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Comparative studies of the chemical parameters of oil extracted from the seeds of ripe and unripe fruits of *Blighia sapida* (ackee)

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ABSTRACT

Apart from other domestic uses, vegetable oils are increasingly being used in the electrical industry as insulators since they are not toxic to the environment, biodegradable if spilled and have high flash and fire points. The present study evaluates and compared the chemical properties of the seed oil of both ripe and unripe ackee (Blighia sapida). The oil parameters for the ripe and unripe seeds are respectively as follows: Moisture contents: 4.79 to 7.81 % and 4.39 to 7.62 %; Crude fat: 12.32 to 18.86 % and 10.56 to 14.87 %; Iodine values: 92.1 to 115.83 and 102.64 to 133.65 mg/g oil; saponification values: 187.92 to 201.73 and 174.79 to 181.61 mg KOH/g; Peroxide value: 8.50 to 9.50 and 8.50 to 10.33 mEq/kg. The oil from ripe seeds have lower unsaponifiable matter than that from unripe ackee seeds thereby making the latter less desirable in soap production. The acid values are less than 4.0mgKOH/g. The parameters differ significantly from those previously reported for the arils of the fruits. These properties may prove useful in their application as pharmaceutics, cooking oils and industrial raw materials.

Keywords: Saponification value, pharmaceutics, ripeness, Ackee, toxicity.

INTRODUCTION

Ackee, the natural fruit of Jamaica, is common in food of many Jamaica diet. The world ‘ ackee’ is from the Twi language. The ackee tree is a tropical evergreen tree that can grow as tall as 40 feet. The leaves are broad and pinnate about 10-cm wide, 100g fruit may be coloured anywhere from straw to bright red. The fruit splits open while still on the tree to reveal 3 glassy black seeds surrounded by a thick, oily, yellow aril [1]. The fruit is rich in essential fatty acids, vitamin A, zinc and protein [2]. The ackee tree is indigenous to West Africa, where it is called *ankye* or *ishin*. Jamaica’s first botanist, Thomas Clarke, introduced the plant to the Island in 1778. However, the ackee tree, *Blighia sapida*, was named after the infamous Captain William Bligh who took the breadfruit to the West indies [3, 4]. *Blighia sapida* is both known for its food values and it poisonous properties [5]. It is a major food in Jamaica and is noted for its high protein and fat contents [6]. The fruit is also rich in essential fatty acid, vitamin A and Zinc [2]. The aqueous extract of the seed is administered as parasites expellant. The crushed new foliage is applied on the forehead as headache reliever. Also, the leaf juice is employed as various preparation and combination of the extract have been made for the treatment of diseases such as dysentery, epilepsy, yellow fever [7] and diabetics [8]. The plant is well known to be acaricidal and insecticidal [9]. The toxicity of the ackee was long misunderstood and believed to reside in the membranes attaching the arils to the jacket or only in the overripe and decomposing arils. It is known that the unripe arils contain hypoglycin A. This toxic property is largely dispelled by light as the jacket opens. When fully ripe, the arils still possess one-twelfth of the amount in the unripe. The seeds are always

poisonous. They contain hypoglycin B which is half as toxic as A [5]. The present study therefore investigated the chemical properties of the oil of both unripe and self-opened ripe ackee (*Blighia Sapida*) seed in order to suggest their various application in domestic and industrial usage.

EXPERIMENTAL SECTION

Sampling

Each collected sample of both ripped and unripe edible parts of *Blighia sapida* were identified easily and labeled immediately. Mode of labeling was described using T to denote the tree from which the samples were collected, E for Edible part of the fruit as well as R and U to denote ripe and unripe edible part of the fruits respectively. For each of the trees under investigation, the arils were freed from the fruits, cleaned and dried in a cabinet oven at about 70^0C for 3 days. The samples were then milled into powder by the use of wooden mortal.

Moisture content

About 3-5 g of each sample was weighed into a previously weighed foil. The foil containing the sample taken was then transferred into the oven set at 100^0 C to dry to a constant weight for 24 hours overnight. At the end of the 24 hours, the foil plus sample was removed from the oven and transferred into the desicator to cool for 10 mins and weighed. The moisture content was then calculated as reported earlier (AOAC, 1990).

Extraction of Crude fat

Extraction was done in batches of approximately 2g of each sample with 250 ml of petroleum ether in a soxhlet extractor. The percentage fat/oil was then determined [10].

