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Note

Nutritional and physical properties of kariya seeds

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A b s t r a c t. Nutritional and physical properties of kariya seeds were determined. Proximate analysis showed that kariya kernels contain 17.5, 2.8, 37.5 and 6.5% of crude protein, ash, fat and crude fibre, respectively. The fatty acids were largely made up of myristic, palmitic, stearic and linolenic acids. The angle of repose and coefficient of friction on wood, aluminium and galvanized steel surfaces were 38.22°, 0.32, 0.34 and 0.35 for the nut and 33.37°, 0.23, 0.30, 0.31 for the kernel. The rupture force in the longitudinal axis was less than in the transverse direction, and the corresponding values for stiffness and maximum deformation at nutshell rupture were 29.71 and 13.53 N mm^{-1}, and 3.39 and 4.18 mm, respectively.

K e y w o r d s: kariya, nuts, kernels, nutritional and physical properties

INTRODUCTION

Kariya (*Hildegardia barteri)* is primarily an ornamental tree in West Africa, grown only for its bright beautiful flowers which blossom during the dry season. The flowers, which are usually borne on leafless branches, mature into one-seeded pods (Hildergadia Notes, 2007), each about 50 mm in length, bearing a peanut-like seed in a nutshell (Fig. 1). The mature pods drop completely when dry and are disposed as refuse in many places, only in few parts of West Africa the kernels are eaten raw or roasted like peanuts (Inglett *et al.,* 1973), or used as condiments in traditional food preparations. The proximate composition and fatty acid profile of biomaterials provide the basis for their exploitation for food or oil. This study was carried out to investigate some nutritional and physical properties of kariya seeds.

MATERIALS AND METHODS

Dried kariya pods were gathered from twenty stands of ornamental kariya trees in Obafemi Awolowo University, Ile-Ife, Nigeria, in January, 2008. About 5 kg of nuts extracted from the pods were winnowed to remove stones and other extraneous particles. About 2 kg of the nuts were dehulled manually and cleaned to remove chaff, broken, shrivelled, immature kernels and broken seeds. The moisture content of the nuts and kernels was determined according to the ASAE (2003) method. The average moisture content of the nuts and the kernels were 13.83 and 16.02%, respectively. The experiment was carried out at these moisture contents.

The proximate composition of the kernels was determined using standard laboratory methods (AOAC, 2002) in three replications. Fatty acid methyl ester (FAME) of the extracted crude fat was prepared by transesterification using methanolic KOH according to the AOCS method Ce 2-66 of 1997 (8). The fatty acids in the sample were identified by comparing retention times of FAMEs with those of standard

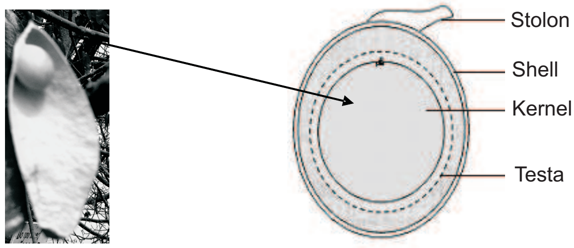

Fig. 1. Longitudinal section through kariya pod and nut.

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FAME mix C8 – C24 (Supelco, Belle, USA). The fatty acids were expressed as relative area percentage and the values obtained were averages of three replicates.

The physical and mechanical properties were determined according to standard methods (Aydin, 2007; Mohsenin, 1986; Omobuwajo *et al*., 1999).

