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EVALUATION OF BOILED AND SOAKED AKEE APPLE (BLIGHIA SAPIDA) ARIL

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ABSTRACT

Akee apple (Blighia sapida) is an under-utilized fruit crop. Akee apple is associated with potent alkaloids known as hypoglycins A and B. The objective of this research was to determine the effect of processing on the chemical properties of akee apple aril. The matured akee apple fruits used for this research work were obtained from Saki, Oke-Ogun area of Oyo state, South-west Nigeria. The aril was subjected to boiling and a combination of boiling and soaking. The processed aril was then subjected to proximate, mineral analysis and antinutritional content determination. The protein, fat and ash content decrease with processing, the moisture content of boiled aril ranged from 3.21% in raw akee apple aril to 3.87% in akee apple aril boiled for 30 minutes. The hypoglycin content of aril boiled for 40 minutes was 10.33 mg/100g and that subjected to boiling and soaking for 8 h was 4.50 mg/100g. The processing employed in this research reduced the antinutrient content of akee apple aril.

Keywords: Akee apple, boiling, soaking, minerals, antinutrient

INTRODUCTION

Akee apple (*Blighia sapida*) is an under-utilized fruit crop belonging to the family *Sapindaceae* which took its name from soapberry tree *Sapindus saponaria.* It is native to Tropical West Africa, widely distributed in Nigeria and found in the drier forest of the savannah region (Esuoso and Odetokun 1995). Among the local consumers, the fruits are selected for consumption when the pod opened and that is when it is believed to be ripened. It may be eaten fresh, dried, roasted or made sauce or soup. It is often cooked with vegetable soups for it meat-like texture or parboiled in salt water or milk and fried lightly in butter into a delicious Jamaican dish (Moya 2001, Agunbiade *et al*. 2012). Investigations indicated that akee apple is one of the plants which could contribute to increase intake of some essential nutrients. It is noted for high protein and fat contents comparable to most legumes and oil seed (Akintayo *et* al. 2002, Ekue *et* al. 2010, Oyeleke *et al*. 2013). The unripe akee apple fruit has potent alkaloids called hypoglycins A and B which are toxic amino acids that causes vomiting, seizures and fatal Hypoglycemia referred to as Jamaican vomiting sickness when consume in an unprocessed form, these antinutrients were reported to reduce as the fruit is ripening (Annongu *et al*. 2013). No comprehensive report has been compiled in literature encompassing the nutritional efficacy of boiled and soaked akee apple aril; hence the objective of this research was to investigate the effect of boiling and soaking on the nutritional content of self opened akee apple aril.

MATERIALS AND METHODS

Materials

The matured akee apple fruits used for this research work were obtained from Saki, Oke-Ogun area of Oyo state, South-west Nigeria. The fruit was sorted, cleaned and separated into arils and seeds. The aril was subjected to boiling and a combination of boiling and soaking. The processed akee apple aril was subjected to analyses such as proximate, minerals, antinutritional content determination. All chemicals used were of analytical grade.

Sample preparation

Processing of raw Akee apple aril

The aril was separated and dried at 50 °C for 24 h until constant weight was obtained. The dried aril was stored in airtight containers in the refrigerator at 4 °C until when needed for analysis (Adeyeye 2011).

Processing of boiled akee apple aril

The method described by *Agunbiade et al. (2012) was used with slight modification.* The aril was separated from their seeds and cooked in boiling water for 10, 20, 30 and 40 min. It was thereafter drained, cooled and dried 50 °C for 24 h. The dried aril was stored in airtight containers in the refrigerator at 4 °C until when needed for analysis.

Processing of boiled and soaked akee apple aril

The akee apple aril was separated and boiled for 10 min; it was then soaked in water for 2, 4, 6 and 8 h. Following the treatment, soaked water was decanted. The aril was thereafter dried 50 °C for 24 h and stored in airtight containers in the refrigerator at 4 °C until when needed for analysis.

Proximate composition analyses

Proximate analysis (moisture content, protein, crude fat, crude fibre and ash) and mineral content were done using AOAC (2005) methods.

