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SOME PHYSICAL PROPERTIES OF *Telfaria Occidentalis* SEEDS AS INFLUENCED BY MOISTURE CONTENT

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Abstract: The effect of moisture content on some physical properties of *Telfaria Occidentalis* seed was investigated at 31%, 34%, 36% and 41% moisture content (wet basis). The mean values of the physical properties of the seeds were determined as length 36.09 – 38.32 mm,width 30.22 – 32.82 mm, thickness 14.22 – 16.42 mm, geometric mean diameter 24.94 – 27.44 mm, sphericity 0.69 – 0.73 mm, thousand seed mass 8.50 – 10.81 kg, bulk density 0.77 – 0.80 $g \cdot cm^{-3}$, true density 0.86 – 1.17 $g \cdot cm^{-3}$, porosity 17.09 - 26.74 %, surface area 1953.46 – 2364.00 cm^2. The coefficient of friction as measured on glass was 0.37 – 0.58%, sheet metal 0.49 – 0.58%, plywood 0.53 – 0.65%. All the physical properties of the seeds evaluated increased with increase in moisture content but however the porosity, decreased with the increase in moisture content. This information will provide engineers and designer the relevant data for efficient equipment design and process handling of *Telfaria Occidentalis* seed thereby increasing its utilization in Nigeria.

Keywords: *Telfairia Occidentalis, moisture content, physical properties, porosity*

INTRODUCTION

Telfairia Occidentalis commonly called fluted pumpkin grows in the forest zone of West and Central Africa, most frequently in Benin, Nigeria and Cameroon. It is known as *Ugwu* in Yoruba, *Ubong* in Efik, *umee* in Urhobo and *umeke* in Edo [1], [2]. The plant is drought resistant and is usually grown for its young leaves and shoots use for various forms of soups in Nigeria [3]. *Telfairia Occidentalis* produces fruits of different sizes

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which contains highly nutritious seeds. The highly nutritious seed of *Telfairia Occidentalis* can be left intact in the pod until when required [4]. The *Telfaria Occidentalis* seeds can be roasted or boiled and eaten like the seeds of breadfruit (*Treculia*) and sometimes used as soup thickeners.

The levels of crude protein (3.47%), crude fat (31.38%), moisture (10.93), ash (2.02%), carbohydrate (50.08%), fibre (2.12%), calcium (280 μg g^{-1}), phosphorus (2100 μg g^{-1}), iron (69 μg g^{-1}), sodium (10.80 μg g^{-1}), potassium (1280 μg g^{-1}), vitamin A (890 IU) and vitamin C (0.7 μg g^{-1}) detected in *Telfaria Occidentalis* seeds are comparable with the nutritional composition of some plant foods in Nigeria [5]. *Telfaria Occidentalis* seeds are for agricultural and domestic purposes, traditional and modern medicines, water purification and other industrial uses such as in biodiesel production [6] [7] [8]. The high oil content makes it a potential source of raw material for the vegetable oil industries in Nigeria. The use of the oil extracted from *Telfaria Occidentalis* seed for the production of bio-diesel has also been reported [9]. In order to design material handling equipment for the proper handling, drying, storing and processing of *Telfaria Occidentalis* seeds, it is imperative to determine their physical properties.

The problems associated with local processing method, the shortage of processing equipment, and inadequate storage of *Telfaria Occidentalis* seed may be due to the fact that the basic necessary data on the physical properties are limited or not available. Furthermore, most agricultural products are visco-elastic, hence the determination of the engineering properties of biomaterials are difficult and complicated since they are apparently affected by comparative moisture content and the rate of loading [10]. The knowledge of the physical properties of *Telfaria occidentalis* seed will be useful for engineers, food scientists as well as plant and animal breeders, who are involved in the design of machine necessary for processing, handling and preservation of *Telfaria occidentalis* seeds. The main objective of this work is to evaluate some physical properties of *Telfaria Occidentalis* seed at four different moisture content levels with the view of creating a database for basic information necessary for the design of processing and handling equipment for *Telfaria Occidentalis* seeds.

