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Research Article

Effects of Maturation and Stem Cooking on Akee Apple Aril Nutritional and Phytochemical Properties

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ABSTRACT
*This study focused the economic potential and effects of maturity and heat treatment on akee apple aril proximate, mineral and phytochemical compositions. Fresh raw mature aril (RMA) is characterized by 57(*58) % moisture, 2.10 (*3.7) % ash, 19(*18) % fat, 3.40(*3.42) % crude protein and 9.8(*9.6) % carbohydrate. As aril matured 1.6% reduction in its ash value and about 1.6% increase in crude protein value were observed. Cooking caused insignificant loss of 0.20-0.3% in immature and mature arils. The fibre contents of arils, whether immature, mature, cooked or uncooked, remained fairly constant. Acidity of raw immature aril (RIA) decreased from 16mg/kg by 5.0mg/kg at maturity, but cooking slightly reduced the acidity of immature aril by 1.5mg/kg in contrast to loss of 10.0mg/kg in cooked mature aril (CMA). Both RIA pH (3.40) and RMA pH (6.00) got normalized to 6.2 by cooking. High tannin composition (3.10mg/kg) and low hypoglycin composition (0.9mg/kg) in RIA got reduced to 0.92 and 0.22mg/kg respectively in RMA and were both destroyed by cooking. A reduction of 31% in flavonoid resulted from maturation of aril; however heat processing had very little effect on both RIA & RMA flavonoid. The major minerals of aril are Ca, Zn, Fe and P. At maturate the concentrations of Ca, Na and P increased but the reverse was the case in Na, K and Zn. Steam cooking, did not change the sweet smell of arils, mature or immature. Immaturity characterizes RIA milky colour and distinguishes it from RMA/CMA with butter colour and cheese taste. Cooking processing makes akee aril non-hazardous as it completely destroys Hypoglycin, the causative agent of Jamaican vomiting.*
***Keywords**: Akee Apple, Aril, Hypoglycin, proximate, phytochemical, and processed*
**Asterisked figures in prentices represent values for fresh immature arils (RIA)*

INTRODUCTION

Akee Apple (Blighia sapida), a member of Sapindaceae (Soapberry family), is a native of Tropical West Africa, including Nigeria [1].From its West African origin, akee apple has traversed the Atlantic Ocean, making the Caribbean its home. Akee apple. like other fruits trees such as citrus, cashew, guava, banana, mango [2] provides fruits for human food. The plant is commonly named after Blighia, a Jamaican Captain (1793) who was instrumental to the plant`s introduction to Caribbean, mainly to furnish food for slaves. Its wide growth, predominantly, by the roadsides, door yards etc and its subsequent adoption made akee apple a favourite food in the Island.

The akee apple fruits-bearing tree reaches 10 to 12 meter with a, grayish, smooth trunk 1.8 meter in circumference and a dense crown of spreading branches. It flowers and bears fruits all the year round in some areas in Nigeria. In some other parts of West African Countries, the tree fruits twice a year (Feb- April and July- October)

In local areas the plant is mainly propagated by planting the matured aril-bearing seed. The fruit pods and seed are said to be used for soap-making, fish poison. The dried seeds, plant bark and leaves are used medically. The wood is locally changed into planks, oars, paddle etc.

At maturity the akee apple pod naturally splits open to reveals 3- cream- coloured fleshy, glossy, crispy arils attached to black, smooth, hard, shiny seeds. At this stage, akee arils are considered safe for consumption uncooked. The consumption of immature arils has been found to be hazardous causing hypoglycemia, referred to as Jamaican vomiting sickness (JVS) [3,4]. This sickness syndrome is believed to be caused by potent alkaloid toxins, hypoglycins A & B concentrated in the unripe akee fruit [5-6]. The actual causative agent of JVS has been shown to be a metabolite of hypoglycin A called methylene cyclopropane acetic acid (MCPA) which subsequently undergoes oxidative decarboxylation to form MCPA-COA [7]. This compound exerts its effects by inhibiting several co-enzymes a deyhdrogenases which are essential for gluconeogenesis.

The Jamaican sickness is identified with drowsiness, sometimes seizure and if not arrested may lead to coma and death. In acute poisoning, the body`s ability to release the back-up supply of glucose via gluconeogenesis from Liver glycogen is limited. The resulting hypoglycemia effect has been controlled by administration of sugar solution. The clinical features caused by JVS includes not only vomiting, hypoglycemia, depletion of hepatic glycogen, but also aciduria, coma and in severe cases, death.The consumption of immature arils, resulting in swollen lips and convulsion has been effectively traditionally treated with oral administration of red oil or a vegetable soup (Personal experience).

