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Physical Characterization and Physicochemical Properties of Jackbean (*Canavalia ensiformis*)

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***Abstract*— Jackbean (*Canavalia ensiformis*) like any other legumes is of high nutritional value. However, information on the physical characteristics and its flour physicochemical properties is not yet completed. Therefore, this work is on the physical characterization of Jackbean seeds and physicochemical properties of its flour. Jackbean seeds obtained from Germ-plasm unit of International Institute of Tropical Agriculture (IITA), Ibadan, Oyo State Nigeria were carefully cleaned, sorted, winnowed and subjected to physical characterization to assist in industrial processing of the seeds. Flour was produced from dehulled seeds and subjected to physicochemical analysis.**

The results of physical characterization carried out on the beans revealed that the beans had its length, breadth and thickness as 0.019mm, 0.013mm and 10.76mm respectively. The sphericity index and aspect ratio were 4.98% and 1.43 respectively. The kernel and bulk density (g/cm^3) were 1.24 and 0.73 respectively while the density ratio was 0.59. Physicochemical properties of the seed were: pH (8.8), titratable acidity (0.60%) and total solid (91.20%).

This work has been able to make available data for the handling (machinability) of the beans and information on the physicochemical properties for its flour processing.

***Index Terms*— characterization, physicochemical, properties and handling.**

I. INTRODUCTION

Legumes are all plants of the pea and beans family (*Leguminoceae*) which comprises the Caesalpinacea (*Senna family*), Mimosaceae (*Locust bean*) and Pappilionaceae [1]. They are of economic importance as cheap sources of protein, energy and other nutrients in the diets in most developing countries of the world. Legumes seeds contained as high as 20 to 50% protein, which in general runs above twice the level found in cereal grains and significantly more than the level in convectional root crops. The protein is high in lysine content, a factor of much nutritional importance when combined with cereal proteins that have lower level of this amino acid [2]. Legumes protein contained most of the essential and non-essential amino acids in proportion very similar to those of animal protein. They therefore form a healthy alternative for obtaining protein compare with animal food such as meat [3].

Legumes have been categorized either as major or minor based on their utilization. The major legumes include soybean, groundnut, cowpea, African locust bean while the usually regarded as miscellaneous, neglected or underutilized include Bambara groundnut, lima beans, pigeon peas, Lablab, Jackbean etc [4]. The major legumes have received much research attention unlike the minor legumes.

Jackbean (*Canavalia ensiformis*) – 'Sese nla' (Yor), family of leguminoceae is a tropical plant of the pea family with purple clustering flowers, native to tropical America, Southern United State [5]. It is one of the minor legumes in Nigeria and other West African countries. It is rich in most essential amino acids, including those deficient in wheat [6]. It is usually planted the seed in Nigeria as ornamental plant and in some places as "snake expellant". Industrially, the crop is yet to enjoy adequate processing. The handling is done by the farmer and local processors manually.

The physical properties of seeds and food generally go a long way in the design and fabrication of suitable machine and equipment for their handling and processing [5]. There is paucity of information of the physical characterization of Jackbean seeds and the physicochemical properties of its raw flour, for this purpose this work is designed to establish data on the physical characterization of Jackbean seeds and physicochemical properties of its flour.

II. MATERIALS AND METHODS

A. Materials

The seeds of Jackbean (*Canavalia ensiformis*) was procured from Germ-plasm unit of International Institute of Tropical Agriculture (IITA), Ibadan, Oyo State, Nigeria. Chemicals (ANALA Grade) and equipment used were obtained from the Department of Food Science and Engineering, Ladoke Akintola University of Technology, (LAUTECH), Ogbomosho, Oyo State, Nigeria and Department of Food Technology, Osun State Polytechnic, Iree, Osun State Nigeria.

