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Fatty Acids and Physicochemical Compositions of Dried and Roasted *Blighia sapida* Arils Oils (Ackee Apple) from Côte d'Ivoire

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Authors' contributions

This work was carried out in collaboration between all authors. Author EAD designed the study, wrote the protocol and wrote the first draft of the manuscript. Author AMFH carried out all laboratoire work. Authors SB and YDD performed the statistical analysis, managed the analyses of the study. Authors LPK and EAD managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

In this work, comparative study of physicochemical properties and fatty acids of dried arils (DA) oil and those roasted (RA), of *Blighia sapida* from Côte d'Ivoire have been done using usual methods. The results showed that the crude fat obtained were 59.08± 0.02 g/100 g for dried arils (DA) and 60.51 ± 0.12 g/100 g for roasted arils (RA) respectively. Physicochemical properties of these oils were equal approximately, except level of saponification (241.19 mg KOH/g (DA) against 216.8 mg KOH/g (RA)); acid value (7 mg KOH/g (DA) and 6.28 mg KOH/g (RA)) and ester acid 234.19 mg KOH/g (DA) against 210.65 mg KOH/g (RA) where variances analysis showed that there was significant difference ($p<0.05$). On the other hand, refractive index, pH, moisture value, relative density and Free fatty acid were respectively; 1.465 (DA) and 1.475 (RA); 5.625 (DA) and 5.8 (RA); 1.757 (DA) and 1.9 (RA); 0.093 (DA) and 0.103 (RA), 3.52 mg KOH/g (DA) and 3.03 mg KOH/g (RA). The color of both oils was yellow.

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Fatty acid profile of these arils oils revealed that values of DA and RA were equal approximately (variances analysis showed that there was no significant difference ($p<0.05$)). These arils oils contained high levels of unsaturated fatty acids, 64.10 % (DA) and 65.17 % (RA), especially linolenic acid 20.02 mg/100 g (DA) and 22.18 mg/100 g (RA); linoleic acid 15.37 mg/100 g (DA) and 16.83 mg/100 g (RA) and Oleic acid 12.76 mg/100 g (DA) and 13.21 mg/100 g(RA). The saturated fatty Acids, accounted for 35.90% (DA) and 34.83% (RA) were constituted by palmitic acid with 18.02 mg/100 g (DA) and 18.11(RA) which were higher values. The values of stearic acid were 7.1 mg/100 g (DA) and 7.9 mg/100 g (RA) and 1.85 mg/100 g (AD) and 1.9 mg/100 g (RA) mg/100 g for myristic acid respectively.
These results showed that the arils oils of *Blighia sapida* fruit from Côte d'Ivoire have highly nutritive fat content because rich in essentials fatty acids. These oils may be suitable for soap making and edible (margarine). The oils extracts exhibited good physicochemical properties and could be useful as edible oils and for industrial applications.

Keywords: Blighia sapida; fruit; dried arils (DA); roasted arils (RA); essential fatty acid; polyunsaturated fatty acids.

1. INTRODUCTION

Blighia sapida, commonly referred to as Ackee, or vegetable brain or Ackee apple [1], is an evergreen tree more widely known for the edible part of its fruit: aril. It belongs to the family *Sapindaceae* and grows to a height of 10 to 12 m at maturity. The Ackee is indigenous to the forests of the Gold coast of west tropical Africa. In Côte d'Ivoire it is most common in the transition zone between dry and moister forest. *Blighia sapida* is both known for its food values and its poisonous properties [2]. They are not largely consumed in Africa, but considered a delicacy in some other parts of the world where *Blighia sapida* has been introduced [1]. It is a major food in Jamaica and is noted for its high protein and fat contents [3].

Previous studies shown that ackee arils have highest oil content, comparable to those of peanuts, rapeseed, sunflower seeds and soybeans [4]. The different study that are effected physicochemical compositions of arils oil (ackee) most often refers to dried arils in oven or in the sun. In West Africa, arils are sometimes eaten raw, fried or roasted [1]. Therefore, a new way of consumption need to be studied Therefore, a new way of consumption need to be studied.

The aim of this study therefore is the comparative study of physicochemical compositions of dried and roasted arils oils (ackee) from Côte d'Ivoire that may be useful in its application as nutritional, industrial and pharmaceutical base.