Determination of Antinutritional factors

Hypoglycin content was determined using AOAC (2005) method. Phytic acid content was determined using method of Maga (1982). Tannin content was done using AOAC (1984) as reported by Onuekwusi *et al*. (2014). Saponin content was determined following the method described by Oloyede (2005) and reported by Nwali (2012). Trypsin inhibitor activity was determined using the method of Kakade (1974) and Oxalic acid content was determined using AOAC (1990).

Data analysis

Analysis were carried out in three replicate, data obtained were subjected to analysis of variance (ANOVA) at 5% significance level and means were separated using Duncan Multiple Range Test using SPSS version 21.0.

RESULTS AND DISCUSSION

Proximate composition of akee apple aril

The results of proximate composition of boiled akee apple aril were presented in Table 3.1. There were significant differences ($p<0.05$) in moisture, fat, ash and crude fibre content of the processed akee apple aril. The moisture content of boiled aril ranged from 3.21% in raw akee apple aril to 3.87% in akee apple aril boiled for 30 min. The moisture content increased with boiling duration. The moisture content recorded was lower than 6.25% reported by Ouattara *et al*. (2012) for dried akee apple aril. These low moisture content indicate that limited amount of moisture will be available for microbial activities hence good storability will be guaranteed (Andrew and Harrison 2006). The protein and ash content were lowered in the processed sample than in the raw sample. The protein content ranged from 14.70% in aril boiled for 40 min to 19.04% in raw akee apple aril, these values were lower than the values of 26.59% to 27.69% reported by Onuegbu *et al*. (2013) for boiled ukpo seed flour. The values were comparable to 15.27% for sun dried akee apple arils reported by Oyeleke *et al.* (2013), but lower than 24.3% of oven dried akee apple arils reported by Akintayo *et al*. (2002). The proximate composition of akee apple aril subjected to boiling for 10 minutes and then soaked was presented in Table 3.2. The protein, fat and ash content decreased with processing whereas the crude fibre, moisture and carbohydrate content increased with processing. There was significant difference ($p<0.05$) in the proximate composition of the samples. The protein content ranged from 10.78% in sample boiled and then soaked 6 h to 19.04% in raw akee apple aril sample. The protein content obtained were higher than the value of 11.99% reported for dried akee aril by Ouattara *et al*. (2010) but were lower than the values of 25.12% reported for kenaf seed by Olawepo *et al*. (2014). The crude fibre content ranged from 0.60% in raw akee apple aril sample to 2.20% in the sample boiled for 4 hours. The moisture content ranged from 3.21% in raw sample to 7.11% in the sample soaked for 6 h.

Mineral Composition of Boiled Akee Apple Aril

The mineral composition of boiled akee apple aril was presented in Table 3.3. There was significant difference ($p<0.05$) in the mineral composition with potassium being the predominant mineral in boiled akee apple aril. The mineral content decreased with the increased duration of boiling.

Table 1: Proximate Composition of Boiled Akee Apple Aril

Sample	AB10	AB20	AB30	AB40	ODRS
crude protein	15.44±0.07^{b}	15.29±0.11^{b}	14.93±0.06^{c}	14.70±0.07^{c}	19.04±0.25^{a}
crude fat	19.42±0.01^{e}	19.65±0.02^{c}	19.57±0.02^{d}	19.74±0.02^{b}	21.31±0.04^{a}
crude fibre	0.50±0.01^{b}	0.45±0.02^{c}	0.34±0.01^{d}	0.24±0.01^{e}	0.60±0.02^{a}
Ash	4.28±0.01^{d}	4.20±0.02^{e}	4.32±0.01^{c}	4.40±0.01^{b}	9.00±0.04^{a}
Moisture	3.73±0.02^{c}	3.84±0.02^{a}	3.87±0.02^{a}	3.80±0.02^{b}	3.21±0.04^{d}
Carbohydrate	56.64±0.05^{b}	56.59±0.07^{b}	56.99±0.03^{a}	57.13±0.06^{a}	46.86±0.20^{c}

