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Varietal Differences in the Oil Composition of the Seed of Two Indigenous *Chrysophyllum albidium* Species

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Authors' contributions

This work was carried out in collaboration among all authors. Authors BAA and MOS designed the study and managed the analyses while Author ICC wrote the first draft of the manuscript. All Authors read and approved the final manuscript.

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Short Research Article

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ABSTRACT

Aim: To investigate the varietal difference in the composition of the oil of two *Chryosophyllum albidium* species.
Study Design: Laboratory experimental design was used.
Place and Duration of Study: *Chryosophyllum acreanum* and *Chrysophyllum africana* seed species of *Chrysophyllum albidium* were collected from Oja Oba market, Ibadan, Oyo State. The study was carried out between February 2019 - August 2019 at the Oilseed Laboratory of Federal Institute of Industrial Research, Oshodi, Lagos State, Nigeria.
Methodology: Oil in both seeds was extracted using Soxhlet extraction method. The physical and chemical properties of the oils were determined using official methods of analysis while the fatty acid composition of the seed oils was analysed using Gas Chromatography- Mass Spectrophotometer.
Results: The oil yield for both seeds was low, 3.52% for C. acreanum and 3.75% for C. africana. The values for the physical properties (Specific gravity, refractive index and unsaponifiable matter)

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of C. acreanum seed oil were higher than for C. africana seed oil. The chemical properties shows that the acid and peroxide values are 2.79mgKOH/g; 2.67mgKOH/g, 1.78mEq/kg; 1.63mEq/kg for C. acreanum and C. africana seed oil respectively while the iodine values for both seed oils are below 100mgI_2/100g. The fatty acid composition shows that both seed oil contains myristic acid as their major fatty acid.

Conclusion: The evaluated characteristics of the seed oils showed that there is no significant differences in the oil composition of C. albidium seed varieties as the oil composition are closely related except for the slight difference in their fatty acid profile.

Keywords: Chrysophyllum acreanum; *Chrysophyllum africana*; *species; seed oil; composition.*

1. INTRODUCTION

Oilseeds are rich sources of energy and nutrition. The main product of oilseeds is oil which is useful as food fat and also as industrial raw material for development of various oleo chemicals such as paints, varnishes, cosmetics, soap, lubricants, biodiesel and so on [1]. Vegetable oil has greater advantage over mineral oil that has been earlier used as industrial raw material. Vegetable oil degrades easily when spilled compared to mineral oil that slowly degrades, hence, the latter causing environmental pollution. The commonly utilized oil crops are soy-bean, groundnut, sesame, sunflower, rapeseed, safflower, castor and linseed [1]. Over the years, there has been an astronomical rise in prices of these commonly used oil crops, hence there is need to source for oils from underutilized or lesser known oilseeds that available to reverse the upward trend in the prices of these essential commodities. This would result in the utilisation of food-processing by-products and wastes, as well as underutilised agricultural products receiving more attention [2]. Such utilisation would contribute to maximising the available resources and result in the production of various products and foods [3]. *Chrysophyllum albidium* seeds belong to this group of unexploited oilseeds that the potential needs to be harnessed.

Chrysophyllum albidum (African Star Apple) is one of the fruits of great commercial importance common to Africa due to its diverse industrial, medicinal and food uses [4]. The fruit belongs to the family of Sapotaceae containing about 800 species making up to almost half of the order Ebernales [5] but few of these species are widely grown in Nigeria. The fruit when ripe is ovoid to sub-globose, pointed at the apex, and up to 6 cm long and 5 cm in diameter. The skin or peel, is orange to golden yellow when ripe and the pulp within the peel may be orange, pinkish, or light yellow. Within the pulp are three to five seeds which are not usually eaten [6]. The seeds are been discarded indiscriminately after the consumption of the succulent fruit [7]. Many research works has been done to determine the physical and chemical compositions of C. albidium seed oil generally but there is little information on the variation in the composition of the oil of various species. This research work is aimed at investigating the varietal difference in the composition of the oil of two *Chryosophyllum albidium* species which are *Chryosophyllum acreanum* and *Chysophyllum africana*.

