The International Journal Of Engineering And Science (IJES)
|| Volume || 5 || Issue || 3 || Pages || PP -05-15 || 2016 ||
ISSN (e): 2319 – 1813 ISSN (p): 2319 – 1805

Antioxidant Properties and Proximate Composition of *Blighia Sapida*k.D Koenig (Aril) In Rainforest and Savanna Zones of South-West, Nigeria.

Olawale, A. E., Adeduntan, S. A., Oyerinde, O. V. And Adeniyi, M. M.
Department of Forestry and Wood Technology, Federal University of Technology, P.M.B 704 Akure, Nigeria.

----------ABSTRACT----------
The Study was carried out to determine the proximate composition ofBlighiasapida an indigenous fruit tree, from rainforest and savanna zone of Ondo, Osun and Oyo state, Nigeria were investigated.Ten percent of all the Local Government Areas (LGAs) was selected in each vegetation zones of the each state. Mature fruits were collectedfrom three different trees in the selected LGAs and polled together for chemical analyses. The analyseswere performed for the edible part (aril).Phenol, flavonoid, Vitamin A, VitaminB1, Vitamin C, Vitamin E and 1-1, diphenyl picaryl hydrazine (DPPH) were the anti-oxidants determined while proximate composition (moisture content, ash, crude protein, crude fibre, fat, carbohydrate, pH) and mineral contents (calcium, magnesium, manganese, iron, potassium, sodium, zinc) were also determined using standardized methods. Analysis of Variance (ANOVA) was used to analyze the data generated through the laboratory analyses. The results revealed that B.sapidahasmore concentration of vitamin A (1007.97±3.18) and Dpph (63.81±0.08) in rainforest of Oyo state, and phenol (4.80±0.08) in savanna zone of Oyo state; other anti-oxidants were of low concentration.The result for the proximate composition showed that Blighiasapidaaril is rich in Potassium with Oyo state having the highest value (80.33±12.62), followed by Sodium (67.33±17.80) in Oyo state and Calcium(61.50±19.17)in Oyo state and that it has high moisture content (66.36±3.62) in Oyo state. Its high deterioration is due to its high moisture content. Significant differences were observed for some of the chemical components between savanna and rainforest while some had no significant differences. Blighiasapida contains essential nutrients that are necessary for good functioning of the body.The concentration of anti-oxidants in the species suggests that they can be good sources of natural anti-oxidants, thus they can be used as supplement in food manufacturing. The findings from this study also reveal that B.sapida can be consumed by pregnant women because of its high concentration of minerals. The consumption of B. sapida is not detrimental to health.Since the results of this study has shown the nutritional value of B sapida, this species should be grown in abundance and industrial uses encouraged, in order for a good number of the populace to continue to harness their good nutritional composition.

Keyword*: Blighia sapida, aril, antioxidants, vegetation zones, proximate composition.*

Date of Submission: 05March 2016 Date of Accepted: 21March 2016

I. INTRODUCTION

Worldwide, natural resources are increasingly becoming important in nutrition and commerce because they are sources of protein, dietary energy, anti-oxidant, bio-fuels and raw material for the manufacture of industrial products. A study by Dansi *et al*. (2012) showed that plant species that are cultivated for food are neglected and underutilized while they play a crucial role in the food security, nutrition and income generation of the rural poor. Most of them are collected not only in the wild, but some of them having a market value are also integrated and managed by local communities in various agro-forestry systems (home gardens and compound farms, forest gardens, parklands, trees on farmlands among others) (Atta-Krah *et al*., 2004). Tree domestication in agro-forestry is a farmer-driven and market-led process, which matches the intra-specific diversity of many locally important trees to the needs of subsistence farmers, the markets for a wide range of products and the diversity of agricultural environment. The products of such domesticated trees are called Agro-forestry (Simons and Leakey, 2004).

The nutritive and calorific values of fruit seeds make them good sources of edible oils and fat diet (Odoemelam, 2005). Seed oils have extensive demands both for human consumption and for industrial applications (Kyari, 2008) and also have been rated as the second most valuable commodity in the world trade today (Ige *et al*., 1984). Some of the fruit plants contain substances that could be used for therapeutic purposes or which are precursors for the synthesis of useful drugs (Sofowora, 1982). Unfortunately, these locally important species are often neglected leading to the erosion of their diversity and usefulness, further restricting development options for the rural.