B. Methods

a) Physical Characterization of the Beans

The Sphericity Index (SI)

The size of the seeds was measured by taken 100 each of randomly picked seeds for their length (L), width (W) and thickness (T). The sphericity index was obtained using the formula :

$$SI = \frac{(L \times W \times T)^{1/3}}{L} \times 100\% \quad (1)$$

[7]

b) The Aspect Ratio (AR)

The modified method of [8] was used. This is the ratio of the length and width of the seeds. This was determined for each of the 100 randomly picked seeds.

c) Seed Density (SD)

The seed density was determined by measuring the volume displaced by the seeds placed in 25cm^3 measuring cylinder using. 50 seeds were randomly picked and coated with a thin layer of adhesive (table gum) and allowed to dry, this will prevent water absorption when the seed will be immersed. The coated seed were weighed and submerged in distilled water in a 25cm^3 graduated cylinder, seed density was

obtained by dividing the weight of the seeds by the volume of water displaced by the seeds [7].

d) Bulk Density (BD)

The bulk density was determined by measuring the volume and the weight of sample placed in 25cm^3 measuring clylinder under constant condition and expressed in g/cm^3 [9].

e) Density Ratio

This was obtained from the ratio of the bulk density to the seed density.

f) Production of Flour from Jackbean Seeds

Matured seeds were carefully cleaned and sorted to remove defective ones from the lot. The seeds were thereafter graded. The cleaned seeds were soaked in water to soften the hull in order to ease its removal. The hulls were removed learning behind dehulled seeds. The dehulled seeds were drained and dried to reduce the moisture content to about 10% moisture content and to facilitate grinding into flour. The dried seeds were milled and sieved to obtain fine powder using 1mm sieve. The flour was packaged inside an airtight container for analytical work.

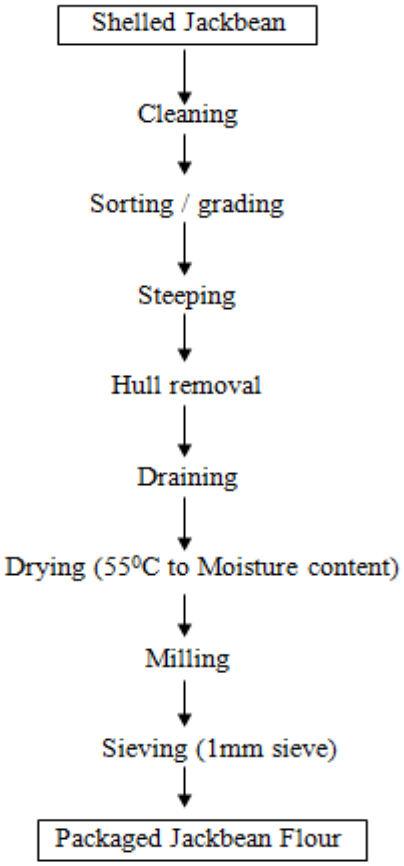

Fig. 1.0: Flow Chart for Flour Production from Jackbean

III. Physicochemical Properties

A. *pH*

100ml of distilled water was added to 10g of Jackbean flour. It was stirred into slurry and allowed to settle. The supernatant was decanted and its pH was measured using a standardized pH meter [9].

B. *Titratable Acidity (TA)*

18g Jackbean flour was weighed into a 25ml conical flask and 200ml of carbondioxide free distilled water was added. The flask was allowed to stand in a water bath maintained at 40^{0}C for 1hr. It was agitated periodically to ensure homogenization before filtration. Phenolphthalein was added as indicator after filtration and this was titrated against 01m NaOH solution [9].

$$\text{Acidity (\% Lactic acid)} = \frac{\text{Volume of 0.1M NaOH used} \times 0.9 \times 100}{\text{Weight of the sample}}$$

C. *Total Solid (TS)*

20g of Jackbean flour was put in 250ml flask. 200ml of water was added and swirl to make a solution. A clean, shallow-bottom dish of aluminum or porcelain was heated in oven at 102^{0}C for about 2hrs, cool in a desicator and weighed. This will give its weight. 5cm^3 of Jackbean flour solution was pipetted into the dish and weighed. The dish was placed on a boiling water bath for 30mins. This was transferred into a hot air-oven, cooled in a desicator and weighed. The heating process was completed when uniform weight was obtained [10].

IV. Results and Discussion

A. *Physical Characterization of Jackbean Seeds*

The results of physical characterization of Jackbean seeds are as presented in table 1.0. The physical properties of kernels, grains and seeds are necessary for the design of equipment to handle, transport, process and store the crop [11]. These properties are very important in design and operation of specific equipment or machines in food materials handling. The length of the seeds ranged from 0.018 to 0.021mm with an average mean value of 0.019 $\pm$ 0.01mm. The width ranged from 0.011 to 0.016mm with an average mean value of 0.013 $\pm$ 0.02mm while the thickness ranged from 9.52 to 11.02mm with an average mean value of 10.76 $\pm$ 0.05mm. These properties are important in the design of hoppers and dehuller for the seed. The sphericity index and aspect ratio in the same table are 5.46 $\pm$ 0.6 and 1.43 $\pm$ 0.13 respectively. The sphericity index was found to be higher than the value recorded for locust bean seed (0.83), which was interpreted to present difficulty in getting locust bean seed roll. These higher values recorded for Jackbean suggests a prospect in designing and fabrication of processing equipment that will allow easy rolling of the beans in the hopper during processing [12].