In some parts of Nigeria, especially, Oke Ogun areas of Oyo State of Nigeria, akee apple arils are often cooked with vegetable soups for its meat like texture. Fresh and firm arils are also parboiled in salt water or milk and lightly fried in butter into a delicious Jamaican dish [7].

The akee arils are canned and exported as the major export product from Jamaican into USA. The Jamaicans often serve arils with staple where it is considered as a meat substitute for its taste.

Arils are known to be rich in fatty acids, linoleic and stearic acids respectively [8].

The main objective of this study was to evaluate the economic importance of the raw and heat treated akee apple arils.

MATERIALS AND METHODS

Sources of Raw Materials

The raw akee apple fruits used for carrying out this work were obtained from Idere in Ibarapa local government area of Oyo state, Nigeria. Both immature and mature fruits were collected. The immature pods were those whose pods did not split open on their own while the mature ones split on their own while on the parent plant, an evidence of maturity.

Pretreatment

The pods of the immature akee apple were forced open with a sharp knife to release the seeds carrying arils. The mature pods having split open on their own readily showcased their seeds with arils. Both mature and immature arils were separated from their seeds and treated as follows:

A portion of each mature and immature arils were cooked in boiling water for 30 minutes, oven dried at 60°C for 18 hours, ground to whip size, kept in screw-capped bottles and stored in deep freezer pending analysis

Physico-chemical analyses

Organoleptic measurements

Colour measurements of arils and seeds of akee apple were based on appearance by visual perception.Taste of arils were determined. This was limited to samples from mature pods. Upon cooking, taste measurement was extended to immature aril, especially after phytochemical screening.

pH determination and acidity: These two parameters were carried out by the method of Bartolome *et al*. [9].

Alkalinity: Titrimetric method as reported by Agunbiade *et al*. [10] was adopted.

Phytochemical screening: The constituent phytochemicals were assayed using the standard methods described by Edeoga *et al.* [11]. Both qualitative and quantitative determinations of saponins, tannins, phlobatannins, alkaloids, flavonoids and steroids were carried out.

Cyanide: Cyanide was determined by the Official Methods of Analysis of the Association of Official Analytical Chemists [12].

Proximate analysis: Proximate composition of samples was carried out using the Official Methods of Analysis of the Association of Official Analytical Chemists [12]. Crude nitrogen was determined by Kjeldhal method and was converted to crude protein by multiplication by 6.25. Carbohydrate percentage was estimated by difference.

Mineral composition: Mineral composition of samples was determined by the methods of Analysis of the Association of Official Analytical Chemists [12]. Phosphorus was estimated by Vanado Molybdate method which effected a reaction between phosphorus and Molybdovanade resulting in molybdovanadate complex colorimetrically measured at 420nm.

RESULTS AND DISCUSSION

Table1: Shows the proximate composition of raw and heat treated immature and mature akee apple arils. The proximate compositions of unripe and ripe arils varied as follows, moisture (57-58%), ash (2.10-3.70%), fat (18.20-18.96%), fibre (3.40-3.42%), crude protein (7.02-8.65%) and carbohydrate (9.6-9.8%). This result reflects slight increase in the nutritive values as the fruit matures. There were observable marginal losses in nutritive values of immature and mature arils due to steam cooking. This is consistent with previous reports [13].

Table 1: Proximate Composition of raw and cooked immature and mature akee apple arils in percentage

Sample	Moisture	Ash	Fat	Crude fiber	Crude protein	Carbohydrate
RIA	58.06 ± 1.02	3.70 ± 0.4	18.20 ± 0.85	3.42 ± 0.58	7.02 ± 0.35	9.60 ± 0.40
CIA	60.73 ± 1.25	3.50 ± 0.50	17.85 ± 0.80	3.20 ± 0.15	6.72 ± 0.28	8.0 ± 0.20
RMA	57.09 ± 1.30	2.10 ± 0.50	18.96 ± 0.68	3.40 ± 0.40	8.65 ± 0.42	9.80 ± 0.34
CMA	60.14 ± 1.45	1.80 ± 0.35	18.45 ± 0.35	2.96 ± 0.45	8.45 ± 0.40	8.20 ± 0.28

