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A Comparative Study of the Nutrient Composition of Tree-Ripened versus Rack-Ripened Ackees (*Blighia sapida*)

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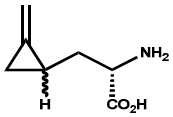
Abstract: *Ackee canners often harvest mature fruits that are placed on sun racks to complete ripening (indicated by pod-opening). It is unknown whether the nutrient composition of rack-ripened fruits differs from those completely ripened on trees. This study compares proximate, mineral and fatty acid composition of raw, mature arils of tree-ripened and rack-ripened fruits. Proximate and mineral compositions were determined, using standard methods, for composite samples of tree-ripened fruits collected from eleven different trees, and for ackees allowed to rack-ripen in the sun over three days. Fatty acid profiles were established by GC-MS analysis of the trans-methylated ackee oils. It was found that rack-ripened ackees had a higher percentage crude fat and crude protein, but lower moisture levels than the tree-ripened ackees ($p < 0.05$). Mineral contents were similar. Higher quantities of oleic acid and linoleic acid ($p < 0.05$) were found in the oils of tree-ripened fruits, while a higher proportion of stearic acid ($p < 0.05$) was present in rack-ripened fruits. In conclusion, the nutritional profiles of tree-ripened and rack-ripened ackees were generally similar. Higher quantities of crude fat and crude protein in rack-ripened ackees were probably a direct consequence of lower residual moisture in the said ackees.*

Keywords: *Ackee; Blighia sapida; proximate analysis; rack-ripened; tree-ripened; nutrient composition*

1. Introduction

Blighia sapida K. D. Koenig is a member of the Sapindaceae family (Adams, 1972). Commonly known as "ackee", it was introduced to the West Indies circa 1776 by Thomas Clark, and is cultivated in some islands such as Jamaica and Haiti. The plant, which is native to West Africa, is also found in Central America and South Florida (Barceloux, 2008; Ouattara et al., 2010). A medium-sized to large, tropical evergreen tree, it has a short trunk, grows up to 10-15 m, is drought-resistant, and is capable of growing in most soil types (Parkinson, 2007; Morton, 1987). According to Parkinson (2007), when the fruit is fully mature the reddish pod splits open to reveal two to four (but more commonly three) cream to yellow, fleshy and glossy arils, having smooth and shiny black seeds, some of which are very small (see Figure 1).

Only the mature fruits, with naturally opened pods are edible. The unripe fruit is known to contain high levels of the toxic amino acid, hypoglycin A (**1**)—consumption of which leads to a condition known as the "Jamaican Vomiting Sickness" (JVS) (Barceloux, 2008; Blake, 2003; Jordan and Burrows, 1937). The illness is caused by a dramatic reduction in blood glucose levels and can result in death (Barceloux, 2008; Moya, 2001). Malnutrition is believed to increase susceptibility to, and severity of JVS particularly among children (Joskow et al., 2006). As the fruit matures, the concentration of hypoglycin A is substantially reduced (Chase et al., 1990; Brown et al., 1992; Bowen-Forbes and Minott, 2011).



(1)

Figure 1. Mature Ackee fruits

Probably, the most important use of the *Blighia sapida* fruit is its use as a staple food in Jamaica and its diaspora (Rashford, 2001). The mature fruits are canned in Jamaica, as well as Belize and Haiti, and exported to the United States of America (US FDA 2012). The canned fruits are also exported to Canada, the United Kingdom (UK) and some Caribbean islands (Hyatt, 2007). The ackee plant is known to possess medicinal and pesticidal properties, and can also be used in the manufacturing of soaps (Ekue et al., 2010; Oladiji et al., 2009; Parkinson, 2007; Khan et al., 2002).

Over forty-eight (48) varieties of *Blighia sapida* have been identified in Jamaica, and they are commonly placed into two main cultivars namely butter (soft-texture, light-yellow arils), and cheese (hard-texture, cream-coloured arils) (Byfield et al., 1999). The harder texture of the cheese cultivar guarantees its preferential selection over the butter cultivar for canning purposes (Reid et al., 1994; Watson, 1980). However, studies have revealed a continuum in the degree of hardness of the arils due to free crossing between butter and cheese varieties (Byfield et al., 1999). Canned ackees consist of arils along this continuum.

