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Fatty acids composition and oil characteristics of nut kernel oil of cashew (*Anarcadium occidentale L.)) from Nsukka, Nigeria*

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ABSTRACT

The lack of information on the fatty acid content and physicochemical profile of nut kernel oil from the eastern part of Nigeria, necessitated the present study. The physicochemical properties and fatty acid profile of kernel oil obtained from cashew nuts from Nsukka community, in Enugu State, Nigeria, was investigated using standard methods. The properties of the oil were: colour (yellow), moisture impurity (1.09%), refractive index (1.86), specific gravity (0.90), acid value (19.58 mg KOH g^{-1}), saponification value (230.01 mg KOH g^{-1}), iodine value (119.72 mg iodine g^{-1}), peroxide value (0.00 mmol kg^{-1} of active oxygen), free fatty acid value (98.0 $g{\cdot}kg^{-1}$), unsaponifiable matter (23.0 $g{\cdot}kg^{-1}$), total lipid content of kernel (425.0 $g{\cdot}kg^{-1}$), fatty acid content of kernel (340.0 $g{\cdot}kg^{-1}$), saturated (74.4 $g{\cdot}kg^{-1}$) and unsaturated (265.6 $g{\cdot}kg^{-1}$) fatty acid content of kernel. Fatty acid profiling showed the oil to be very rich in oleic (59.95%), linoleic (17.33%), palmitic (14.72%) and stearic (6.78%) acids, with a linoleic to linolenic acid ratio of 84.99. The oil contained 77.70% unsaturated fatty acids, 29.15% of which were polyunsaturated. This result indicates that the oil is of good quality, relatively rich and safe for consumption; is semi-drying and may be suitable for soap making.

Key words: Cashew nut; fatty acid profile; kernel oil; physicochemical properties; safe oil.

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1. INTRODUCTION

Cashew tree (*Anarcadium occidentale* L.) is an evergreen plant of the Anacardiaceae family that grows up to 10-12 m tall (Axtell and Fairman, 1992). Though indigenous to tropical America, it was brought to West Africa, East Africa and India by the Portuguese in the 15^{th} and 16^{th} centuries, with the primary intension of checking soil erosion, but is now mainly grown for its commercially important nuts, kernel and shell oil, and other products (Gill, 1992; Nandi, 1998; Yahaya *et al*., 2012). The cashew nut grows externally in its own kidney shaped hard shell at the end of the pseudo fruit or pedicle which is commonly referred to as the cashew fruit or apple (Yahaya *et al*., 2012). In Nigeria, about 6.6 tons of cashew nuts are produced annually (Ogunsina, 2013). It is called “akwe” by the Ibos, “kanju” by the Hausas, “kanju kantonoyo”, “ikashu” by the Edos, all in Nigeria. The shell is 2-3 m thick, with a leathery outer case and a thinner, harder inner case, between which is a honey combs structure containing the phenolic cashew nut shell liquid (Onilude *et al*., 2010); an excellent source of phenol for polymer production (Antony and Pillai, 1994; Akinhanmi *et al*., 2008). Cashew kernels are of high nutritive value (Trox *et al*., 2010), containing about 47% fat (Akinhanmi *et al*., 2008; NutritionData, 2013). Cashew kernel oil has found great use in domestic cooking and pharmaceutics (Yahaya *et al*., 2012); and has antioxidant (Singh *et al*., 2004) and aphrodisiac (Mbatchou and Kosoono, 2012) activities.

Nsukka community, in Enugu State, Nigeria produces a lot of cashew nuts, and has a high potential for the production of cashew kernel oil. Therefore, in this study, the physicochemical and fatty acid profiles of kernel oil, extracted from cashew nuts obtained from Nsukka community, was investigated.

2. MATERIALS AND METHODS

2.1 Collection and preparation of samples

Samples of fresh cashew nuts were collected from Nsukka community, in Enugu State, Nigeria. After sorting and thorough screening to remove impurities, they were cut open with a microtone, to remove their shells, while the kernels were collected and milled with a Moulinex blender.