MATERIALS AND METHODS

Telfaria Occidentalis fruit was obtained from the Kure central market in Minna, Niger State Nigeria. The fruit was broken with a knife and the seeds removed. The initial weight and moisture content of the seed were determined using standard method as described by Mosehnin [11]. The seed samples were divided into four parts; A, B, C, D and the moisture content was varied to 31% (wb), 34% (wb), 36% (wb) and 42% (wb) respectively. These moisture contents were attained by heating samples A, B, C in an oven at 105^0C for 90 minutes, 60 minutes and 30 minutes respectively, while sample D was not heated. The moisture content of the samples were then determined by oven drying at a temperature of 105^0C and the moisture content wet basis was calculated using the expression given by Mosehenin [11]. The moisture content, length, width, thickness, thousand seed mass, geometric mean, sphericity, volume and true density, as well as the porosity were determined as described by Mosehin [11] and ASAE, [13]. The static coefficient of friction, angle of repose, static coefficient of friction and specific gravity were determined as described Mosehin [11], Olaofe [16], Adejumo [17] and Olaoye [18].

RESULTS AND DISCUSSION

The results of the effect of moisture content on some physical properties of *Telfaria Occidentalis* seeds are as presented in Table 1. The physical properties were determined at 31%, 34%, 36%, 41% for sample A, B, C and D respectively.

Table 1. Effect of moisture content on some physical properties of Telfaria Occidentalis seeds

Parameters	*Sample A*	*Sample B*	*Sample C*	*Sample D*
Length (mm)	*36.09*	*36.27*	*36.28*	*38.32*
Width (mm)	*30.22*	*32.40*	*32.64*	*32.82*
Thickness (mm)	*14.22*	*14.52*	*15.65*	*16.42*
Geometric Mean Diameter (mm)	*24.94*	*25.74*	*26.46*	*27.44*
Surface Area (mm²)	*1953.46*	*2081.78*	*2199.70*	*2364.61*
Sphericity (mm)	*0.70*	*0.71*	*0.72*	*0.73*
Thousand Seed Mass (kg)	*8.50*	*9.43*	*9.56*	*10.81*
Bulk Density ($g\cdot cm^{-3}$)	*0.77*	*0.79*	*0.80*	*0.80*
True Density ($g\cdot cm^{-3}$)	*0.86*	*0.96*	*1.09*	*1.17*
Porosity (%)	*26.74*	*21.88*	*18.35*	*17.09*
Angle of Repose (degree)	*38.66*	*41.35*	*50.19*	*60.02*
Coefficient of Friction				
Glass Surface	*0.36*	*0.45*	*0.53*	*0.58*
Sheet Metal Surface	*0.49*	*0.55*	*0.58*	*0.58*
Wood Surface	*0.53*	*0.58*	*0.62*	*0.65*
Specific Gravity	*0.30*	*0.31*	*0.33*	*0.37*
Moisture Content (%)	*31.00*	*34.00*	*36.00*	*41.00*

The result shows that the three linear dimensions (length, width and thickness) increase with the increase in the moisture content because of the increase in microscopic structure of the seed as it absorbs moisture. The length, width and thickness increased from 36.09 to 38.32 mm, 39.22 to 32.82 mm and 14.22 to 16.42 respectively for moisture content increase from 31 to 41 % w.b. This result is similar to that reported on the increase in linear dimensions with increase in moisture content of Desma seed, two varieties of Lablab seed (Rongai seed and Highworth seed) and Tef seed [19], [20], [21].

The geometric mean diameter, sphericity and surface mass area also increase with increase in moisture content. These properties are dependent on the three linear dimensions, which were observed to increase within increase in moisture content. This occurs probably due to the fact that these properties are directly dependent on moisture content. The geometric mean diameter which increased from 24.94 mm to 27.44 mm is similar to that of different varieties of watermelon seed (Sarakhsi, Kolaleh and Red) which increased with an increase in moisture content [22]. The sphericity of *Telfaria Occidentalis* seeds which ranged from 0.691 mm to 0.729 mm is similar to that of the different varieties of barley kernels (Sahra and Valfarjr) [23].

The thousand seed mass of the seed varies from 8.50 kg to 10.81 kg with respect to the increase in moisture content. The knowledge of thousand seed mass is applicable in design of storage structure for seeds. The true density varied from 0.86 to 1.17 $g \cdot cm^{-3}$ and the bulk density also varied from 0.77 $g \cdot cm^{-3}$ to 0.80 $g \cdot cm^{-3}$ with the increase in moisture content from 31 to 42 % w.b. This indicates the significant importance of the mass of biomaterials on their bulk and true densities. The direct proportionality in the increase in true density with increase in moisture content is similar to that reported for sunflower seed and karinda seed respectively [24]. The increase in bulk density of the seed with increase in moisture content indicates that the increase in mass owing to moisture gain in the sample is more than the accompanying volumetric expansion of the bulk. The bulk density of agricultural products have been reported to be important in the design of silos and storage bins, maturity and quality evaluation of products which are essential in grain marketing. It also has practical application in the calculation of thermal properties in heat transfer problems, in determining Reynolds's number in pneumatic and hydraulic handling of materials and in predicting physical structure and chemical composition [25]. Similar results has been were reported for soybean grains and rubber seeds, respectively [26] [27].