RESULTS AND DISCUSSION

The proximate analysis showed that kariya kernels contain 17.5, 37.5, 2.8 and 6.5% of crude protein, crude fat, ash and crude fibre, respectively. The crude protein content of kariya compares favourably with 18.3% for gingelly seeds, 15.6% for walnut, and 19.8% for both pistachio and sunflower seeds; whereas, it is less than 21.2 % for cashew nut, 20.8% for almond, 26.3 for groundnut, 20.3% for linseed and 20% for mustard seeds (Gopalan *et al.,* 2007). With this protein content, the functionality of kariya defatted flour can be explored in food applications. The crude fat content can be compared with 39.3% for sponge gourd seeds (Ogunsina *et al.,* 2009), 39.8% for groundnut, 37.1% for linseed, 39.7% for mustard and 39% for niger seeds (Gopalan *et al.,* 2007). The fatty acid profile of kariya oil shows that it has 77% of saturated fatty acids and 23% of unsaturated fatty acids (Table 1). This is similar to that of palm kernel oil which has 82% saturated fatty acids and 18% unsaturated acids (Akinoso *et al.,* 2006). Such oils are characteristically stable and will turn solid texture at room temperature. It was observed that the fat contains an almost equal amount of myristic, palmitic, stearic and linolenic acids, which is quite uncommon among oil seeds. Palmitic acid was the major fatty acid, up to 29.4 %, while stearic, myristic and linolenic acids were 23.8, 23.3, and 21.5%, respectively. A small amount of linoleic acid (1.43%) and trace amounts of lauric (0.6%) and oleic (0.03%) acids were also observed.

T a b l e 1. Fatty acid composition of crude fat extract from kariya seeds

Fatty acids	Composition (%)
Saturated	
Lauric	0.60
Myristic	23.32
Palmitic	29.38
Stearic	23.74
Total	77.04
Unsaturated	
Oleic	0.03
Linoleic	1.43
Linolenic	21.50
Total	22.96

The axial dimensions, shape indices, gravimetric properties, density characteristics and frictional properties of kariya nuts and kernels are shown in Table 2. The average length, width, thickness, geometric mean diameter and mass of kariya were 14.1, 10, 9.6, 11.1 mm and 0.5 g, for the nuts and 10.2, 7.2, 7.2, 8.1 mm and 0.4 g for the kernels, respectively. The seed volume and the surface area were 719.8 mm^3 and 387.1 mm^2 for the nuts and 324.3 mm^3 and 203.6 mm^2 for the kernels. These axial dimensions are close to 10.5, 9.5 and 8.5 mm for bambara groundnut (Baryeh, 2001), whereas with an average width and thickness of 16.7 and 15.7 mm, respectively, kariya is smaller than peanut (Aydin, 2007). Similarly, kariya is smaller in size compared to almond and pistachio for which length, width and thickness were 25.5, 17 and 13.1 mm (Aydin, 2003) and 16.9, 12.1 and 11.8 mm (Kashaninejad *et al.,* 2006), respectively. It was observed that kariya nut is lighter in weight compared to peanut and pistachio which weigh 2.2, 3.9, 1.1, 1.2 and 2.6 g, respectively (Aydin, 2007 and Kashaninejad *et al.*, 2006). The following general expressions were derived for the relationship between the principal dimensions and mass for the nut and the kernel:

$$L = 1.38\ W = 1.47\ T = 31.15\ M,$$

$$l = 1.42\ w = 1.43\ t = 29.54\ m,$$

and similarly, we can write:

$$L = 1.39\ l,\ W = 1.47\ w,\ T = 1.40\ t,\ M = 1.24\ m,$$

where: mass, length, width and thickness are M, L, W, T for nut and m, l, w, t for the kernel, respectively.

The lower mass ratio of 1.24 of nut indicates a relatively high yield of kernels per unit weight of kariya nuts. Table 3 shows the dimensions and mass of kariya nuts and kernels based on their size distribution. The trend shown by each curve is that of normal distribution. The geometric mean diameter of kariya is less than 13.4 mm for pistachio (Kashaninejad *et al.,* 2006), 20.96 mm for filbert (Pliestic *et al.,* 2006) and 12.6 mm for peanut (Aydin, 2007).

