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Research Paper

Dimensional Properties of *Garcinia kola* Nuts as Influenced by Moisture Content

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ABSTRACT

The dimensional properties of biomaterials are important parameters during sorting, conveyance, cleaning, grading, processing and many other post-harvest operations. The dimensional properties of *Garcinia kola* was investigated at different moisture content using standard procedures. The properties determined include length, breadth, width, geometric mean diameter, arithmetic mean, sphericity and projected area. The results showed that within the moisture content range of 5–35% wet basis, the length of bitter kola varied between 31.89–34.40 *mm*, the width varied between 14.63–20.1 *mm* and the thickness varied between 13.97–19.13 mm with average values 33.32 (± 1.01), 18.04 (± 1.72) and 16.99 (± 2.08) mm respectively. The geometric mean diameter varied between 20.06–22.92 mm while the arithmetic mean diameter varied between 21.30–24.02 mm with average values 21.48 (±1.04), and 22.78 (±1.01) mm respectively. The sphericity of the bitter kola seeds ranged between 0.61–0.67 with an average value of 0.64 (±0.02), and the projected area of the bitter kola nuts ranged between 116.4 – 170.6 mm^2 with an average value of 151.8 mm^2 (±17.58), within moisture content range of 5–35% wet basis. Moisture content exhibits non-linear relationship with the dimensional and axial properties of *Garcinia kola* nuts. These properties are useful in characterizing the nuts and designing and development of processing/post harvest machines for their processing.

Keywords: axial dimension, sphericity, projected area, moisture content.

INTRODUCTION

The existence of humans is solely dependent on plants availability due to their enormous importance including provision of food, oxygen for breathing and raw materials for industries and building. Moreover, some herbal plants (including bitter kola and kolanut) are used in traditional medical practice by almost 60% of the world population in both developing and developed countries where modern medicine is predominantly used (Mythilypriya *et al.*, 2007). An estimated 60-80% of Africa's population depends solely on herbal remedies for its primary health care needs (Adesuyi *et al.*, 2012) and some of these resources contribute immensely to economy and food security in the country (Dah-Nouvlessounon *et al.*, 2015).

Bitter kola (*Garcinia kola* Heckel), Family Guttiferae is a tree found in Southern part of Nigeria and other West African nations. It is an angiospermae with a bitter stringent and resinous taste, somewhat resembling that of raw coffee, followed by a slight sweetness, it is a highly valued ingredient in African ethno medicine because of its varied and numerous uses which are social and medicinal. It is regarded as a wonder plant because every part of the plant (bark, leaves, root and wood) has medicinal importance due to presence of phytochemicals (Iwu *et al.*, 1990). *Garcinia kola* is traditionally used by Africans as a purgative, anti-parasitic, and antimicrobial properties. Bitter kola is used as a substitute for hops in brewing lager beer as it is especially useful in preventing beer spoilage.

The nuts are used for bronchitis, throat infections, colic, head or chest colds, and cough. It is also used for liver disorders and as a chewing stick (Iwu *et al.*, 1999). Consumption and use of bitter kola in Nigeria is low due to inadequate information on its postharvest handling. Consequently, it becomes imperative to investigate this nut and create awareness on some of its properties and potentials. Several authors have reported the physico-chemical and nutritive properties of the bitter kola (Eleyinmi *et al.*, 2006; Mazi *et al.*, 2013), some physical properties of the tabletted seeds of *Garcinia kola* (Onunkwo *et al.* 2004*), s*ome physical properties of *Vernonia amygdalina* and *Garcinia kola* microspheres prepared with high molecular weight polyethylene glycols (Eraga *et al.*, 2015). The determination of engineering properties of foods including physical, mechanical, thermal, electrical, magnetic, and optical properties is important for proper design of food processing, handling, and storage systems (Akinoso and Raji, 2011). Food processing methods can alter the engineering and nutritional properties causing desirable or non-desirable changes in nutrient content, texture, colour, taste, aroma, and other quality attributes. A major parameter that affects these properties is the moisture content which is the amount of water present in food crops; moisture content determination is important as it is a vital and influential factor on all crops processing procedures and properties of crops.

Literature is scanty on the influence of moisture content on the physical properties including axial and dimensional properties of bitter kola which are needed for design and development of postharvest equipment for the nut including cleaning, grading, sorting, milling and generally postharvest operations. Thus, the main aim of this study was to determine the effect of moisture content on some physical properties of *Garcinia kola.*

MATERIALS AND METHODS

Sample Procurement and Preparation: fresh bitter kola nuts were procured from Ede Township market, Ede, Osun State, Nigeria. The nuts were cleaned to remove all foreign and dissimilar products such as dirt, pieces of stone and broken nuts, selected good nuts were labelled accordingly for ease of identification.