2. MATERIALS AND METHODS

2.1 Sample Collection and Pre-Treatment

C. acreanum and C. africana fruits were purchased at Ojo-Oba market, Ibadan, Oyo State. The fruits were washed, cut into halves and the seeds were removed. The pulps surrounding the seeds were scrapped off and the seeds were washed thoroughly with distilled water. The resulting seeds were deshelled manually to remove the cotyledon and dried to a constant weight. The dried seeds were milled with the aid of Philip electric blender and the dry powder for each of the variety was kept in different air tight container.

2.2 Extraction of Oil

The oil extraction was carried out according to the method described by [8]. The pulverized seeds (5g) were weighed in triplicate. The weights of the filter papers were taken, followed by the weight of filter paper with the sample, the filter papers were tied with the samples and the oils were extracted using Soxhlet apparatus. The weights of the filter papers with the samples were taken after extraction. The oil yield was calculated as follows:

$$\text{Oil yield} = \frac{\text{weight of the oil}}{\text{weight of the sample}} \text{ X } 100$$

2.2.1 Physical properties of the C. acreanum and C. africana seed oils

The physical properties were determined according to the methods of [9] with some modifications.

2.2.1.1. Specific gravity (S.G.)

Empty specific gravity bottles were weighed and labelled as (M_e), the oil samples were dispensed into the specific gravity bottles, weighed and labelled as (M_o). The oils were then substituted with water of the same volume and weighed to give (M_w). Thus specific gravity of the oil samples was determined according to the formula below:

$$\text{Specific gravity} = (\text{Mo} - \text{Me}) / (\text{Mw} - \text{Me})$$

Where,

M_o-Specific gravity bottle + oil
M_e-Empty specific gravity bottle
M_w-Specific gravity bottle + water

2.2.1.2. Refractive index

The refractive index of the oil samples was determined with the aid of an Abbe type refractometer 60/95, (Model 2754 T3-NE, Germany). Few drops of the oil samples were put on the refractometer glass slide. At no parallel position, the refractive index was read through the eyepiece and recorded. An average of three readings was taken.

2.2.1.3 Unsaponifiable matter

This was determined by dissolving the oils in alcoholic KOH and refluxed. The homogenous KOH was then extracted with diethyl ether and filtered using pre-weighed filter paper, solid matter left in the filter paper was then dried to a constant weight and also reweighed.

2.2.2 Chemical properties of C. acreanum and C. africana seed oils

The chemical properties of C. acreanum and C. africanum seed oils were determined according to the methods of [9] with some modifications.

2.2.2.1 Acid value

Mixture of ethanol and diethylether, 25 mL (denatured alcohol) (V/V) with the addition of 3 drops of phenolphthalein indicator was neutralized with 0.1M ethanolic KOH solution. 0.5mL of the oil samples were added to the neutralized solution in the presence of 3 drops of phenolphthalein and was finally titrated against 0.1M ethanolic potassium hydroxide solution till a permanent pink colour was attained. The acid value was calculated as follows:

$$\text{A.V} = \frac{\text{Vol. of KOH used} \times \text{mass of KOH}}{\text{Mass of sample}}$$

2.2.2.2 Peroxide value

The peroxide values of the oil samples were determined by dissolving 0.5 mL of the oil in a solvent mixture (1:2) of acetic acid and chloroform. Potassium iodide (1.3 g) was added to the resulting solution. The mixture was place in a dark cupboard for 1 hr, after which, 75mL of distilled water was added followed by 3 drops of starch indicator, the mixture then was titrated against 0.05M sodium thiosulphate. The peroxide value was further calculated as follows:

$$\text{P.V} = \frac{\text{S} \times \text{N} \times 1000}{\text{Weight of sample}}$$

S= (Vol. of $Na_2S_2O_3$ for blank – Vol. of $Na_2S_2O_3$ for sample)
N= Normality of $Na_2S_2O_3$

2.2.2.3 Iodine value

The iodine values of the oil samples were determined by Wijjs method. Oil samples (0.5 mL) each was dispensed into a conical flask and mixed with chloroform (5 mL) and Wijjs reagent (8 mL), (9 mL of iodine trichloride and 10g of iodine in chloroform (300 mL)/acetic (700 mL) solution). The conical flask was shaked and placed in the dark cupboard for 1hr. After which, 7 mL of potassium iodide and 75 mL of distilled water were added and titrated against 0.05M sodium thiosulphate solution using starch as the indicator. A blank test was carried out simultaneously using water in place of the oil under the same conditions.