The sphericity of kariya nut (79.3%) and kernel (80.5%) compares favourably with that of pistachio, 79.54% (Kashaninejad *et al.,* 2006) and filbert nut, 82.86% (Pliestic *et al.,* 2006), but are less than that of bambara groundnut which varied from 87-90% (Baryeh, 2001). These values indicate that kariya has a near spherical shape and provide useful information for the design of nutcracker, kernel-shell separator, milling machine for kariya seeds and other similar agricultural products where the flow pattern of the material on flat surfaces is an important factor.

The true density, bulk density, density ratio and porosity are 787.2, 375.4 kg m^{-3} 56.4 and 47.7% for the nut and 1 058, 508 kg m^{-3}, 45.4 and 52% for the kernel, respectively. The bulk density of kariya kernels is greater than 213.5 kg m^{-3} for peanuts (Aydin, 2007), but lesser than 520.8, 590 and

795 kg m^{-3} for pistachio (Kashaninejad *et al.*, 2006), almond (Aydin, 2003), and bambara groundnut (Baryeh, 2001), respectively. Similarly, the true density of kariya is greater than 484.5 kg m^{-3} for peanut and lower than 868 kg m^{-3} for filbert, 1 141.77 kg m^{-3} for pistachio and 1 285 kg m^{-3} for bambara groundnut. The porosity compares with that of almond which ranges from 35.32 to 53.21 (Aydin, 2003), but is higher than 41.53-45.24% for filbert nuts (Pliestic *et al.*, 2006).

T a b l e 2. Physical properties of kariya nuts and kernels seeds

Properties	Nuts	Kernels
Length (mm)	14.06±1.10	10.16±0.64
Width (mm)	10.20±0.59	7.20±0.41
Thickness (mm)	9.57±0.40	7.16±0.50
Geometric mean diameter (mm)	11.10±0.47	8.05±0.32
Volume (mm^3)	719.81±2.22	324.28±8.31
Surface area (mm^2)	387.13±2.34	203.60±1.86
Sphericity (%)	79.26±4.34	80.45±0.05
Aspect ratio (%)	73.38±0.07	71.33±0.07
Mass (g)	0.47±0.08	0.35±0.04
Thousand seed mass (g)	485.61±10.20	396.23±8.54
True density (kg m^{-3})	787.17±31.63	1 058.02±78.3
Bulk density (kg m^{-3})	375.39±10.81	508.02±22.01
Density ratio (%)	56.42±4.29	45.37±4.01
Porosity (%)	47.69±4.27	51.98±3.97
Hull ratio (%)	24.73±0.06	Not applicable
Coefficient of static friction on:		
- wood (with grain parallel to axis of slide)	0.32±0.05	0.23±0.04
- aluminium	0.34±0.04	0.30±0.02
- galvanized steel sheet	0.35±0.04	0.31±0.01
Dynamic angle of repose (°)	38.22±2.09	33.37±2.59

The angle of repose of kariya nut and kernel are 38.22 and 33.37°, respectively. The coefficient of static friction on wood, aluminium and galvanized sheet are 0.32, 0.34, and 0.35 for the nut and 0.23, 0.3 and 0.31 for the kernel, respectively. It was observed that for the kernel the angle of repose is lower than that of the nut and this may be attributed to the rough nature of the hull which offers resistance to motion when sliding on the test surface. Both the nut and the kernels are near spherical in shape, thus they both glide easily on one another. Information about the frictional properties of biomaterials is important in the design of hopper and conveyor systems. Usually, hopper walls are inclined at an angle greater than the angle of repose to allow material flow by gravity (Baryeh, 2001). The coefficient of static friction of kernel on all the surfaces considered was lesser than that of the nut due to the smoother surface of the kernel.