Values are duplicate determinations ± standard deviation (SD)

Key RIA - Raw Immature Aril**;** CIA - Cooked Immature Aril; RMA – Raw Mature Aril; CMA – Cooked Mature Aril

Akee apple aril is high in moisture, low in crude protein, ash, fibre and carbohydrate. It is, however, very rich in fat, signifying its rich non-starchy source of energy. Loss of 1.6% in its rather low carbohydrate content may account for its soluble portion. Losses in analytes of the cooked arils may be due to the vigorous thermal process during cooking in total agreement with the report of Lund (1977). Table 2: Shows the effect of heat treatment on the physico-chemical properties of unripe and ripe akee apple arils. Low alkalinity is exhibited by both immature and mature arils. Both of them exhibited relatively high acidity, 16.0mg/kg in RIA and 11.0mg/kg in RMA. Cooking reduced aril acidity slightly being 1.5mg/kg loss in CIA in contrast to 0.6mg/kg in CMA. The pH value of RIA increased by 0.2 i.e. 6.20, pH of CMA which is identical to that of CIA resulting from cooking RIA with pH of 5.40. The colour of RIA and RMA were retained upon cooking. All arils manifested characteristic sweet smell. Both RMA and CMA tasted cheesy. Akee apple aril is an acid fruit as revealed by its pH.

Table 2: Effect of heat treatment on the physic-chemical properties of immature and mature apple arils

Sample	**Alkalinity mg/kg**	**Acidity mg/kg**	**pH**	**Colour**	**Taste**	**Odour**
RIA	1.30 ± 0.28	16.00 ± 0.71	5.40	Milky	N.D	Sweet smell
CIA	1.00 ± 0.18	14.50 ± 0.63	6.20	Milky	N.D	Sweet smell
RMA	0.90 ± 0.10	11.00 ± 0.50	6.00	Butter colour	Cheesy	Sweet smell
CMA	0.70 ± 0.10	4.40 ± 0.40	6.20	Butter colour	Cheesy	Sweet smell

Values are means ± standard error (SE) of triplicate determinations

All abbreviated words are as found under Table 1

Table 3: Shows the effect of heat treatment on the physico-chemical composition of raw akee apple arils and seed cotyledon. Tannin in raw immature aril was 3.37 times as high as its content in raw mature aril. Tannin is highly heat sensitive and all tannin contents of RIA and RMA were totally lost to ordinary steam cooking. No Tannin was found in raw seed cotyledons, whether mature or non-mature. Saponin, not found in RIA and RMA was appreciably present in RISCOT and RMSCOT varying from 5.8-8.10mg/100g being higher in raw mature than immature seed cotyledon. 0.9mg/100g Hypoglycin found in RIA and 0.22mg/kg hypoglycin in RMA were totally destroyed by steam cooking. The hypoglycin content of 1.82mg/100g found in raw immature seed cotyledon got reduced by 23.08% in the raw mature seed cotyledon of akee apple. Cyanide was not detected in all samples, raw or heat treated. Flavonoid, about 2.9mg/100g in raw and heat treated (RIA and CIA), signifies that flavonoid in immature aril is substantially heat resistant. This work indicates 27.59% loss of flavonoid as a result of maturation and loss of 9.52% due to cooking of mature aril. No cyanide and saponin were found in both immature and mature seed cotyledon of akee apple. The observed complete loss of Tannin and hypoglycin due to cooking and non-detection of saponin and cyanide in

apple arils indicate that they are non-deliterous as processed and hence are safe for human consumption. Akee apple seed cotyledon is the site of high concentrations of saponin and hypoglycin, a condition which seemingly portrays the cotyledon as toxic if consumed as such,

Above 23% loss in hypoglycin on cooking does not guarantee its safe consumption. Its potency at this level may still cause Jamaican sickness. Flavornoid show anti-allergic, anti-inflammatory and anti- cancer activities . These activities may be due to flavornoid.

Table 4: shows reduction in the concentrations of Ca, Na, P due to maturation and whereas the reverse is the case in K, Fe and Zn. These increases are not astronomical except in Na and Zn. Heat processing causes decrease in the minerals which probably stem from leaching into cooking water. In support of this finding, heat treatments have been reported to have reduced minerals [14].