Blighia sapida (ackee) belongs to the family *Sapindaceae*. It is commonly known as Ackee. In Nigeria,the Yoruba calls the plant "*Isin*". It is an ever green tree with a dense crown. *B. sapida* occurs naturally from Senegal to Cameroon and Equatorial Guinea, and possibly also in Gabon. It is commonly planted in its natural area of distribution, as fruit tree and ornamental shade tree. It has been introduced in many other tropical countries and in some subtropical regions such as Florida (United States) and is widely cultivated as fruit and ornamental tree in India and tropical America.

When ripe, Ackee fruit splits to expose a fleshly cream coloured pulp (aril) attached to a shiny black oblong seed (Akintayo *et al*., 2002). Quattara *et al*. (2010) also stated that the nutritional composition of the aril suggest that it could be useful in human diet. The analyses of sun dried aril-oil for iodine value, saponification value, acid value, peroxide value show that this oil could be used in human diet and as raw material. Omobuwajo *et al*. (2000) noted that the arils may be eaten fresh as a vegetable, roasted and eaten as such or used in soups as a meat substitute. Arbonnier (2002) has also reported that the aril is being eaten raw, made into sauce or fried in oil. Economically, preliminary analyses of the seed oil found in the aril (Oladeji, 1993; Olapade, 1997) highlight the potential application in the paint industry.

B. sapida is useful in African traditional medicine. The bark pulp is used as a liniment for oedema intercostals pains in Ivory Coast. The pulp and leafy types are used as eye drops in ophthalmic and conjunctivitis (Irvin, 1965). The main objective of the study is to investigate the variations that exist in antioxidant properties of *Blighia sapida* of rainforest and savanna zone of Ondo, Osun and Oyo State. The antioxidants to be determined are: Vitamin, A, B, C and E, DPPH(free radicals), Phenol and Flavonoidwhile proximate compositionto be determined are (moisture content, ash, crude protein, crude fibre, fat, carbohydrate, pH) and mineral contents (calcium, magnesium, manganese, iron, potassium, sodium, zinc).

II. MATERIALS AND METHOD

Method of Data Collection

Sampling technique

A multistage sampling technique was used for this study.Two ecological zones (rainforest and savanna) were selected from Ondo, Oyo, and Osun state. Of the 18 LGAs in Ondo State, four were in the savanna and ten in the rainforest. In Oyo state which has a total of 33 LGAs, 24 were in the savanna and 9 in the rainforest while in Osun state which has a total of 30 LGAs, 18 were in the savanna and 12 in the rainforest. For this study, ten percent of the LGAs in each vegetation zone were randomly selected. For vegetation zones where the percentage of the local government was not up to one (1), one local government was picked. Fruits of *B. sapida* were collected from three different trees in each local government and polled together for chemical analyses.

Data collection

The chemical analyses was carried out at the Biochemistry post graduate laboratory, Federal University of Technology, Akure to assess the phenol, flavonoid, vitamins, DPPH (1,1-diphenyl-2 picryphydrazyl) content of *Blighia sapida* using standardized methods. All analyses were carried out in three replicates.

Determination of the Antioxidants

Determination of total phenol

The total phenol content of the extract was determined by using the method of Singleton *et. al*. (1999). About 0.2ml of the extract was mixed with 2.5ml of 10% Folinciocalteau's reagent and 2ml of 7.5% Sodium carbonate. The reaction mixture was subsequently incubated at 45℃ for 40mins, and the absorbance was measure at 700nm in the spectrophotometer, garlic acid would be used as standard phenol.

Determination of total flavonoid

The total flavonoid content of the extract was determined using a colorimeter assay developed by (Bao, *etal*., 2005). 0.2ml of the extract was added to 0.3ml of 5% $NaNO_3$ at zero time. After 5min, 0.6ml of 10% $AlCl_3$ was added and after 6min, 2ml of 1M of NaOH was added to the mixture followed by the addition of 2.1ml of distilled water. Absorbance was read at 510nm against the reagent blank and flavonoid content was expressed in milligramme.