In the commercial processing of ackees, it is mainly the unopened, but mature fruits, that are harvested (Rashford, 2001). The unopened ackees are placed on racks, allowed to ripen in the sun, and as they open, are removed for processing (Henry, 1979; Hyatt, 2007; Rashford, 2001). Any fruit that remains unopened after three days is rejected (Henry, 1979). No ripening chemicals are used.

Proximate data, that is, the relative amounts of crude lipid, crude protein, water, ash and total carbohydrate, for ackee arils are limited to tree-ripened fruits. It is not known how the composition of rack-ripened ackees compares with tree-ripened ackees. Hence, the objective of this study was to determine moisture, crude fat, crude protein, total carbohydrates, crude fibre, ash, minerals and fatty acids in the raw mature arils of *Blighia sapida* (ackee) fruits that were tree-ripened, as well as rack-ripened.

2. Materials and Methods

2.1 Sample Collection, Preparation and Storage

1) Tree-ripened Ackees - Mature, opened ackee pods were harvested from a cross section of trees of various botanical varieties located on the Mona Campus of the University of the West Indies (Kingston, Jamaica). Pods harvested from different trees, were combined to give a composite sample. Arils were manually detached from the pods with subsequent removal of the seeds and raphe. The arils were pre-dried in a convection oven at 50^{o}C for 48 hours, then stored in a freezer (-18^{o}C) until ready for use.

2) Rack-ripened Ackees - Unopened but mature ackees (large, brightly coloured pods) were harvested at the Mona Campus. Like the tree-ripened fruits, a composite sample was collected with no control for botanical varieties. The fruits were placed on mesh shelves elevated about 1 metre above the ground on a roof for full sun-exposure. At night, the racks were stored indoors. The ackees were replaced on the roof the following morning. Ackees that opened within 24 hours from the start of racking were removed and labelled as 'Day 1 Sample'. Ackees that opened between 24 and 48 hours of racking were designated 'Day 2 Sample' and those that opened between 48 and 72 hours of racking designated 'Day 3 Sample'. Ackees that remained unopened after 72 hours were discarded. Rack-ripened samples were oven-dried and stored in the same way as the tree-ripened sample.

2.2 Proximate Analyses

The moisture content of the fresh arils was determined by removing a small number of ackee arils from each sample prior to drying. Arils were weighed (in triplicate, A), placed on watch glasses and dried in a convection oven, alongside the bulk of the sample. At the end of drying, the arils were removed, reweighed (B) and the moisture content calculated based on the loss of mass of the arils as shown in Equation 1.

$$\% \text{ Moisture} = [(A - B) \div A] \times 100 \quad \text{..... Eq.1}$$

where, A = mass of sample before drying (fresh weight, g);
B = mass of sample after drying (g)

Pre-dried arils were milled (IKA M20 analytical mill, IKA-Werke GmbH &Co. KG, Staufen, Germany) prior to determination of proximates. Analyses were carried out in replicates of six. Residual moisture, crude fat, crude protein, crude fibre and ash were determined according to the Association of Official Analytical Chemists (AOAC) (2000) Official Methods 930.15, 920.39, 988.05, 962.09 and 942.05 respectively.

Residual moisture was determined by heating ground pre-dried samples (C, ca. 2g) in a convection oven (EW-52120-02, Cole-Parmer, Vernon Hills, IL) at 135^{o}C ± 2^{o}C for 2 hours, and measuring the loss of mass on final drying (D). Equation 2 was used to calculate residual moisture:

$$\% \text{ Residual Moisture} = [(C - D) \div C] \times 100 \quad \text{..... Eq.2}$$

where, C = mass of pre-dried sample (g);
D = mass of sample after final drying (g)