The porosity calculated from relevant experimental data decreased from 26.74 % to 17.09 %. This trend was observed in some other seeds like pumpkin seed and pigeon pea [28] [29]. The decrease in porosity occurred due to the fact that increase in moisture content results in more significant increase of linear dimensions, thereby leading to reduction in pore spaces and giving a more compact arrangement of the seeds, thus reducing the porosity.

The angle of repose increased with increase in moisture content. This may be due to the fact that an increase in moisture content increased the cohesion between the seeds, thus increasing the friction the seed experiences during its movement on the selected surface. The angle of repose is paramount in the design of hopper openings, storage-bin side wall and chutes for bulk transport [25].

Coefficient of friction for all the samples at all moisture content followed a similar pattern; it increased with increase in moisture content on all the surfaces used. It was observed that coefficient of friction was highest on wood surface as reported for Karinda seeds [24], while the minimum friction occurred from the samples tested on the glass surface which is also similar to that reported for lentils seeds [15]. This difference in coefficient of friction is due to the roughness of the various surfaces. This is because the effect of moisture content is more significant with decrease in roughness of the selected surface since the smoother the surface, the less the friction. The knowledge of the coefficient angle of friction is important in the design of an arch free hopper, silo and storage structures. The coefficient of mobility, which represents the freedom of motion of a substance, is inversely related to the angle of friction. The higher the angle of friction the larger the opening and side wall slope of the hopper. Therefore, optimum design will avoid immature flow (where some depth of granular particles remains stationary) and the arching phenomena to ensure a fully developed sliding flow in the hopper [25]. The coefficient of friction of the seeds on the three different surfaces is similar to that reported for *Moringa Oliefera* seeds [30].

The specific gravity of the seed increased from 0.30 to 0.37 g. The specific gravity of the seed increased with increase in moisture content as a result of increase in weight. Specific gravity is an important quality criterion for processing of biomaterials. It is used as an estimate of solid or dry matter content of biomaterials. The higher the dry matter content, the lower the water content and the higher the specific gravity.

CONCLUSIONS

The length, width, thickness, sphericity, geometric mean diameter, thousand seed mass, angle of repose, surface area, true density, and coefficient of friction, showed an ascending linear relationship except, the porosity which has a descending linear relationship with moisture gain. These properties will provide important and essential data for efficient process and equipment design.

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NEKE FIZIČKE OSOBINE SEMENA OŽLJEBLJENE TIKVE – TIKVE TELFARIJE (*Telfaria Occidentalis)* IZLOŽENOG UTICAJU VLAGE

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Sažetak: Uticaj sadržaja vlage na neke fizičke osobine semena *Telfaria Occidentalis* bio je ispitivan pri vlažnostima od 31%, 34%, 36% i 41%. Srednje vrednosti fizičkih osobina semena koje su određene su: dužina 36.09 – 38.32 mm, širina 30.22 – 32.82 mm, debljina 14.22 – 16.42 mm, geometrijski srednji prečnik 24.94 – 27.44 mm, sveričnost 0.69 – 0.73 mm, masa hiljadu zrna 8.50 – 10.81 kg, gustina gomile 0.77 – 0.80 g·cm^{-3}, stvarna gustina 0.86 – 1.17 g·cm^{-3}, poroznost 17.09 - 26.74 %, spoljna površina 1953.46 – 2364.00 cm^{2}. Koeficijent trenja meren na staklu iznosio je 0.37 – 0.58 %, na metalnoj ploči 0.49 – 0.58 % i šperploči 0.53 – 0.65%. Sve vrednosti fizičkih osobina ocenjivanog semena povećale su se sa povećanjem sadržaja vlage, izuzev poroznosti koja je opadala sa porastom sadržaja vlage. Ove informacije će inženjerima i konstruktorima obezbediti relevantne podatke za efikasno konstruisanje uređaja i opreme za tretman semena *Telfaria Occidentalis* čime će se povećati njegova upotreba u Nigeriji.

Ključne reči: *Telfairia Occidentalis, sadržaj vlage, fizičke osobine, poroznost*

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