2. MATERIALS AND METHODS

2.1 Collection and Preparation of Samples

Blighia sapida fruit that served as sample for analysis were collected from Abidjan (Côte d'Ivoire) during the peak fruiting seasons of April to June 2016 and 2017. The arils were separated manually from seeds, washed with distilled water and about 3 kg of arils was dried at sun (30-35°C) for 2 weeks.

Dried arils were separated into two equal portions. The first batch (1.5 kg of dried arils) was ground into a paste using Moulinex blender. This batch represents DA (Dried Arils), and the second batch (1.5 kg of dried arils) was roasted at 120°C for 10 min in dry heat bath. This batch, which represents RA (Roasted Arils) was ground into a paste using Moulinex blender. The different pastes DA and RA were stored in polythene bags and kept in refrigerator at 4°C until used for analysis.

2.2 Extraction of Oil

The oils of differents pastes (DA and RA) of *Blighia sapida* fruits arils were extracted in Soxhlet [5], using hexane as solvent and the lipid value was evaluated at 70°C for 6 hours.

2.3 Physicochemical Characteristics Determination

For the determination of physicochemical characteristics of DA and RA oils extracted from *Blighia sapida* arils, several methods have been

used: moisture was determined with pH method [6], index refractive with Multisecale Automatic Refractometer, the color was measured with a colorimeter. Acid value, ester value, peroxide value, iodine value and saponification values were determined by Official Methods of Analysis [7]. All analyses were performed in triplicate.

2.4 Fatty Acid Composition Analysis

Fatty acid methyl esters (FAME) were obtained by transmethylation of lipid aliquots (100 mg) according to European Pharmacopoeia (2008): samples were dissolved with 1.5 mL of hexane and 1.5 mL of boron-trifluoride in methanol (14%, w/v), and heated at 100°C under nitrogen for 1 h. After cooling, the fatty acid methyl esters were extracted in hexane under nitrogen; equipped with a flame ionization detector (FID) and fused capillary column HP-5 (Cross-Linked 5% PH ME Siloxane) length 30 m; film thick 0.25 µm ; 0.32 mm intern diameter; 5% of biphenyl; 95% dimethyl polysiloxane; no polar, with a programming of oven temperature is croissant de 60 at 325°C at the rate of 1°C /min. Both the injector and the detector were maintained at 275°C and 325ºC, respectively Nitrogen was used as the carrier gas at 1cm/min with a time-out is 1 min 15 s (hydrogen 40 cm /s).

Fatty acids were identified by comparing their retention times with those of standard compounds (palmitic; miristic, lauric, linolenic; linoleic; oleic; stearic acids …).

2.5 Statistical Analysis

The analyses were carried out in triplicate and data were expressed as mean ± standard deviation. Analysis of variance (ANOVA) followed by Newman Keels range test to show, at the level of 5%, was used to compare means followed by standard deviation (STATISTICA 7.1 software)

3. RESULTS AND DISCUSSION

3.1 Crude Fat

The crude fat obtained were 59.08± 0.02 g/100 g for dried arils (DA) and 60.51 ± 0.12 g/100 g for roasted arils (RA) respectively, A p value of .05 was significant. That high fat value from roasted arils (RA) could be explained by a bigger evaporation of water than the dried one. So permeated the availability of oil. According to these values, Ackee would be considered as good lipid source. These results were higher than those of full fat and defatted Ackee (*Blighia sapida*) aril flours from Ghana [8], with oven dried arils (56.60 ± 0.27) and freeze dried arils 51.60 ± 2.23 and those of *Blighia Sapida* Pulp and Pulp Oil (Ackee Apple) (51.58±0.04) [9], similary, with the values for varieties of melon seeds oils ranging between 47.9-51.1% reported by Ige et al. [10], values from Pumpkin seeds 49.2% and 47.01% respectivel by Aisegbu, [11], Fagbemi,. and Oshodi, [12] and *Citrullus lanatus* seed oils (49.24-56.08%), by N'guetta et al. [13].

Fat is important in diets because it promotes fat soluble vitamin absorption [14]. Lipids are essential because they provide the body with maximum energy; approximately twice that for an equal amount of protein or carbohydrate and facilitate intestinal absorption and transportation of fat-soluble vitamins A, D, E and K [15]. Those with high lipid content are comparable with those of soybean oil, locust bean and cottonseed with 19.10 g/100 g, 20.30 g/100 g and 14.05 g/100 g crude fat, respectively. Commercially exploited and classified as oil seed [16]. A fact that Ackee was considered as good lipid sources hence could complement conventional vegetable oils, which are very expensive. Dried and roasted arils of *Blighia sapida* from Côte d'Ivoire could also be sources of oils for soap and paint industries.