Crude fat was determined by exhaustively extracting ground samples (ca. 5g) in a Soxhlet apparatus for 6 hours, using petroleum ether as the solvent. Crude protein was determined by the Kjeldahl method using ground samples (ca. 1g) for the analyses; total nitrogen was multiplied by a factor of 6.25. Ashing was conducted on the defatted ackee samples (ca. 2g) in a muffle furnace (Thermolyne Type 4800 Furnace, Thermo Fisher Scientific, Inc., Waltham, MA) at 600^{o}C for 2 hours and the ash residue weighed. Crude fibre was determined by boiling the defatted ackee samples in H_2SO_4 (0.128 M) for 30 minutes followed by boiling in NaOH (0.313 M) for 30 minutes. The residue was dried

overnight at 110°C, weighed and ashed at 550°C for 2 hours. Crude fibre was calculated as the difference in mass between the dried residue and the ash. Total carbohydrate (dry weight basis) was calculated by difference according to Equation 3.

Total carbohydrate = 100 – (% residual moisture + % crude fat + % crude protein + % ash) …..Eq.3

2.3 Mineral Analyses

Minerals were determined according to AOAC (2000) Official Method 965.09. Minerals were extracted by dissolving ash (ca. 250 mg, six (6) replicates for each sample set) in HCl (ca. 10 ml, 3M); and mixtures were heated for 10 minutes, filtered and made up to 100 ml using deionised water. Sample solutions were stored in a refrigerator at 4°C until analyses were completed. Subsequent dilutions, where necessary, were done with deionised water. Mineral contents were determined using a Perkin-Elmer 2380 Atomic Absorption Spectrophotometer (Perkin-Elmer Corporation, Waltham, MA). Potassium was determined with a Sherwood M410 C flame photometer (Sherwood Scientific Ltd., Cambridge, UK).

2.4 Fatty Acid Analyses

1) Methylation

Fatty acid determinations were based on the method of Masood et al. (2005). Fat (ca. 10 mg), previously extracted in accordance with AOAC (2000) Official Method 920.39, was placed in a vial to which methanol, acetyl chloride solution (9:1, 3 ml) and 0.9 ml $C_{19:0}$ FAME internal standard (prepared by dissolving 50 mg $C_{19:0}$ FAME in 25 ml methanol) were added. The vial was screwed tightly, and heated on a sand bath at 100°C for 2 hours. After cooling, hexane (2-3 ml, HPLC grade) was added, the mixture was shaken for 1 minute, left to stand for ca. 10 minutes, and the top layer carefully removed with a Pasteur pipette and placed in a GC vial. The extraction was repeated by the addition of further 0.5 ml portions of hexane. The fatty acid methyl ester composition was determined by GC-MS analyses.

2) GC-MS Analyses

Analyses were conducted on a HP 6890 Gas Chromatograph equipped with a HP 5973 Mass Selective Detector (Agilent Technologies, Santa Clara, CA). The following operating conditions were utilised: injector temperature, 225°C; detector temperature, 250°C; initial temperature, 130°C (held for 1 min); ramp rate, 4°C/min to 178°C, then 1°C/min to 225°C followed by 40°C/min to 245°C with a 13 minute hold. The carrier gas used was helium with a linear velocity of 60 cm/s at a constant pressure of 102.4 kPa. FID temperature was 250°C, with air and nitrogen make-up--gas flow rates were 450 and 10 ml/min, respectively. Mass scan range was 50-500 MHz. The column used was a HP 5 MS capillary column: 60 m x 0.25 mm (internal diameter) x 0.25 μm (film thickness), fused silica.

After all chromatographic conditions had been optimised, the methylated test solutions (2 μL) were injected into the GC-MS. The relative percentage of each fatty acid methyl ester was reported. Analyses were done using four to six replicates.

2.5 Statistical Analyses

The statistical analyses (including F-test and t-test) were performed using Microsoft Office Excel 2007 (Microsoft Corporation, Redmond, WA).