Means± standard deviation of three replicates determination. Values in rows with different superscript are significantly different ($p<0.05$). AB10 - Aril boiled for 10 min. AB20 - Aril boiled for 20min. AB30 - Aril boiled for 30 min. AB40 -Aril boiled for 40 min. ODRS – Oven dried raw aril sample

Table 2: Proximate composition of akee aril boiled and then soaked

Sample	Raw akee aril	Aril Boiled and soaked for 2h	Aril Boiled and soaked for 4h	Aril Boiled and soaked for 6h	Aril Boiled and soaked for 8h
crude protein	19.04±0.35^{a}	11.88±0.10^{c}	12.88±0.09^{b}	10.78±0.10^{e}	11.57±0.09^{d}
crude fat	21.31±0.05^{a}	9.69±0.03^{c}	10.40±0.02^{b}	8.66±0.03^{e}	9.39±0.40^{d}
crude fibre	0.60±0.03^{e}	2.03±0.02^{b}	2.20±0.03^{a}	1.86±0.04^{d}	1.95±0.02^{c}
Ash	9.00±0.06^{a}	3.12±0.05^{c}	3.63±0.02^{b}	2.98±0.03^{d}	3.08±0.04^{c}
Moisture	3.21±0.05^{e}	6.85±0.04^{c}	5.21±0.03^{d}	7.11±0.02^{a}	7.02±0.02^{b}
Carbohydrate	47.02±0.04^{e}	66.45±0.51^{c}	57.67±0.08^{d}	68.61±0.13^{a}	67.00±0.10^{b}

Means± standard deviation of three replicates determination.
Values in rows with different superscript are significantly different ($p<0.05$).

Table 3: Mineral composition of Boiled Akee Apple Aril

Sample	AB10 (mg/100g)	AB20 (mg/100g)	AB30 (mg/100g)	AB40 (mg/100g)	ODRS (mg/100g)
Na mg	210.00±1.00^{b}	202.50±1.50^{c}	193.50±1.50^{d}	180.50±2.50^{e}	269.00±1.00^{a}
K	626.67±1.53^{b}	607.50±1.50^{c}	590.50±1.50^{d}	560.50±2.50^{e}	873.00±1.00^{a}
Ca	310.50±1.50^{b}	296.00±1.00^{c}	286.00±0.00^{d}	265.00±0.00^{e}	455.50±1.50^{a}
P	332.50±1.50^{b}	326.50±1.50^{c}	318.00±0.00^{d}	309.00±0.00^{e}	426.50±1.50^{a}
Mg	330.50±1.50^{b}	306.00±1.00^{c}	294.00±1.00^{d}	280.00±2.00^{e}	380.00±2.00^{a}
Mn	11.00±0.20^{b}	10.20±0.10^{c}	9.60±0.10^{d}	8.70±0.10^{e}	11.85±0.25^{a}
Fe	115.45±0.15^{b}	114.80±0.10^{c}	113.40±0.10^{d}	112.20±0.10^{e}	196.95±0.15^{a}
Cu	7.30±0.10^{b}	6.80±0.10^{c}	6.40±0.10^{d}	5.70±0.10^{d}	8.00±0.20^{a}
Zn	87.60±0.10^{b}	86.40±0.10^{c}	85.85±0.05^{d}	84.65±0.05^{e}	92.40±0.10^{a}
Pb	ND	ND	ND	ND	0.025±0.00

Means± standard deviation of three replicates determination. Values in rows with different superscript are significantly different ($p<0.05$). ND – not detected AB10 - Aril boiled for 10 min. AB20 - Aril boiled for 20min. AB30- Aril boiled for 30 min. AB40 - Aril boiled for 40min.

The sodium content ranged from 180.50 mg /100 g in sample boiled for 40 min to 210 mg/100 g in sample boiled for 10 min while the raw akee apple aril sample had a value of 269.00 mg/100 g of sodium content, these values were higher than those reported by Dossuo *et al*. (2014) i.e. 84.24 mg/100 g and 73.37 mg/100 g for oven dried and freeze dried akee apple aril respectively. The phosphorus content of the samples ranged from 309.00 mg/100 g in sample boiled for 40 min to 426.50 mg/100 g in raw sample.