The force deformation curves of kariya nuts during quasi-static compression tests in both axial directions are presented in Fig. 2 and the data are shown in Table 4. Maximum force occurred in the transverse axis while the minimum was observed in the longitudinal axis. This behaviour was also reported for almond (Aydin, 2003), but the converse was

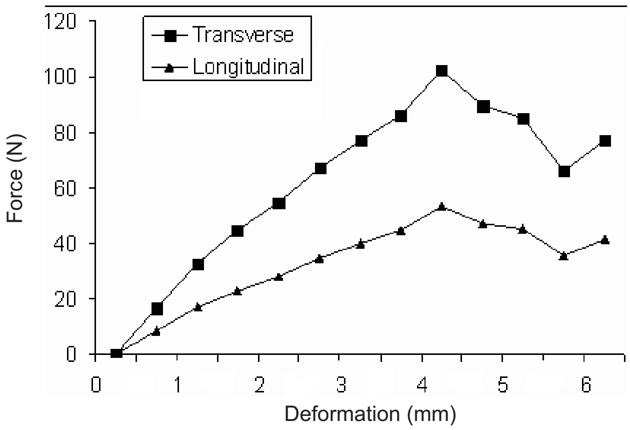

Fig. 2. Force deformation curves of kariya nuts under quasi-static compression along the longitudinal and transverse axes.

T a b l e 3. Size distribution of kariya nuts and kernels

	Properties	Large	Medium	Small
Nut	Length (mm)	15.48±0.48	14.05±0.53	12.32±0.39
	Width (mm)	11.25±0.24	10.19±0.29	9.54±0.21
	Thickness (mm)	10.13±0.22	9.63±0.13	9.04±0.24
	Mass (g)	0.58±0.03	0.48±0.04	0.36±0.06
Kernel	Length (mm)	10.90±0.33	10.03±0.29	9.03±0.25
	Width (mm)	7.69±0.16	7.25±0.15	6.64±0.25
	Thickness (mm)	7.69±0.15	7.14±0.27	6.12±0.25
	Mass (g)	0.40±0.03	0.34±0.02	0.28±0.03

T a b l e 4. Force deformation characteristics of kariya nuts during quasi-static compression tests

Parameters	Load orientation	
	longitudinal axis	transverse axis
Stiffness (N mm^{-1})	29.71	13.53
Maximum elastic deformation (mm)	3.39	4.18
Load at nutshell rupture (N)	91.65	104.87

true for filbert (Pliestic *et al.,* 2006). This implies that the nutshell is more resistant to fracture in the transverse axis as compared to the longitudinal. The differences in the shape and shell thickness of biomaterials affect their deformation and fracture.

CONCLUSIONS

1. Kariya seed is an under-utilized oil seed, having 17.5 and 37.5% of crude protein and fat. The fatty acids in its crude fat indicate an almost equal amount of myristic, palmitic, stearic and linolenic acids.

2. The average values of length, width, thickness, equivalent diameter and mass were 14.06, 10.20, 9.57, 11.10 mm and 0.47 g for the nuts and 10.16, 7.20, 7.16, 8.05 mm and 0.35 g for the kernels, respectively, while the volume, surface area, sphericity and aspect ratio were 719.81 mm^3, 387.13 mm^2, 79.26, 73.38% and for the nuts and 324.28 mm^3, 203.60 mm^2, 80.45, 71.33% for the kernels, respectively.

3. The true and bulk density, density ratio and porosity were 787.17, 375.39 kg m^{-3}, 56.42 and 47.69%, for the nuts and 1 058.02, 508.02 kg m^{-3}, 45.37 and 51.98% for the kernel, respectively.

4. The angle of repose and coefficient of friction on wood, aluminium and galvanized steel surfaces were 38.22°, 0.32, 0.34 and 0.35 for the nut and 33.37°, 0.23, 0.30, 0.31 for the kernel.

5. The average compressive force required to cause nut rupture in longitudinal orientation (91.7±8.5 N) was less than in the transverse orientation (104.9±35.3 N). The corresponding values for stiffness were 29.71 and 13.53 N mm^{-1}, while the average maximum deformations of at nutshell rupture were 3.4 and 4.2 mm, respectively.

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