Acid value determination

25 ml of diethyl ether and 25 ml of ethanol were first mixed in a conical flask with the addition of 1ml phenolphthalein. The mixture was then neutralized with 0.1 M sodium hydroxide and heated on the water bath. 2g of the fat was then added into the hot neutralized mixture. The mixture was titrated with 0.1 M potassium hydroxide until a pink colour that persisted for 15 seconds was observed. The acid value was calculated [10].

Saponification value determination

2g of the extracted Oil was weighed into a conical flask and exactly 25ml of 0.5M ethanolic potassium hydroxide was added. The mixture heated on the reflux condenser for 1hr with constant shaking, 1ml of 2 % phenolphthalein indicator was then added and the hot solution was titrated against 0.5M hydrochloric acid. The average titre value was determined from which the saponification value was obtained as earlier reported [10].

Unsaponifiable matter determination

The titrated liquids for saponification value for each of the sample were used for the determination of unsaponifiable matter. The saponified sample solution was transferred into a separating funnel and 50ml water was used to wash the flask. The solution was then warmed. The warmed solution was extracted by adding three 50 ml portions of diethyl ether in the separating funnel. The ether extracts (upper layer) was poured into another separator. The combined ether extracts was then washed with three 20 ml portions of water until the wash water is no longer alkaline to phenolphthalein. The ether extract (golden yellow) was transferred into a weighed beaker and the water was then evaporated off. The dark brown residue was dried to a constant weight in the oven. The unsaponifiable matters were then calculated as previously described [10].

Peroxide values determination

3g of each sample were weighed into a 250 ml stoppered conical flask. 10 ml of chloroform was added to dissolve the oil and 15 ml glacial acetic acid was also added. Then 1 ml of freshly saturated potassium iodide solution was added and allowed to stand for 5 minutes in a dark place. 75 ml distilled water was added to the solution and mixed. The mixture was then slowly titrated with 0.01 M Na_2SO_3 with vigorous shaking until the reddish colour changes to yellow. At this point 0.5 ml of starch solution was added and the titration is continued until blue- black colour disappears. The blank also performed. The peroxide values were then calculated [10].

Iodine number determination

0.2 g of the extracted fat was weighed into separate stoppered conical flask. 10 ml chloroform was added to dissolve the oil. 30 ml of Hanus iodine solution was then added from a burette kept under the fume cupboard. The stopper is

then inserted and the content was mixed thoroughly without any of the solution being touched by the stopper or the neck of the conical flask and the conical flask was set aside for 30 minutes to complete the halogenation. The stopper was then removed and 20 ml of 15% potassium iodide was added. 100 ml distilled water was also added. The stopper was inserted and the content was mixed by shaking. The solution was then titrated immediately with 0.0877 M standard sodium thiosulphate solution. The solution was added rapidly with stirring until most of the iodine had been titrated as shown by the solution becoming pale yellow. This point was recorded and 2 ml starch indicator was added again and the titration continued until the blue - black disappears and the point was also recorded. Then the blank was also determined. The iodine numbers were then calculated [10].

Statistical analysis

All data are represented as means ± SD for five independent determinations. Statistical analyses were performed using the Student's *t*-test on a software package, GraphPad Quick Calcs Software (from Graph Pad Software Inc. USA).

RESULTS AND DISCUSSION

The chemical parameters of the oil from the seeds of the ackee trees from from different locations in Ogbomoso, Oyo State, Nigeria are as shown in Tables 1 to 4.

Table 1: Chemical analysis of the oil from ripe and unripe seed of Ackee tree from Ahoyaya area in Ogbomoso South Local Government Area, Nigeria (T_1)

	% moisture content	% crude fat	Iodine value	Saponification value	Peroxide value	Acid value	Unsaponifiable matter
T_1SR	7.81 ± 0.39	12.32±0.42	92.21±2.81	187.92±5.64	8.50 ± 0.34	3.79 ± 0.19	10 ± 1
T_1SU	6.85 ± 0.27	10.56±0.62	133.65±6.68	181.0 ± 7.24	10.30±0.31	3.45 ± 0.10	10 ± 1
[a] Mean differences	0.96	1.76	-41.48	6.91	-1.80	0.34	0.00
P values for mean differences	0.0019 [c]	0.0008 [c]	0.0001 [c]	0.1308 [b]	0.0001 [c]	0.0001 [c]	1.0000

[a] This indicates the mean values of parameters for ripe seed minus the mean values of unripe ones.
Negative values indicate higher mean values for unripe seeds.
[b] Mean difference is not significant
[c] Mean difference is significant at P<0.05