2.2 Determination of total fat content/extraction of oil

The AOAC Official Method 920.39 (AOAC International, 2006) was adopted. The studied oil was extracted from the milled kernels by an 8 h Soxhlet extraction with analytical grade petroleum ether (60-80 °C); and allowing the solvent to evaporate, leaving the pure oil extract. This was then weighed and stored for subsequent use. The total lipid or oil content of the kernel was computed with the following equation.

$$\text{Crude lipid or oil content (\%)} = \frac{\text{weight } (g) \text{ of lipid or oil extract}}{\text{weight } (g) \text{ of the milled kernel used}} \times 100$$

2.3 Determination of the calculated fatty acid content of the kernel oil

The calculated fatty acid content of the kernel oil was computed according the following equation (Aremu *et al*., 2006).

$$\text{Calculated fatty acids content (\%)} = 0.8 \times \text{crude fat content (\%)}$$

2.4 Determination of physical characteristics

The physical properties were determined by AOAC methods (AOAC International, 2006). The moisture content was determined by drying in an oven (Plus II Sanyo, Gallenkamp PLC, England), according to AOAC Official Method 967.03. Specific gravity was determined picnometrically at 25 °C, according to AOAC Official Method 920.212. Refractivity index was determined at 25 °C with an Abbé refractometer, according to AOAC Official Method 921.08. These determinations were carried out in triplicate.

2.5 Determination of chemical characteristics

The chemical properties were determined by AOAC methods (AOAC International, 2006). Acid value was determined according to AOAC Official Method 969.17. Free fatty acid content was determined according to AOAC Official Method 940.28. Iodine value was determined according to AOAC Official Method 993.20. Saponification value was determined according to AOAC Official Method 920.160. Peroxide value was determined according to AOAC Official Method 965.33 (AOAC International, 2006). Unsaponifiable matter was determined according to AOAC Official Method 933.08. These determinations were carried out in triplicate.

2.6 Determination the fatty acid profile

The fatty acid profile of the oil was determined by gas liquid chromatography, using a Pye Unicam Series 104GCD equipped with flame ionization detector and connected to a Hitachi model 056 recorder (Hitachi Ltd., Tokyo, Japan). Oil sample (50 mg) was esterified for 5 min at 95 °C with 3.4 mL of the 0.5 mol·L^{-1} KOH in dry methanol. The mixture was neutralized using 0.7 mol·L^{-1} HCl, and 3 mL of 14% boron triflouride in methanol was added. The mixture was heated for 5 min at the temperature of 90 °C to achieve complete methylation process. The fatty acids were thrice extracted from the mixture with redistilled n-hexane, concentrated to 1 μL, and subjected to gas chromatographic analysis on a column of 10% Silar 10C on chromosorb WHP 80/100 mesh (split ratio 10:1). Helium was used as the carrier gas with at flow rate 1.0 mL·min^{-1}. The column initial temperature was 230 °C, ramped at 10 °C·min^{-1} to a final temperature of 275 °C, while the injection and detector were maintained at 230 °C and 275 °C respectively.

2.7 Computation of per cent daily value

Per cent daily values (%DV) were determined by comparison to the appropriate daily values (Food and Drug Administration, 2013), using the following formula.

$$\text{Per cent daily values (\%)} = \frac{\text{weight of the particular nutrient in 1 } kg \text{ of sample}}{\text{daily value for the nutrient}} \times 100$$

2.8 Data analysis

All values are reported as the mean ± s.d. (standard deviation) of three determinations except the colour and fatty acid profile of the oil.

3. RESULTS AND DISCUSSION

Table 1 shows the physicochemical properties of the cashew nut kernel oil. Its refractive index was greater than that reported for the same type of oil by Aremu *et al*. (2006). The iodine value recorded here is greater than that reported by Aremu *et al.* (2006) for the same oil. It is greater than that of coconut oil, comparable to that of sesame oil (Evans, 2005), but less than that of amaranth oil (Martirosyan *et al.*, 2007). By virtue of the iodine value recorded here, the cashew nut kernel oil can be referred to as a semi-drying oil, since semi-drying oils have iodine values of about 100-120. The density observed in this study is comparable to that reported by Aremu *et al.* (2006) for the same oil. A higher saponification value was observed here than was reported for the same oil by Aremu *et al.* (2006), thus indicating its suitability for soap making. The acid value was higher than what Aremu *et al.* (2006) reported for the same oil, but less than that reported by Martirosyan *et al.* (2007) for amaranth oil. The free fatty acid value was less than that reported by Aremu *et al.* (2006). A higher value for unsaponifiable matter was found in this study, than was reported for the same oil by Nandi (1998). The peroxide value of the study oil was less than was reported by Aremu *et al.* (2006). This is a reflection of the stability of the oil, since peroxide value is used as an indicator of the level of deterioration of oils. The total lipid content, recorded for the nut kernels in this study, is less than was in the reports by Nandi (1998) and NutritionData (2013), but greater than that by Aremu *et al.* (2006). The fatty acid content of the nut kernels was also higher than that reported by Aremu *et al.* (2006). Nutritionally, a 100 g of the oil is equivalent to 65.54 and 37.54%, respectively of the daily values for lipid and saturated fatty acid (Table 1).