$$\text{I.V.} = \frac{(\text{Blank} - \text{sample}) \text{X } 0.01269}{\text{w}} \text{ X } 100$$

2.2.2.4. Saponification value

The alcoholic KOH solution of the oil was refluxed, 2 mL of the oil was weighed in a conical flask and 30 mL of 0.1M of ethanolic KOH was

added to it. The mixture was then allowed to boil for 30mins under reflux. 3 drops of phenolphthalein indicator was then added to the warm mixture and titrated against 0.5M HCl acid until pink colour disappears (end point). A similar procedure was administered to the blank.

$$S.V = \frac{56.1\,(Blank-Sample)N}{W}$$

where

N= normality of HCl
W=weight of the oil

2.2.3 Determination of fatty acids profile

The oil samples were prepared for fatty acids profile determination following the method used by [10] with some modifications while the GC-MS analysis was carried out according to the method of [11]. Potassium hydroxide – Methanol methylation –The methods and conditions of fatty acid methyl esters (FAME) preparation were set up. 1Ml of the oil was placed into 25 mL conical flask to which 5 mL of KOH–MeOH solution (0.5M) was added. The mixture was heated at 60 °C for 10 mins. After cooling to room temperature, 5 mL of n-hexane and few drops of H_2SO_4 were added and mixed thoroughly to remove the methyl esters. The extract was collected for GC-MS analysis. Hewlett Packard HP 6890 Series gas chromatograph coupled with a Hewlett Packard 5973 mass spectroscopy detector (GC-MS) system was used. Gas Chromatography was done with a HP 7673 and HP 7673 auto sampler. Helium gas was used as the carrier gas with a column pressure of 10psi with a flow rate of 2.5ml/min through the column. The temperature gradient started from 70°C with a linear increase to 170°C at 11°C/min till it reached 220°C 20°C/min. separating the closely eluting fatty acids. The saturated fatty acids eluted first before the unsaturated fatty acids.

3. RESULTS AND DISCUSSION

3.1 Physical Properties of C. acreanum and C. africana Seed Oil

The specific gravity decreases from 0.902 to 0.892 (C. acreanum to C. africana), the C. africana variety seed oil was lighter than C. acreanum seed oil. However, these values were not largely different. These values are in close range with the values (0.900) reported by [12] for both sundried and seeds dried at the temperature of 50°C. The refractive index also decreases from C. acreanum to C. africana (1.453 to 1.447). According to [13], the weight of oil affects the degree of reflection caused by a ray of light during refractive index determination of the oil. These values are higher than the values (1.405 and 1.400) reported by [12] but in close range for the value (1.4672) reported by [8]. The unsaponifiable matter of C. africana variety seed oil was also lower than for the C. acreanum variety. This could be as a result of C. acreanum seed oil containing higher triglyceride level and lesser impurities than C. africana seed oil.

3.2 Chemical Properties of C. acreanum and C. africana Seed Oil

The oil yield for C. africana seed oil was higher than that of C. acreanum, although this values were lower than the values (11.6%, 10.82% and 12.00%) reported by [14,15,16] respectively. The values are very low compared to those reported for most convectional oilseeds such as egusi melon seeds 53.20% reported by [17] and palm kernel seeds 51.35% reported by [18]. The seeds may therefore not be suitable for industrial applications due to the low oil yield. The acid value for C. acreanum seed oil 2.79mgKOH/g was lower than for C. africana seed oil 2.67mgKOH/g. These values are within the range of 2.881mgKOH/g, 2.868mgKOH/g and 2.52mgKOH/g reported by [15,12,4] respectively. Acid value is the extent at which triglycerides in oil decomposed by lipase action. The low acid value is an indication that the oil samples contain less free fatty acids thus reducing its exposure to oxidation. The peroxide value for C. acreanum seed oil 1.78mEQ/kg was higher than for C. africana seed oil 1.63mEQ/kg. However, these values are still within the permitted limit as reported by [19], the peroxide value for freshly prepared oil should be ≥ 10mEQ/kg. This is an indication that the oil will be stable to deterioration. The iodine value for C. acreanum seed oil 35.20 g/100g was higher than for C. africana seed oil 34.00 g/1100g. The values are in close range with 31.06g/100g and 33.22g/100g reported by [15,12] respectively. Iodine value measures the degree of unsaturation in vegetable oil, these values falls within the range of saturated oil thereby making the oils resistance to oxidation and rancidity. The saponification values for the two varieties are within close range. These values are in agreement with the values 199.50mgKOH/g and 200.67mgKOH/g reported [8,14].