Moisture Content Determination: The moisture content of the nuts was determined according to ASAE Standard S358.2 (1983) by drying nuts in an Electro-heating standing temperature air dry Oven (DHG-OA, FCD-3000 series) at 105°*C* until constant weight was obtained using Electronic Weighing Scale (PA 413 $\pm$ 0.001g).They were further conditioned to desired moisture levels by dehydration and rehydration; Conditioned samples were sealed in air-tight separate polythene bags and kept in the refrigerator for 48 hours to enable the moisture to distribute uniformly throughout the samples. The mass of water added to obtain desired moisture content levels was obtained using Equation 1 (Bisht, 1986; Akinoso, 2006, Fakayode *et al.* 2016, Aremu and Ogunlade, 2016a and 2016b). The moisture content of the samples in percent dry basis was calculated using Equation 2.

$$Q = \frac{A(b-a)}{(100-b)} \qquad (1)$$

$$Ms = \frac{100\ (W_i - W_f)}{W_f} \qquad (2)$$

Where: Q is the mass of water added (g), A is the initial mass of samples, a is the initial moisture content of samples and b is the final (desired) moisture content of samples, Ms is the moisture content (% dry basis), Wi is the initial mass before oven drying (in grams) and Wf is the final mass after oven drying (in grams).

Physical Properties

Axial Dimensions: Alphabets x, *y*, z were used to represent axial dimensions (major, intermediate and minor diameters respectively) which otherwise can be referred to as the length, width and thickness respectively. Vernier calliper (0.001 mm accuracy) was used in taking the measurement.

Geometric Mean: the geometric mean was calculated using Equation 1 described by Mohsenin (1986).

$$Gm = (xyz)^{\frac{1}{3}} \quad (1)$$

Where: *Gm* is the Geometric Mean, *x* is the Major Diameter, *y* is the Intermediate Diameter, *z* is the Minor Diameter (*mm*).

Arithmetic Mean: this was calculated from the axial dimensions using Equation 2.

$$Am = \frac{x+y+z}{3} \quad (2)$$

All parameters remain as defined.

Sphericity: the higher the sphericity value of a material, the closer its shape to a sphere; this property is useful in the design of hopper and dehulling equipment for agricultural products (Ajav and Ogunlade, 2014; Ogunlade *et al.* 2016). It determines the tendency of a material to roll when placed on a particular orientation. The degree of sphericity was calculated using Equation 3 described by Mohsenin (1986).

$$\Phi = \frac{(xyz)^{1/3}}{x} = \frac{Gm}{x} \quad (3)$$

Where: *Φ* is the Sphericity in decimal and other parameters remain as defined above.

Projected Area: the projected area *S* in mm^2 was estimated by the relationship given by Asoiro and Anthony (2011) as:

$$S = \pi Gm^2 \quad (4)$$

Where: *Gm* is the geometric mean diameter (*mm*) and *S* is the projected area of the nuts (mm^2).

RESULTS AND DISCUSSION

Influence of moisture content on Axial dimensions, Geometric and Arithmetic Mean: The effect of moisture content on length, breadth, thickness, geometric mean diameter and arithmetic mean of *Garcinia kola* is shown in Figure 1. It was observed that moisture content had significant effect on the axial dimensions, arithmetic mean and geometric mean diameter ($p < 0.05$) within the moisture content range of 5 – 35 % wet basis. The length of bitter kola varied between 31.89 – 34.40 *mm*, the width varied between 14.63 – 20.1 *mm* and the thickness varied between 13.97 – 19.13 mm with average values 33.32 (±1.01), 18.04 (±1.72) and 16.99 (± 2.08) mm respectively. The geometric mean diameter varied between 20.06 – 22.92 mm while the arithmetic mean diameter varied between 21.30 – 24.02 mm with average values 21.48 (±1.04), and 22.78 (±1.01) mm respectively. These properties will be useful in characterizing the nuts, cleaning, screening, grading, milling and in designing machines for their processing (Ilori *et al.* 2010).

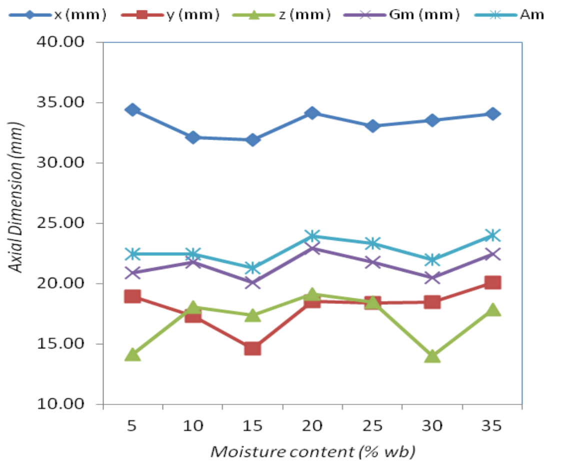

Figure 1: Influence of Moisture content on Dimensional Properties of *Garcinia kola*.
x-major diameter, y- minor diameter, z-intermediate diameter, Gm-Geometric mean Diameter, Am- Arithmetic mean Diameter.