Table 1: Physicochemical properties of cashew nut kernel oil

Parameter	Status	%DV·kg^{-1}
Colour	Yellow	
Refractive index	1.860±0.001	
Moisture impurity (g·kg^{-1})	10.900±0.020	
Specific gravity	0.900±0.011	
Total lipid content of kernel (g·kg^{-1})	425.000±0.280	655.400±0.180
Fatty acid content of kernel (g·kg^{-1})	340.000±3.560	
Saturated fatty acid content of kernel (g·kg^{-1})	74.400	375.400
Unsaturated fatty acid content of kernel (g·kg^{-1})	265.600	
Saponification value (mg KOH/g)	230.010±4.244	
Unsaponifiable matter (g·kg^{-1})	23.000±0.080	
Acid value (mg KOH/g)	19.580±0.007	
Peroxide value (mmole/kg of active oxygen)	0.000±0.000	
Free fatty acid value (g·kg^{-1})	98.000±0.140	
Iodine value (mg iodine/g)	119.720±1.080	

Values are means ± standard deviation of triplicate determinations, except colour, saturated and unsaturated fatty acid contents. %DV = per cent daily value

The fatty acid profile of the cashew nut kernel oil is shown in Table 2. The study oil had higher percentage of linoleic and palmitic acids, and lower oleic and stearic acids than was reported for the same oil by Nandi (1998). Its linoleic to linolenic acid ratio was 84.99, which was far less than the 129.7 reported for the same oil by Nandi (1998).

Table 2: Fatty acid profile (g·kg^{-1}) of cashew nut kernel oil

Fatty acid	/total fatty acid	/kernel
Lauric acid	1.93	0.65
Myristic acid	1.81	0.61
Myristoleic acid	2.08	0.71
Palmitic acid	147.19	50.05
Stearic acid	67.77	23.04
Oleic acid	599.49	203.83
Linoleic acid*	173.34	58.94
Linolenic acid*	2.04	0.69

*Essential fatty acids

This is a further indicator of its nutritional relevance, since from the point of view of essential fatty acid requirements, the ratio of linoleic to linolenic acid is considered important, as oils with lower ratios are deemed to be more nutritionally relevant (Makrides *et al.*, 2000; Makrides *et al.*, 2000; Tan *et al.*, 2009).

The proportion of unsaturated fatty acids in the study oil (Table 3) was higher than the reported values for cocoa butter, coconut oil, cotton seed oil, lard and palm oil; was comparable to those of amaranth oil and olive oil, but less than those of almond oil,

Table 3: Degree of saturation of the cashew nut kernel oil

Parameter	Value
Total saturated fatty acid (%)	21.870
Total unsaturated fatty acid (%)	77.695
Monounsaturated fatty acid (%)	60.157
Polyunsaturated fatty acid (%)	17.538
Saturated/unsaturated fatty acid ratio	0.281

castor oil, cod liver oil and groundnut oil (Evans, 2005; Martirosyan *et al.*, 2007). This degree of unsaturation observed here, is higher than the 73% (Nandi, 1998) and 75% (NutritionData, 2014), reported for the same oil, but is comparable to the 79% reported by SkipThePie.org (SkipThePie.org, 2012). The ratio of saturated to unsaturated fatty acids was approximately 0.28, which is higher than that of amaranth oil (Martirosyan *et al.*, 2007). The high content of unsaturated fatty acids implies any or both of the following. It might mean that the oil may be safe for consumption by individuals prone to dyslipidaemia, diabetes mellitus and cardiovascular diseases. This is because, according to Martirosyan *et al*. (2007), decreased intake of saturated and increased intake of unsaturated fatty acids reduces the risk and severity of cardiovascular diseases and other diseases associated with dyslipidaemia. This is attributable to the fact that intake of unsaturated fatty acids lowers serum cholesterol and triglyceride levels (Chaney, 2006). In addition to being unsaturated, about 22.57% of the unsaturated fatty acids in the study oil, is made up of the essential fatty acids, linoleic and linolenic acids, which is also an added advantage. The high content of the monounsaturated fatty acid, oleic acid, might also be beneficial in cases of bowel enteropathy (Nandi, 1998).

This might also imply that the oil has a high tendency to undergo spoilage, due to its high degree of unsaturation. This is in line with the report by Nieto and Ros (2012) that the possibility of becoming rancid, due to peroxidation, during storage, increases with increase in the degree of unsaturation. It is therefore recommended that this oil whenever extracted for use, should be protected from light and oxygen, and stored at very low temperatures to avoid peroxidative changes.

4. CONCLUSION

The results of the present study show that the cashew nut kernel oil, extracted from cashew nuts obtained from Nsukka community in Enugu State, Nigeria, has the indices of good quality and relatively rich oils that are safe for consumption, and other industrial uses.

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