Table 1. Physical properties of C. acreanum and C. africana seed oil

Parameters	C. acreanum	C. africana
Specific Gravity (g/cm³)	0.902±0.002	0.892±0.002
Refractive Index	1.453±0.003	1.447±0.002
Unsaponifiable Matter (%)	1.02±0.02	0.90±0.01

Values are mean ± standard deviation of triplicate determinations

Table 2. Chemical properties of C. acreanum and C. africana seed oil

Parameters	C. albidium	C. africanum
Oil yield (%)	3.52±0.01	3.75±0.02
Acid value (mgKOH/g)	2.79±0.003	2.67±0.005
Peroxide value(mEQ/kg)	1.78±0.008	1.63±0.001
Iodine value (mgI_2/100g)	35.20±0.012	34.00±0.003
Saponification value (%)	199.89±0.03	201.00±0.02

Values are mean ± standard deviation of triplicate determinations

Table 3. Fatty acid composition of C. acreanum and C. africana seed oil

Fatty acid	Fatty acid No	C. albidium (%)	C. africanum (%)
Caprylic acid	C8:0	-	0.10±0.001
Pelargonic acid	C9:0	-	0.12±0.005
Undecanoic acid	C11:0	3.98±0.01	4.00±0.02
Lauric acid	C12:0	1.99±0.03	2.01±0.006
Myristic acid	C14:0	60.14±0.004	60.01±0.01
Pentadecanoic acid	C15:0	0.62±0.006	0.22±0.003
Palmitic acid	C16:0	1.48±0.005	1.49±0.002
Margaric acid	C17:0	1.47±0.001	1.58±0.01
Stearic acid	C18:0	1.59±0.03	1.60±0.03
Arachidic acid	C20:0	0.35±0.002	-
Behenic Acid	C22:0	0.36±0.01	-
Lignoceric acid	C24:0	-	0.42±0.04
Cerotic acid	C26:0	-	0.29±0.005
Palmitoleic acid	C16:1	0.19±0.04	0.21±0.03
Oleic acid	C18:1	22.96±0.003	23.02±0.01
Elaidic acid	C18:1	3.89±0.01	4.27±0.03
LInolenic acid	C18:3	0.98±0.03	0.88±0.004
% SFA		71.98±0.008	71.62±0.01
% MUFA		27.04±0.02	27.50±0.005
% PUFA		0.98±0.005	0.88±0.008

Values are mean ± standard deviation of triplicate determinations

3.3 Fatty acid Composition of C. acreanum and C africana Seed Oil

The fatty acid profile for the two species showed that the oil contain majorly saturated fatty acids. Both seed oils were dominated with myristic acid ($C_{14}H_{28}O_2$), 60.14% and 60.01% for C. acreanum and C. africana seed oil respectively. Myristic acid is a saturated long chain fatty acid found naturally in palm oil, coconut oil and butter fat. The difference in their fatty acid profile showed the presence of arachidic and behenic fatty acids in C. acreanum seed oil which was absent in C. africana seed oil but was substituted with lignoceric and cerotic fatty acids. The fatty acid profile is different from the one reported by [7] that stated that C. acreanum seed oil contain majorly undecylinic acid ($C_{14}H_{28}O_{22}$) which is an unsaturated fatty acid.

4. CONCLUSION

The acid and peroxide values of the seed oils shows that the C. acreanum and C. africana seed oils are of high quality and will not be susceptible to oxidation. The iodine value and fatty acid profile shows that the seed oils contains large amount of saturated fatty acids. This study shows less significant difference in the oil composition of C. albidium seed varieties as the oil composition are closely related except for the slight difference in their fatty acid profile.

CONSENT

It is not applicable.

ETHICAL APPROVAL

It is not applicable.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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