Moisture content exhibits non-linear relationship with the dimensional properties of *Garcinia kola* nuts, a similar trend was reported by Asoiro and Anthony (2011), Ajav and Ogunlade (2014) for ginger rhizomes, Jaiyeoba and Ogunlade (2017) for locust bean produced in four different locations in Nigeria.

Influence of Moisture Content on Sphericity: the sphericity value of the bitter kola seeds ranged between 0.61 – 0.67 with an average value of 0.64 (±0.02) within moisture content range of 5 – 35 % wet basis. This implies that the nuts of *Garcinia kola* will slide easily when processed within the range of moisture content considered for this study. This is in similar trend with report of Simonyan *et al.* (2009) for *Ronghai lablab* seeds, Ajav and Ogunlade (2014) for ginger rhizomes, Akinoso *et al.* (2014) for kola nuts. The effect of moisture content on the sphericity of the nuts is presented in Figure 2.

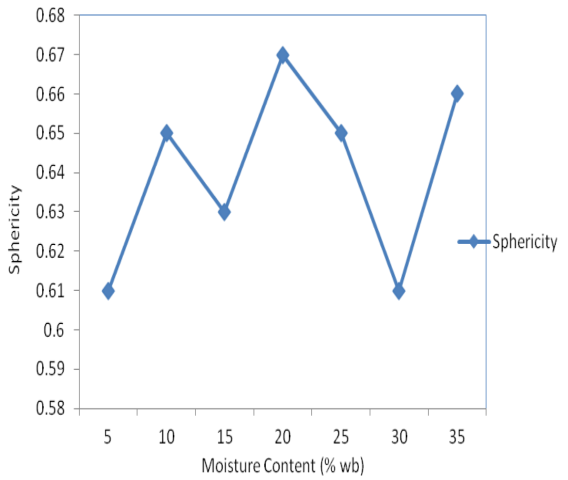

Figure 2: Effect of Moisture Content on Sphericity of *Garcinia kola*

Influence of Moisture Content on Projected Area: the projected area of the bitter kola nuts ranged between 116.4 – 170.6 mm^2 with an average value of 151.8 mm^2 ($\pm$ 17.58) within moisture content range of 5 – 35 % wet basis. The variation of projected area with the moisture content may be attributed to its dependence on the three axial dimensions, values obtained falls within similar trend with findings of Hsu *et al*. (1991) for pistachios, Baryeh (2001) for bambara nuts, Baryeh and Mangope (2002) for pigeon pea. The effect of moisture content on the projected area of bitter kola nuts is presented in Figure 3.

The influence of moisture content on projected area of bitter kola nuts is non-linear and falls within same trend with Orji (2001) for bread fruit seeds, Akaaimo and Raji (2006) for *Prosopis africana*, Asoiro and Anthony (2011) for African Yam Beans, Ajav and Ogunlade (2014) for ginger rhizomes.

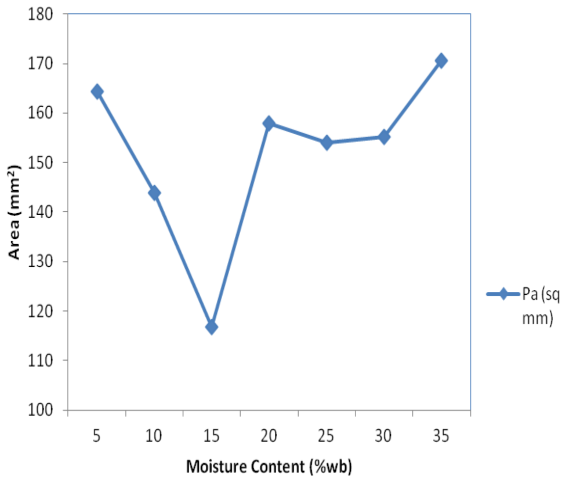

Figure 3: Influence of moisture content on Projected Area of *Garcinia kola* Nuts

CONCLUSION

The effect of moisture content on some dimensional properties of *Garcinia kola* was investigated. These properties include length, breadth, thickness, geometric mean diameter and arithmetic mean, sphericity and projected area. Moisture content exhibits non-linear relationship with the dimensional properties of *Garcinia kola* nuts considered for this study. The sphericity value obtained implies that the nuts will slide easily when processed within the range of moisture content. The data obtained are useful in characterisation, design of processing machines and generally in post harvest handling of the nuts of *Garcinia kola*.

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