The mineral composition of akee apple aril subjected to boiling for 10 min and then soaked at different duration was presented in Table 3.4. The mineral content of the samples decreased with increased duration of soaking with zinc being the least mineral followed by copper and manganese. The most abundant mineral is potassium just like in all other samples. The value of potassium ranged from 873.00 mg/100 g in raw akee apple aril to 377.67 mg/100 g in sample subjected to 6 h soaking. The values obtained for potassium were less than the value of 1503.3 mg/100g reported by Ouattara *et al.* (2010) for dried akee apple aril. The phosphorus content ranged from 264.00 mg/100g in sample soaked for 2 h to 238.00 mg/100 g in sample soaked for 6 h. The iron content ranged from 196.95 mg/100 g to 169.50 mg/100 g.

Table 4: Mineral composition of akee aril boiled and then soaked

Sample	Raw akee aril (mg/100g)	Aril Boiled and soaked for 2h (mg/100g)	Aril Boiled and soaked for 4h (mg/100g)	Aril Boiled and soaked for 6h (mg/100g)	Aril Boiled and soaked for 8h (mg/100g)
Sodium	269.00±2.83^{a}	143.33±0.58^{b}	138.00±0.00^{c}	129.00±0.00^{e}	131.67±0.58^{d}
Potassium	873.00±1.41^{a}	407.67±0.58^{b}	397.00±0.00^{c}	377.67±0.58^{e}	385.33±0.58^{d}
Calcium	455.50±2.12^{a}	200.33±1.16^{b}	194.00±0.00^{c}	172.67±0.58^{e}	177.67±0.58^{d}
Phosphorus	426.50±2.12^{a}	264.00±0.00^{b}	247.00±0.00^{d}	238.00±0.00^{e}	251.33±0.58^{c}
Magnesium	380.00±2.83^{a}	227.67±0.58^{b}	218.00±0.00^{d}	207.00±0.00^{e}	221.33±0.58^{c}
Manganese	118.50±3.54^{a}	46.33±0.58^{d}	49.00±0.00^{c}	38.33±0.58^{e}	51.33±0.58^{b}
Iron	196.95±2.12^{a}	178.63±0.58^{c}	183.80±0.00^{b}	169.50±0.00^{e}	173.03±1.16^{d}
Copper	80.00±2.83^{a}	51.33±0.58^{c}	54.00±0.00^{b}	37.00±0.00^{e}	44.00±0.00^{d}
Zinc	92.40±1.41^{a}	26.40±0.00^{d}	26.87±0.58^{c}	24.57±0.58^{e}	27.20±0.00^{b}
Lead	0.025±0.00	ND	ND	ND	ND

Means± standard deviation of three replicates determination. Values in rows with different superscript are significantly different ($p<0.05$) ND – not detected

Antinutritional composition of boiled akee apple aril

Table 3.5 showed the antinutritional composition of boiled akee apple aril. There was no significant different ($p>0.05$) in tannin and saponin composition of the sample whereas there were significant difference in phytate, oxalate and hypoglycin composition. The antinutritional content of the sample decrease with increase in the duration of processing. The tannin content ranged from 7.00 mg/100 g in sample boiled for 40 min to 19.50 mg/100 g in sample boiled for 10 min and 44.50 mg/100 g in raw sample. The phytate content ranged from 143.00 mg/100 g in raw sample to 93.50 mg/100 g in sample boiled for 40 minutes.