3.2 Physicochemical Characteristics

No major differences in the general proportions of Physicochemical Characteristic of *Blighia* sapida were found between dried and roasted arils oils (Table 1), where, marginally significant differences were found in Saponification value; acid value and Ester acid with higher levels in dried arils.

The saponification values of *Blighia sapida* arils oils, (241.19 mg KOH/g (DA) against 216.68 mg KOH/g (RA) were higher than those found by Oyeleke et al. [9] and Anderson-Fosteret al. [17] respectively 75,73 mg KOH/g and197 mg KOH/g from *Blighia sapida*,of Jamaica and those of some common oils like palm oil (196-205 mg KOH/g), groundnut oil (188- 196 mg KOH/g) as reported by Cocks and Van Reed [18]. But these values were smaller than those of Coconut oil (253 mg KOH/g) and palm kernel oil (247 mg KOH /g) reported by Pearson [19] The high saponification values of oils (from DA and RA) in this study indicate that they may be suitable for soap making. Value ester acid 234.19 mg KOH/g

(DA) against 210.65 mg de KOH/g (RA) were three times higher than those of Anderson-Foster et al. [17] works (64.52 mg KOH/g).

The color of fats extracted from dried or roasted arils oils of *Blighia sapida* from Côte d'Ivoire, were yellowish, as reported by Oyeleke et al. [9].

The Relative density, 0.093 (DA) and 0.103 (RA), Free fatty acid 3.52 ± 0.02 (DA) and 3.03± 0.02 (RA) were lower than those reported by Djenontin et al. [20]. This parameter, which is often closely linked to oil stability against oxidation because of associated metallic cations, plays a role in the use of the oil whether for an edible or industrial purposes.

Refractive index 1.465 (DA) and 1.475 (RA) are similar to the work of Oyeleke et al. [9] on *Blighia sapida* arils oil from Jamaica, (1,462), *Jatropha curcas* oil (1,468) reported by Djenontin et al. [20] and those of N'guetta et al. [13] from *citrullus lanatus* seed oils, (1.4595-1.4739). The refractive index of oils depend on their molecular weight, fatty acid chain length, and degree of unsaturation [10]. This is consistent with high iodine values 56.97 mg/100 g (DA) and 66.75 mg/100 g (RA). These indices were high compared to those of *Blighia sapida* (4.56 mg/100g) as reported by Oyeleke et al. [9] and 38.50 mg/100 g, reported from Hausa melon seeds for Oladimeji et al. [21]. High iodine values obtained therefore indicate that the arils oils from *Blighia sapida* of Côte d'Ivoire have a high content of unsaturated fatty acids, and can justify rate high in unsaturated fatty acid (64.10% (DA) and 65.179% (RA) with respect to the proportion of saturated fatty acids (35.90% (DA) and 34.83% (RA)). This parameter, which is often closely linked to oil stability against oxidation because of associated metallic cations plays a role in the use of the oil, either for an edible or industrial purpose [20] and plays a role in the use of oil in food and industrial purposes [22].

The peroxide index 3.92 meq O_2/kg (DA) and 3.89 meq O_2/kg (RA) is smaller than that advocated for a dietary fat by Codex Alimentarius [23] which is 4, *Blighia sapida* oil used in this study would therefore not be in the process of alteration and enters peroxide index limits.

3.3 Fatty Acid Composition

No major differences in the general proportions of fatty acids were found between dried and roasted arils oils from *Blighia* sapida (Table 2). These oils were composite those are palmitic Acid (18.02 ± 0.02 mg/100 g (DA) and 18.11± 1.11 mg/100 g (RA)); myristic acid (1.85± 0.85 mg/100 g (DA) and 1.9 ± 0.1 mg/100 g (RA)); oleic acid (12.76 ± 0.36mg/100 g (DA) and 13.21± 0.21 mg/100 g (RA)); linolenic acid (20.02 ± 1.02 mg/100 g (DA) and 22.18 ± 0.18 mg/100 g (RA)) and linoleic acid (15.37 ± 0.37 mg/100 g (DA) and 16.83 ± 0.17 mg/100 g (RA)).