3. Results and Discussion

Proximate composition of the tree-ripened and rack-ripened ackees on a dry weight basis (dwb) is shown in Table 1. The corresponding data on a fresh weight basis are shown in Table 2. Fresh weight basis refers to the weight of a particular nutrient relative to the weight of the ackee arils prior to pre-drying; dry weight basis refers to the weight of a particular nutrient relative to the weight of the arils after pre-drying. For all samples, after moisture, crude fat was in largest quantities followed by carbohydrates, protein and ash.

3.1 Moisture

Tree-ripened and rack-ripened (Day 1) ackees had higher moisture contents (66.2 ± 0.4% and 66.0 ± 1.4%, respectively) than the Day 2 and Day 3 rack-ripened fruits (63.9 ± 1.6% and 65.0 ± 2.2, respectively). However, statistical analyses (t-test) showed that there were no significant differences in the moisture content of the samples.

3.2 Residual Moisture

Dried arils of the tree-ripened ackees had higher residual moisture content (8.39 ± 0.25%) than the rack-ripened samples (6.96 ± 0.13% to 7.37 ± 0.21%), and statistical analyses revealed that there was a significant difference at the 95% confidence level. During ripening, the rack-ripened ackees were placed in the sun, and some evaporation of moisture would have occurred, while the tree-ripened ackees were shaded from the direct sunlight. This could have contributed to the lower moisture observed in the rack-ripened fruits.

When the moisture content of the dried arils of the rack-ripened samples was compared, the trend was in the order of Day 1> Day 2> Day 3. Residual moisture content of the ackee samples was within a similar range to the value reported by Ouattara et al. (2010) (6.8%), but lower than the 13.8% reported by Akintayo et al. (2002). Differences in reported moisture content could be due to different methods of drying.

Table 1. Proximate Data for Tree-ripened and Rack-ripened Ackees (Dry Weight Basis)

Nutrient	Tree-ripened (%, dry wt.) [a]	Rack-ripened (%, dry wt.)[a]		
		Day 1	Day 2	Day 3
Crude Fat[b, c]	54.8 ± 2.1a	53.9 ± 2.7a	56.5 ± 1.7b	56.8 ± 1.4b
Crude Protein[b]	11.23 ± 0.55c	11.94 ± 0.29d	10.28 ± 0.28e	10.82 ± 0.37c
Residual Moisture[b, d]	8.39 ± 0.25f	7.37 ± 0.21g	7.22 ± 0.34gh	6.96 ± 0.13h
Ash[b]	4.14 ± 0.31i	3.82 ± 0.17j	3.84 ± 0.10j	4.16 ± 0.07i
Crude Fibre[b]	1.45 ± 0.19k	1.36 ± 0.17k	1.52 ± 0.23k	1.36 ± 0.32k
Total Carbohydrate	21.5	23.0	22.1	21.3

[a]Values represent the Mean ± standard deviation (Number of replicates, N = 6)
[b]Values with the same letter in a row are not significantly different at the 95% confidence level
[c]N = 12
[d]Represent moisture content of the pre-dried arils as determined in Equation 2

Table 2. Proximate Data for Tree-ripened and Rack-ripened Ackees (Fresh Weight Basis)

Nutrient	Tree-ripened (%, Fresh wt.)	Rack-ripened (%, Fresh wt.)		
		Day 1	Day 2	Day 3
Crude Fat[a,d]	14.0 ± 0.6a	14.3 ± 0.7a	16.3 ± 0.5b	15.9 ± 0.4c
Crude Protein[a,d]	2.85 ± 0.14d	3.18 ± 0.08e	2.97 ± 0.08d,f	3.03 ± 0.10f
Moisture[b,d]	66.2 ± 0.4g	66.0 ± 1.4g	63.9 ± 1.6g	65.0 ± 2.2g
Residual Moisture[c,d]	8.39 ± 0.25h	7.37 ± 0.21i	7.22 ± 0.34i,j	6.96 ± 0.13j
Ash[a,d]	1.03 ± 0.08k	1.02 ± 0.05k	1.11 ± 0.03l	1.17 ± 0.02m
Crude Fibre[a,d]	0.37 ± 0.05n,o	0.36 ± 0.05n	0.44 ± 0.07o	0.38 ± 0.09n,o
Total Carbohydrate[a]	5.45	6.13	6.39	5.97

