: physical properties of jatropha seed.

Physical properties	small	medium	large
Size(mm)	14.7+(6.3)	20.0(8.6)	23.60(10.2)
Sphericity(%)	5.40(6.3)	6.60(8.6)	7.30(10.2)
Surface area(mm2)	1309.8(6.30)	959.1(8.60)	520.30(10.2)
Bulk density(g/cm2)	2.40(0.0003)	2.70(0.0005)	3.0(0.0021)
True density(g/cm2)	0.90(0.11)	0.80(0.13)	1.20(0.07)

Values in parenthesis are the standard deviations. +Each value is the mean of 5 test samples except for bulk density and true density which is the mean of three replications.

The mean values for the major, intermediate and minor diameter of the seeds were found to be 14.70, 20.0 and 23.60mm, respectively for the small, medium and large size of the Jatropha seeds.
The importance of these dimensions is to determine the aperture size of the machines, particularly in separation of materials has been discussed by (Ali et al 2006). The major axis was found to be indicating the natural rest position of the material and hence in application of compressive force to induce mechanical fracture. Also, this dimension will be useful in applying shearing force during silicing (Owalarafe and Shondonde, 2004). The seeds are fairly sphere with average sphericity 0f 5.40, 6.60 and 7.30mm with the larger sizes having higher value than medium the small seeds, this is in agreement with the findings of Abodenyi (2016) for breadfruit seed varieties where the sphericity of the seeds increased with increase in moisture content. This is very important in design of hoppers for processing machines. The average bulk density was found to be 2.40, 2.70 and 3.0g/cm3respectively, while average true density was found to be 0.90, 0.80 and 1.20g/cm3 the characteristics are useful in the estimation of load and hence in the design of load shafts for processing machine. The results are in agreement with the findings of Pradhan et al 2009, Salawu et al 2015, Ayoub-Baqvand and Ali 2013 and Abodenyi 2016 for physical properties of tree born oil seed, jatropha seed and breadfruit seed respectively.

Conclusion

The following conclusion were drawn from the results of this study, the mean values of 14.7mm, 20.0mm, 23.60mm for small, medium and large seed sizes of the major, intermediate and minor diameter respectively. The mean of the unit bulk density and true density were found to be 2.40, 2.70 and 3.0g/cm3, 0.90, 0.80 and 1.20gcm-3 respectively. Surface area was found to be 1309.80 mm2, 959.10 mm2 and 520.30 mm2, while sphericity was found to be 54.0 %, 66.0 %and 73.0 % for the three sizes respectively. Furthermore, the study has shown that the Jatropha seed is spheroid in shape based on the result obtained. The result of this research can serve as information design of equipment and machines for shelling, conveying, drying and extraction of oil from Jatropha seed.

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