Fatty acid composition study revealed that the most abundant fatty acids in DA and RA oils were linolenic acid witch showed the highest percentage of composition of (20.02 ± 1.02 mg/100 g (DA) and 22.18 ± 0.18 mg/100 g (RA)) respectively with palmitic acid followed close by with 18.02 ± 0.02 mg/100 g (DA) and

Table 1. Physicochemical Characteristic of dried and roasted arils oils of *Blighia sapida* from Côte d'Ivoire

	Value	
Parameters	**DA**	**RA**
pH	5.62 ± 0.07[a]	5.8± 0.01[a]
moisture	1.76 ± 0.04[a]	1.9± 0.02[a]
Relative density (g/ml)	0.0933± 0.02[a]	0.1028± 0.01[a]
Color	Yellow	Yellow
Refractive index	1.465± 0.007[a]	1.475± 0.04[a]
Acid value (mg KOH/g)	7.00± 0.02[a]	6.28± 0.03[b]
Saponification value (mg KOH/g)	241.19 ± 0.10[a]	216.68 ± 0.05[b]
Iodine value (mg Iodine / 100 g)	56.97 ± 0.08[a]	66.75± 0.10[a]
Ester acid	234.19± 0.02[a]	210.65± 0.01[b]
Peroxide acid (meq O2/kg)	3.92± 0.01[a]	3.89± 001[a]
Free fatty acid	3.52± 0.02[a]	3.03± 0.02[a]

Values with the same superscript along the column are not significantly different from each other at 5% probability level

Table 2. Fatty acid composition of dried ant roasted arils oils of *Blighia sapida* from Côte d'Ivoire

	Value (mg/100g of arils)	
Fatty acid	**DA**	**RA**
Palmitic Acid	18.02± 0.02[a]	18.11± 1.11[a]
Myristic acid	1.85± 0.85[a]	1.9± 0.1[a]
Oleic acid	12.76± 0.36[a]	13.21± 0.21[a]
Stearic acid	7.1± 1.1[a]	7.9± 0.7[a]
Linoleic acid	15.37± 0.37[a]	16.83± 0.17[a]
Linolenic acid	20.02± 1.02[a]	22.18± 0.18[a]
Saturated fatty Acids	35.90± 0.65[a]	34.83± 0.63[a]
unsaturated fatty Acids	64.10± 0.58[a]	65.17± 0.18[a]
monounsaturated fatty Acids	16.99± 0.36[a]	16.49± 0.21[a]
polyunsaturated fatty Acids	47.11± 0.46[a]	48.68± 0.11[a]

Values with the same superscript along the column are not significantly different from each other at 5% probability level

18.11± 1.11 mg/100 g (RA), respectively. In this study, saturated acids accounted for 35.90± 0.65 mg/100 g and 34.83± 0.63 mg/100 g of total fatty acids, for DA and RA oils, respectively. Variances analysis showed that there was no significant difference ($p<0.05$) in these different type of fatty acids. Among them, the main saturated normal chain fatty acids were palmitic, myristic and stearic acids.

These values were higher than those found by Djenontin et al. [20], (4.3 mg/100) for linolenic acid and similar for linoleic acid value (15.2 mg/100) from *Blighia* sapida oil of Benin. However, these values were lowed of at level acid linoleic (52.70 mg/100 g) and practically equal level linoleic acid (19.42 mg/100 g) for works of Esuoso and Odetokun [24]. The observed differences may be due to seed maturity, climatic conditions, where the seed is grown or the interaction between these factors [25]. The saturated fatty acid content such as myristic acid, palmitic acid and stearic acid, are generally solid at ordinary temperature, while those rich in unsaturated fatty acids such as oleic, linoleic and Linoleic, usually liquid at room temperature [26], that makes conferred to DA and RA arils oils the liquid form fat. Linoleic and linoleic acids are classified among the essential fatty acids [27,28] because they are primarily derived from vegetable oils and seeds are essential to human health [29], and it has even been suggested that long chain polyunsaturated fatty acids (LC-PUFA), especially those of the omega-3 (n-3) series, played an important role in human evolution, providing essential elements to build cerebral tissues [30].

4. CONCLUSION

These results showed that *Blighia sapida* seeds arils from Côte d'Ivoire have highly nutritive fat content because rich in essentials fatty acids, these oils may be suitable for soap making and edible (margarine). The oils extracts exhibited good physicochemical properties and could be useful as edible oils and for industrial applications. Theses oils could also be used for food, and help reducing the local deficit of fat in people's diet. Therefore, consumption of edible arils of *Blighia sapida* fruit can contribute to improve nutrition and health in rural populations.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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