Table 5: Anti-nutritional content of boiled akee apple aril

Sample	AB10	AB20	AB30	AB40	ODRS
Tannin (mg/100g)	19.50±2.12^{b}	16.00±1.41^{b}	10.00±1.41^{c}	7.00±1.41^{c}	44.50±0.71^{a}
Saponin (mg/100g)	15.00±1.41^{b}	12.00±1.41^{bc}	7.50±2.12^{cd}	3.00±1.41^{d}	63.00±2.83^{a}
Phytate (mg/100g)	114.00±1.41^{b}	108.00±1.41^{c}	102.50±2.12^{d}	93.50±2.12^{e}	143.00±1.41^{a}
Oxalate (mg/100g)	105.00±2.83^{b}	90.50±2.12^{c}	74.00±2.83^{d}	57.00±1.41^{e}	132.00±1.41^{a}
Hypoglycin (mg/100g)	16.50±2.12^{b}	12.00±1.41^{c}	9.00±1.41^{c}	4.50±2.12^{d}	45.00±1.41^{a}
T. inhibitor (TIU/mg)	3.00±0.00^{b}	1.00±0.00^{c}	ND	ND	25.40±0.03^{a}

Means± standard deviation of three replicates determination. Values in rows with different superscript are significantly different ($p<0.05$). AB10 - Aril boiled for 10 min. AB20 - Aril boiled for 20min. AB30 - Aril boiled for 30 min. AB40 - Aril boiled for 40

The hypoglycin content decrease with processing and the value ranged from 45.00 mg/100 g in raw sample to 4.50 mg/100 g in sample boiled for 40 min. The results of the antinutritional composition of akee apple aril boiled for 10 min and then subjected to soaking at different duration were presented in Table 3.6. There was significant difference ($p<0.05$) in the antinutritional composition of the processed sample. The antinutrient decreased with processing duration. The tannin content ranged from 44.50 mg/100 g in raw sample to 33.67 mg/100 g in sample soaked for 8 h. The sample soaked for 8 h had amount of hypoglycin content of 10.33 mg/100 g. Akee apple aril subjected to boiling for 30 and 40 min had acceptable level of the potent antinutrient that is, hypoglycin in the range of 10 mg/100g recommended as maximum tolerated dose

when pure hypoglycin was fed to laboratory rats (Blake *et al*., 2006). The oxalate content value ranged from 132.00 mg/100 g in raw akee apple aril sample to 73.67 mg/100 g in the sample subjected to 8 h soaking. The values of antinutritional factors obtained in this research were more than those reported by Oyeleke *et al*. (2013) for akee apple aril (*Blighia sapida* pulp). The tannin contents were lower than the values of 4662.83 mg/100g and 3622.33 mg/100g reported for ripe and unripe *Blighia sapida* seed respectively by Onuekwusi *et al*. (2014).

Table 6: Antinutritional composition of akee aril boiled and then soaked

Sample	Raw akee aril	Aril Boiled and soaked for 2h	Aril Boiled and soaked for 4h	Aril Boiled and soaked for 6h	Aril Boiled and soaked for 8h
Tannin (mg/100g)	44.50±0.71^{a}	42.33±2.52^{b}	39.33±2.52^{c}	37.00±2.00^{c}	33.67±2.52^{d}
Saponin(mg/100g)	63.00±2.83^{a}	34.33±3.06^{b}	33.00±2.00^{b}	31.00±2.00^{b}	29.00±3.00^{b}
Phytate (mg/100g)	143.00±1.41^{a}	112.67±3.51^{b}	110.67±3.51^{b}	109.00±3.00^{b}	107.00±2.00^{b}
Oxalate(mg/100g)	132.00±1.41^{a}	82.33±2.52^{b}	79.00±2.00^{bc}	75.67±2.52^{cd}	73.67±2.52^{d}
Hypoglycin (mg/100g)	45.00±1.41^{a}	28.33±2.52^{b}	25.33±1.53^{b}	19.33±2.52^{c}	10.33±1.53^{d}
T.inhibitor (TIU/mg)	25.40±0.03^{a}	5.69±0.35^{b}	5.42±0.025^{c}	4.79±0.025^{d}	3.85±0.025^{e}

Means± standard deviation of three replicates determination.
Values in rows with different superscript are significantly different ($p<0.05$).

CONCLUSION

The processing methods employed in this research reduced the antinutrients in akee apple aril, although the nutritional composition reduced with increase in duration of processing. Boiling for 40 min was most effective against hypoglycin present in akee apple aril; this was followed by akee apple aril subjected to a combined process of boiling for 10 min and soaking for 8 h.

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