Table 2: Chemical analysis of the oil from ripe and unripe seed of Ackee tree from General area in Ogbomoso North Local Government Area, Nigeria (T_2)

	% moisture content	% crude fat	Iodine value	Saponification value	Peroxide value	Acid value	Unsaponifiable matter
T_2SR	6.52±0.33	17.79±0.89	105.65±3.17	201.73 ± 6.05	9.50±0.83	3.65±0.18	10 ± 1
T_2SU	7.62±0.30	12.61±0.50	125.64±6.28	174.79 ± 6.99	10.33±0.31	3.09±0.09	15 ± 4
Mean differences	-1.10	5.18	-19.9	26.94	-0.83	0.56	-5
P values for mean differences	0.0006 [c]	0.0001[c]	0.0002[c]	0.0002 [c]	0.0695 [b]	0.0003[c]	0.0266 [c]

[a] This indicates the mean values of parameters for ripe seed minus the mean values of unripe ones.
Negative values indicate higher mean values for unripe seeds.
[b] Mean difference is not significant
[c] Mean difference is significant at P<0.05

Table 3: Chemical analysis of the oil from ripe and unripe seed of Ackee tree from Iresaadu Village in Surulere Local Government Area, Nigeria (T_3)

	% moisture content	% crude fat	Iodine value	Saponification value	Peroxide value	Acid value	Unsaponifiable matter
T_3SR	7.25±0.36	17.84±0.89	115.83±3.47	200.35± 6.01	8.77±0.35	3.82±0.19	10 ± 1
T_3SU	5.58±0.22	12.23±0.49	131.98±6.60	175.48±10.02	8.67±0.26	3.51±0.11	15 ± 3
[a] Mean differences	1.67	5.61	-16.15	24.87	0.10	0.31	-5
P values for mean differences	0.0001 [c]	0.0001[c]	0.0013[c]	0.0014 [c]	0.6219 [b]	0.0134[c]	0.0077 [c]

[a] This indicates the mean values of parameters for ripe seed minus the mean values of unripe ones.
Negative values indicate higher mean values for unripe seeds.
[b] Mean difference is not significant
[c] Mean difference is significant at P<0.05

The percentage moisture contents ranged from 4.79 to 7.81 % for ripe seeds and 4.39 to 7.62 % for unripe seeds. The percentage moisture contents obtained in this study were in agreement with 6.84 ± 1.13 % moisture for sundried ackee aril obtained from Cote d'ivoire [11]. The differences in the mean moisture content of ripe and unripe seeds differ significantly ($P< 0.01$) in all the trees but unripe seeds are with higher values in T_2. The differences that exist among the ackee trees may be as a result of the soil conditions at different geographical locations [11]. The low

moisture content obtained is an indication that these oils may have high shelf life against external conditions when properly packaged.

Table 4: Chemical analysis of the oil from ripe and unripe seed of Ackee tree from Iluju Village in Oriire Local Government Area, Nigeria (T_4)

	% moisture content	% crude fat	Iodine value	Saponification value	Peroxide value	Acid value	Unsaponifiable matter
T_4SR	4.79±0.24	18.86±0.94	92.1±2.77	188.61±5.66	9.10±0.36	3.96±0.20	10 ± 1
T_4SU	4.39±0.18	14.87±0.59	115.83±5.79	181.61 ± 7.26	8.50±0.26	3.79±0.11	10 ± 1
[a] Mean differences	0.40	3.99	-23.66	7.00	0.60	0.17	0.00
P values for mean differences	0.0170 [c]	0.0001 [c]	0.0001 [c]	0.1275 [b]	0.0165 [c]	0.1344 [c]	1.0000 [b]

[a] This indicates the mean values of parameters for ripe seed minus the mean values of unripe ones.
Negative values indicate higher mean values for unripe seeds.
[b] Mean difference is not significant
[c] Mean difference is significant at P<0.05

Crude fat

The crude fat contents of the ripe and unripe seeds ranged between 12.32 and 18.86 % and 10.56 and 14.87% respectively. The mean crude fat content of the ripe seeds are significantly different ($P < 0.01$) from that obtained with unripe seed of the fruit with the values of the ripe being higher than that of unripe part. The high fat content reported in this work for the ripe seeds is not as high as those of edible part of ackee [12]. Also, the value is lower than the oil content of *Arachis hypogaea,* (groundnut, 45 %) and *Moringa oleifera* (moringa, 41.58 %) [13, 14].