B. *Density Characteristics of Jackbean Seeds*

The density characteristics which are a measure of the heaviness of a flour or food sample. It is important for determining packaging requirements, material handling and application in wet processing in food industry. It also determines the capacity for storage and transport system [13]. The result of the density characteristics are presented in Table 2.0. These parameters are used in predicting the grain machine operation. The density has also been established to be proportional to the material components in a grain food sample. It is good in calculating the through-put capacity of the machine and the material samples in relation to the power

of the machine. The values obtained for kernel density, bulk density and density ratio were 1.24 ± 0.02 (g/cm^3), 0.70 ± 0.06 (g/cm^3) and 0.59 ± 0.01% respectively. The kernel density was higher than water 1.00g/cm^3 which implied that the seeds are heavier than water and this characteristic can be used to design a separation or cleaning process for the seeds since their lighter fractions will float [12]. Bulk density determines the capacity of storage and transport systems. Density is useful for designing separating equipment; porosity of the mass of seeds determines the resistance to airflow during aeration and drying. The bulk density recorded for the seed was higher than that recorded for raw jackfruit seeds (0.80 g/cm^3) [14]. This is expected because of the compactness of the seed.

C. Physicochemical Properties of Jackbean Flour

The results of physicochemical properties of the raw Jackbean flour were as presented in table 3.0. From the table, the pH value for the flour was found to be 8.8 ± 0.06. The total titratable acidity value for the flour was 0.60 ± 0.1. The high value recorded for pH and lower value for TTA indicates that there is no organic acid formation since the legume is still in the raw form. Increase in pH normally attracts decrease in titratable acidity and vice versa. This indicates that the flour is alkaline in nature. Several researchers have reported this relationship in their works [15]. The total solid content of 91.20 ± 0.2 was obtained. This indicates the dry nature of the flour which conferred on the product a longer shelf life.

V. CONCLUSION

The results of physical characterization of Jackbean seed revealed that the seed had a higher value for sphericity index which suggest that it will roll easily. This property is important in equipment design especially hoppers and dehulled. The density characteristics of the seed is very useful in calculating the through – put capacity of processing machine. Parameter like bulk density is useful for separation equipment, determination of packaging requirements, materials handling and application in wet processing in food industry. The total solid content result for the raw Jackbean flour was high i.e. 91.20 ± 0.2. This indicates the dry nature of the flour. The product thus has relatively longer shelf life in this form. These results presented the seed as a crop of high industrial potentials.

Table 1.0: Result of Physical Characterization of Jackbean Seeds

Trials	Dimension (mm)			Sphericity Index (%)	Aspect Ratio (%)
	Length	Width	Thickness		
1	0.021	0.016	10.80	5.08	1.31
2	0.019	0.013	10.70	4.78	1.46
3	0.018	0.013	10.70	4.78	1.39
4	0.019	0.014	10.78	5.08	1.36
5	0.018	0.011	10.80	5.08	1.64
Mean±SD	0.019±0.01	0.013±0.02	10.76±0.05	5.46±0.61	1.43±0.13

Table 2.0: Density Characteristic of Jackbean Seeds

Density characteristics	Values			
	1	2	3	Mean ± SD
Kernel Density (g/cm^3)	1.25	1.22	1.24	1.24 ± 0.02
Bulk Density (g/cm^3)	0.73	0.63	0.74	0.70 ± 0.06
Density Ratio	0.58	0.60	0.60	0.59 ± 0.01

Table 3.0: Physicochemical Properties of Jackbean Flour

Parameters	Values			
	1	2	3	Mean ± SD
pH	8.7	8.8	8.8	8.8 ± 0.06
TTA (%)	0.612	0.600	0.588	0.600 ± 0.01
TS (%)	91.00	91.20	91.40	91.200 ± 0.2

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