[a]: Represent corresponding data from Table 1 converted from dry weight to fresh weight based on Equation 4 below:
% Fresh Weight = [100- (% Moisture + % Residual Moisture)] × [% dry weight ÷100] ……. Eq.4
[b]: Moisture content of arils prior to pre-drying as determined in Equation 1, N = 3
[c]: Same as in Table 1
[d]: Values with the same letter in a row are not significantly different at the 95% confidence level

3.3. Crude Fat

Generally, the rack-ripened ackee samples had a higher fat content than the tree-ripened fruits. On a fresh weight basis (see Table 2), the fat content of the tree-ripened and the Day 1 rack-ripened ackees were similar ($p>0.05$), however, Day 2 and Day 3 rack-ripened ackees had significantly higher fat contents. There was a strong inverse correlation ($R = -0.943$) between the crude fat content and the moisture content of the ackees on a fresh weight basis.

Data from the Caribbean Food and Nutrition Institute/ Pan American Health Organisation (CFNI/PAHO, 2000) showed that ripe, raw ackee arils have a fat content of 17.4% fresh weight (or 61.1% dry weight basis (dwb)). These values are slightly higher than the results arising from this study (53 to 57% dwb). Meanwhile, Odutuga et al. (1992) reported that ackees had a fat content of 51 to 58% (dwb). Lower fat contents were reported by Akintayo et al. (2002) and Ouattara et al. (2010), that is, 45.4% and 45.3% (dwb), respectively.

3.4 Crude Protein

No clear trends were observed in protein content between the tree-ripened samples and the rack-ripened samples, when the data were compared on a dry weight basis; there was a protein decrease in the order Day 1 > Day 3> Day 2. Statistical analyses showed that there were significant differences in the protein content among all of the samples, the only exception being between the tree-ripened ackees and Day 3 ackees. On a fresh weight basis, the protein content of the Day 2 rack-ripened ackees was similar to the tree-ripened ackees ($p>0.05$), however, Day 1 and Day 3 fruits had higher protein contents ($p<0.05$).

The average protein content of the ackee samples ranged from 10.2 to 12.0% dwb, slightly below the 4.2% fresh weight (14.7% dwb) reported by the CFNI/PAHO (2000) for raw ackee arils, and similar to the 2.9% fresh weight (12.4% dwb) reported for canned ackee arils by the same source. The experimental values were also in close agreement to the 11.99% reported by Ouattara et al. (2010) for sun dried arils. However, Akintayo et al. (2002) reported that the dried arils have a protein content of 24.3% (i.e., much higher than those determined from this study).

3.5 Crude Fibre

On a fresh weight basis, the crude fibre content of the tree-ripened ackees, Day 1, Day 2 and Day 3 rack-ripened ackees was 0.37%, 0.36%, 0.44% and 0.38% respectively; statistical analyses showed no significant variations between the tree-ripened and rack-ripened fruits. The quantity of crude fibre was therefore unaffected by the method of ripening. In this study, the crude fibre content of the ackee samples (1.36 to 1.52%, dwb) was slightly higher than those reported by the

CFNI/PAHO (2000), that is 1.1% (converted from fresh weight to dry weight). Higher quantities of crude fibre, 4.2% and 3.2%) were reported by Akintayo et al. (2002) and Ouattara et al. (2010) respectively.

3.6 Ash

On a dry weight basis, the ash content of the tree-ripened ackees was 4.14%, and for the rack-ripened ackees, this ranged from 3.82 to 4.16%. Statistical analyses showed that Day 1 and Day 2 samples had similar ash content, and this was also true for Day 3 and the tree-ripened ackees. On a fresh weight basis, the tree-ripened and Day 1 rack-ripened fruits had similar ash content, while Day 2 and Day 3 rack-ripened ackees had higher ash contents. No trend was observed in the ash content of the tree-ripened versus rack-ripened ackees. The ash content of the ackee samples was lower compared with other studies. Akintayo et al. (2002) reported an ash content of 5.6% dwb, while Ouattara et al. (2010) and the CFNI/PAHO (2000) reported an ash content of 4.9% dwb.