Iodine value

The iodine values of oils of ripe seed from the four trees are lower than oils obtained from unripe seeds with the highest values of 115.83 and 133.65 respectively. The values obtained fall within the range of 80 – 140 earlier reported [15]. The means iodine values of the ripe seeds are significantly different ($P < 0.01$) from the that obtained with unripe seed part of the fruits. Iodine values for the range above indicate higher degree of unsaturation of the extracted oil of unripe fruits. The high values of iodine values is as a result of low moisture content recorded. *Blighia sapida* seeds iodine value is comparable to iodine value of groundnut oil (80-106), cotton seed (99-119), maize (103-128), sesame (104-120) and sun flower seed (120-173) [15]. Thus, *Blighia sapida* seeds oils can only be classified amongst the semi-drying oils [15]. Iodine value is a measure of the degree of unsaturation in oil and could be used to quantify the amount of double bonds present in the oil which shows the susceptibility of oil to oxidation and the extent of contamination in any specific oil.

In location T_1 and T_4, the ripe seeds oil had iodine values of 92.21 and 92.1 respectively which is less than 100. These have been classified as non-drying oils, which could find application as lubricant, because oils with low iodine values would not deteriorate to any appreciable extent due to oxidation and polymerization [16]. The differences in iodine values may also be related to the soil conditions at that particular geographical location. The unripe seeds oils had iodine values above 100 and in the range of 115.83 to 133.65. These oils are semi-drying oils and might be suitable for the manufacture of paint and varnishes. For edibility purpose, oil with higher level of unsaturation is desirable because consumption of too much saturated ones might lead to or aggravate heart disease incidences.

Saponification value

The saponification value of *Blighia sapida* (ackee) oil ranged between 187.92 and 201.73 mgKOH/g as well as 174.79 and 181.61 mgKOH/g for ripe seeds and unripe seeds of ackee oil respectively. These saponification values are very high and are comparable to the saponification values of palm oil (190-209), olive oil (190-192), soy bean oil (189-195), cotton seed oil (189-198) which are commonly used for soap making [14]. The mean differences between the saponification values of ripe and unripe ackee seeds are insignificant ($P>0.05$) for T_1 and T_4 but significant ($P<0.01$) in T_2 and T_3. High saponification values signifies high fatty acid content [17]. Hence, the ackee oil could have higher fatty acid content and might find application in soft soap manufacturing.

Peroxide values

The peroxide value of the ackee seed oil extracted ranged from 8.50 to 9.50 mEq/Kg and 8.50 to 10.33 mEq/Kg for both ripe and unripe ackee seed respectively. The mean difference in peroxide value of ripe and unripe seed differ significantly ($P<0.01$) in T_1 and T_4 but insignificant ($P<0.05$) in T_2 and T_3 with higher values recorded in the ripe seeds. All these values obtained for ackee oils was lower than 10.9 mEq/Kg peroxide value reported fpr groundnut oil [18] but it is in agreement with 8.98 mEq/Kg peroxide value reported for guinea peanut oil [16]. The peroxide

value is an indication of level of rancidity of oil, but if the peroxide value of any oil is very high, it does not necessarily mean that the oil has gone rancid but it is an indication that it will soon go rancid.

Acid value

The acid values are used to express the quality of free fatty acid present in the oil and the determination is often used as a general indication of the condition and edibility of oil. The acid value obtained ranged from 3.65 to 3.96 mgKOH/g for ripe ackee seed and 3.09 to 3.96 mgKOH/g unripe ackee seed. These values are lower than the minimum safe limit of 4mgKOH/g set by the recommendation codex standard for edible groundnut, cotton seed, maize, rapeseed and sesame seed oils [19]. The value obtained for acid shows that the oils are still fresh and has a low deteriorating rate and could be suitable for cooking [20].

Unsaponifiable matter

The values of unsaponifiable matters range from 10 to 15 g/Kg. These values indicates the unsaponified portion of the oil, the material present in oils and fats which after saponification of oils or fats by caustic alkali and extraction by a suitable organic solvent remain non volatile on drying. Unsaponifiable matter is used to test for the oil purity.

CONCLUSION

Blighia sapida oils are partly semi-drying oils and might be suitable for the manufacture of paint and varnishes. The chemical properties of both oils are comparable to that of some conventional oils and thus could complement these oils in both domestic and industrial application.

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