Table 3: Phytochemical Composition of raw and cooked akee apple aril and unprocessed seed cotyledon

Sample	Tannin	Phlobotannin	Saponin	Alkaloid (Hypoglycin)	Cyanide	Flavonoid
RIA	3.10 ± 0.50	ND	ND	0.90 ± 0.12	ND	2.90 ± 0.95
CIA	ND	ND	ND	ND	ND	2.85 ± 0.50
RMA	0.92 ± 0.12	ND	ND	0.22 0.10	ND	2.10 ± 0.20
CMA	ND	ND	ND	ND	ND	1.90 ± 0.30
RISCOT	ND	ND	5.80 ± 0.42	1.82 ± 0.25	ND	ND
RMSCOT	ND	ND	8.10 ± 0.64	1.40 ± 0.28	ND	ND

Values are means ± SD of duplicate determinations.
RISCOT=Raw immature seed cotyledon.; RMSCOT=Raw mature seed cotyledon.
Other abbreviated words are as found under Table 1.

Table 4: Effect of cooking on the mineral composition of Akee Apple Aril (mg/100g)

Mineral	RIA	CIA	RMA	CMA
Ca	79.00 ± 2.0	68.00 ± 1.68	84.00 ± 1.30	82.00 ± 1.54
K	2.30 ± 0.70	1.98 ± 0.40	1.90 ± 0.25	1.54 ± 0.52
Na	3.00 ± 0.40	2.00 ± 0.14	6.00 ± 1.00	4.00 ± 0.28
Fe	7.20 ± 0.60	6.55 ± 0.70	5.53 ± 0.45	4.90 ± 0.50
P	90.00 ± 2.82	87.00 ± 1.92	96.00 ± 2.60	96.00 ± 1.45
Zn	16.25± 1.30	12.19 ± 0.32	12.79 ± 0.41	12.46 ± 0.24

Values are means± SD of duplicate determinations.
Abbreviated words are as found under Table 1

REFERENCES

1. Riffle Robert (1998). The Tropical Look. Timber Press. New York 1988
2. Singha, S. (2003). Concise Encyclopedia of temperate tree fruit. New York: Food Productions press pp. 3-5.
3. SarDesai, Vishwanath (2003). Introduction to Clinical Nutrition. New York: Marcel Dekker Inc, ISBN 0-8247-4093-9, pp 1842-1852.
4. Kumar, P. J. (2006): Clinical Medicine (5ed) Saunders (IVB) Co. Ltd. ISBN 978-0702025792.
5. McGowan, C. Wiley, V.A and Bakes, R.P. (1987); Biochromatology, American MISSISSIPI Press, pp 88-90
6. Ghalams, S and Botting, H. G. J. (1994): Association of Anal Chemistry vol. 105, Issue 6, 110-112.
7. Van Holt, C. Von Holt, M and Bohm (1966), Biochem, Biophysics, Acta. Vol 18, Issue 10, 81-87.
8. Duke J. and Duke A. (2002). Handbook of Mechanical herbs. ISBN 978-0702025792
9. Bartolome, A.P., P. Ruperez and C.O. Fuster, 1996. Non-volatile organic acids, pH and titrable acidity changes in pineapple fruit sliced during frozen storages. J.Sc. Food Agric.70:457-480.
10. Agunbiade, S.O., O.A. Akintobi and O.M. Ighodaro, 2010. Some Biochemical and Organoleptic changes due to microbial growth in Minced Beef packaged in aluminium polythene trays and stored under chilled conditions. Life Science Journal 7(2): 47-51.
11. Edeoga H.O. , D. E. Okwu and B.O Mbaebie (2005). Phytochemicals constituents of some Nigerian medicinal plants. African J.Biotec. Vol. 4 (7), pp. 685-688
12. AOAC, (1990). Official method of Cyanide of the Association of Official Analytical Chemists, Washington D.C.
13. Agunbiade,S.O, and O.G. Longe,1996. Effect of processing on the physico-chemical properties of African yambean,Sphenostylis stenocarpa(HOCHST ex A.Rich) Harms. Nahrung,40 Nr 4 184-188.
14. Oladunmoye, O. O., Ojeniyi, S and AO Bankole, Mineral composition of tender and matured cassava leaves after home cooking procedures. Proceedings: annual Conference of the Nigerian Institute of food science and Technology: Eboyi State University, Abakaliki, 2005, pp 151-152.