3.7 Carbohydrates

On a dry weight basis, Day 1 (23.0%) and Day 2 (22.1%) rack-ripened ackees have slightly higher carbohydrate content than the tree-ripened and Day 3 fruits (21.5% each). When the carbohydrate contents of the ackees were expressed on a fresh weight basis, the rack-ripened fruits appeared to have greater quantities of this nutrient (6.0 to 6.4%) than the tree-ripened fruits (5.5%). The lower moisture content of the rack-ripened fruits could have accounted for the higher carbohydrate content.

The CFNI/PAHO (2000) reported that the mature, raw arils of the ackee fruit have a carbohydrate content of 5.5% (fresh weight). This value agreed closely with the experimental results. Ouattara et al. (2010) reported carbohydrate content (24.4%, dwb) for sun-dried ackee arils; however, much lower carbohydrate content (6.53%, dwb) was recorded by Akintayo et al. (2002).

3.8 Minerals

The three most abundant minerals in the ackee fruit were potassium, magnesium and calcium, as shown in Table 3. Tree-ripened ackees contained larger quantities of potassium (1605 mg/100 g) in comparison to the rack-ripened fruits (1445 to 1514 mg/100 g). Magnesium content did not vary significantly among the samples; though slightly higher in tree-ripened ackees (251 mg/100 g). For calcium, higher levels were present in the Day 1 (79 mg/100 g) and Day 3 (85 mg/100 g) rack-ripened ackees, when compared with the tree-ripened ackees (65 mg/100 g). Composition of the trace elements (Fe, Zn and Cu) was essentially similar for the tree-ripened and the rack-ripened ackees. Minor differences observed can be attributed to different ackee varieties and random errors, rather than sample treatment.

The Reference Daily Intakes (RDIs) for potassium, magnesium and calcium are 3500 mg, 400 mg and 1000 mg respectively (Nielsen and Metzger, 2003). Thus, while the ackee fruit could be regarded as a good source of potassium and magnesium; it supplies less than 10% of the calcium RDI. Given that the RDIs for iron, zinc and copper are 18 mg, 15 mg and 2 mg respectively (Nielsen and Metzger, 2003), the ackee fruit, while being a good source of copper, would be a poor source of iron and zinc. The mineral profiles for the ackee samples were similar to those published by the CFNI (2000), Ouattara et al. (2010), and Akintayo et al. (2002).

3.9 Fatty Acids

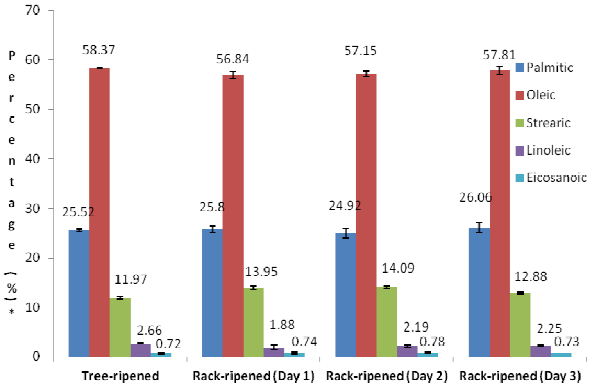
The overall fatty acid profiles of the tree-ripened and rack-ripened ackees were similar (see Figure 2). There were no significant differences ($p > 0.05$) among any of the samples for palmitic acid, which ranged from 25 to 26%. Oleic acid was highest in the tree-ripened ackees (58.4%), which was significantly higher in comparison to the Day 1 and Day 2 rack-ripened ackees. Among the rack-ripened ackees, oleic acid quantities did not vary to any significant extent (56.8-57.8%).

Stearic acid was statistically lower in the tree-ripened ackees when compared with the rack-ripened samples. There were also significant differences in stearic acid among the rack-ripened ackees, with Day 3 samples having significantly lower quantities. The fatty acid analyses also showed that significantly higher quantities ($p < 0.05$) of linoleic acid were in the oils of the tree-ripened ackees. The proportion of eicosanoic acid was however evenly distributed among the samples,

Table 3. Mineral Analyses for Tree-ripened and Rack-ripened Ackees

Mineral	Tree-ripened (mg/100 g)	Rack-ripened (mg/100 g)		
		Day 1	Day 2	Day 3
Potassium (K) [a,b,c]	1605± 169a (403)	1473 ± 58b (389)	1514± 90b(433)	1445 ± 100b (402)
Calcium (Ca)	65.2 ± 8.2c (16.6)	79.3 ± 3.8d (21.1)	72.7 ± 2.6c (21.0)	85.0 ± 6.5d (23.8)
Magnesium (Mg)	251 ± 34e (64)	239 ± 11e (64)	235 ± 48e (68)	228 ± 14e (64)
Iron (Fe)	2.86 ± 0.23f (0.73)	2.74 ± 0.22f (0.73	2.62 ± 0.18f (0.76)	2.58 ± 0.21f (0.72)
Zinc (Zn)	2.24 ± 0.24g (0.57)	2.08 ± 0.13g,h (0.55)	1.95 ± 0.14h (0.56)	2.00 ± 0.17g,h (0.56)
Copper (Cu)	0.92 ± 0.17i,j (0.23)	1.01 ± 0.05i (0.27)	1.03 ± 0.14i,j (0.30)	0.91 ± 0.10j (0.26)

[a] Values represent mean ± standard deviation (N = 6)
[b] Values with the same letter in a row are not significantly different at the 95% confidence level
[c] Values in parenthesis represent corresponding fresh weights



*: Error bars represent standard deviations

Figure 2. Fatty Acid Profile of Tree-ripened and Rack-ripened Ackees

and statistical analyses indicate no significant differences. Overall, the results revealed that the tree-ripened ackees had higher quantities of linoleic and oleic acids but lower quantities of stearic acid. However, contributions from different botanical varieties could have also been a factor, as samples were not controlled for varietal differences.

The major fatty acids in the ackee oils, identified in this study, were oleic, palmitic and stearic acids. Studies conducted by Odutuga et al. (1992) and Wellington et al. (1999) also showed that palmitic and stearic acids were among the main fatty acids. However, Odutuga et al. (1992) reported that linoleic acid was present in largest quantities. Studies by Oladiji et al. (2009) showed a predominance of behinic, oleic and 9,12-eicosadienic acids.

4. Conclusions

Rack-ripened ackees had lower residual moisture content than tree-ripened ackees, which is a contributory factor to the generally higher levels of crude fat, crude protein and total carbohydrates observed in the rack-ripened fruits. It could not be ascertained whether the higher quantities of oleic and linoleic acids in the oils of the tree-ripened ackees were as a result of the sample treatment, or differences in the varietal mixture of the composite samples, or a combination of factors. Overall, there were no significant differences in the mineral composition of the tree-ripened and rack-ripened ackees. Although there were statistical differences in the quantities of some nutrients in the tree-ripened and rack-ripened ackees, the overall nutritional profiles did not vary significantly. Several topical issues require further investigations: These include, for instance, quantification of hypoglycin A in the rack-ripened fruits, and the effects of botanical varieties on proximate composition. Hypoglycin levels in commercial products are regulated; the upper limit in canned ackees set by the US FDA is 100 ppm drained weight (Whitaker et al., 2007). Studies conducted by the US Department of Agriculture and the US FDA (2012) revealed that the concentration of hypoglycin A in canned ackees ranged from 2.77 to 252.58 ppm; more than 77% of samples had concentration of less than 100 ppm (Whitaker et al., 2007). Another study reported average hypoglycin levels of 94 ppm in the drained solid portion of six samples of commercially canned ackees (Chase et al., 1989). No information is available in the literature concerning the hypoglycin levels in rack-ripened ackees, however a large portion of the ackees used for canning is rack-ripened. Quantification of the toxin in rack-ripened ackees is thus a necessary study.

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