Determination of free radical scavenging ability

The free radical scavenging ability of the extract against DPPH (1, 1- diphenyl-2-picryhydrazyl) using (Gyamfi *et. al*., 1999) method. About 1ml of the extract was mixed with 1ml of the 0.4mm methanolic solution of the DPPH the mixture was left in the dark for 30min before measuring the absorbance at 516nm.

Determination of Vitamin A

A weighed quantity sample that contained not more than 1g of fat and at least 240 unit of vitamin A was mixed with 30ml of absolute alcohol and 3ml of 5% potassium hydroxide and gently boiled under reflux for 30min in a stream of oxygen free nitrogen. Cooled rapidly, 30ml of water was added, transferred to separator, washed with 3 x 50ml ether and the vitamin A was extracted by shaking it for 1min. After the complete separation, the lower layer was discarded and washed the extract with 4 x 50ml of water and then mixed, especially and cautiously during the first two washes to avoid emulsion formation. The washed extract was evaporated to about 5ml and the remaining ether in a stream of nitrogen at room temperature was removed. The residue in sufficient isopropyl alcohol was dissolved to give a solution on containing 9-15 units per ml and measured the extinctions at 300,310,325 and 334nm and the wavelength of maximum absorption (Pearson 1975).

Determination of vitamin B_1 (Thiamin)

About 5g of the sample was homogenized with 50ml ethanoic sodium hydroxide. It was filtered into a 100ml conical flask, 10ml of the filtrate was pipette and the colour was develop by addition of 10ml of potassium dichromate and read the absorbance at 360nm. A blank solution is also prepared (Okwu and Josiah 2006).

Determination of Vitamin C

The vitamin C content was determined using the ascorbic acid as the reference compound. About 200ml of the extract was pipette and mixed with 300ml of 13.3% of TCA and 75microliter of DNPH . The mixture was incubated at 37℃ for 3hrs and 500ml of H_2SO4 was added and the absorbance was read at 520nm (Benderitter *et. al.,* 1998).

Determination of Vitamin E

A suitable weight of sample 1.0g was placed in 100ml flask fitted with a reflux condenser, and then 10ml of absolute alcohol and 20ml of 1M alcoholic sulphuric acid (H_2SO_4)was added. It was refluxed for 45mins and cooled. 50ml of water was added; transferred it to a separating funnel of low actinic glass with the addition of a further 50ml of water. The unsaponifiable matter with 5x30ml diethyl ether was extracted; the combined ether extract was washed free from acid and dried over anhydrous sodium sulphate. The extract was evaporated at low temperature, protected from sunlight then dissolved the residue in 10ml absolute alcohol, then both the standard and the sample were transferred to a 20ml volumetric flask and added 5ml of absolute alcohol followed by 1ml conc. nitric acid. The volumetric flask was placed on a water bath at 90^0C for 3min, cooled under running water and make up the volume to 20ml with absolute alcohol. The absorbance was measured at 470nm against blank containing absolute alcohol. (Pearson 1975)

Determination of proximate Composition

Moisture Content Determination

The moisture content of the sample was determined using air oven (AOAC, 2000).The petri dishes were washed and dried in air oven. The dishes were then transferred into the desiccator and allowed to cool. The weights of the petri dishes were determined. 3g of sample was weighed in to a dry petri dish and the contents were transferred into an oven maintaining a temperature of 105^0C. The contents were allowed to dry at this temperature for 6hrs. The petri dishes with their content were removed from the oven and placed in the desiccators. After cooling, the weight was recorded, after drying to constant weight. The percentage of moisture was calculated using the following equation:

$$\text{Moisture \%} = \frac{\text{Original sample weight (g)} - \text{Dried sample weight (g)} * 100}{\text{Original sample weight (g)}}$$

Ash Content Determination

Clean crucibles were ignited at350^0C for about 15mins, cooled in a desiccator and weighed. 1g of each sample was transferred into each of the appropriately labeled crucibles and then reweighed. Then, the crucibles with their contents were transferred into the muffle furnace at 550^0C for about 5hours. After complete ashing, the crucibles were allowed to cool in a desiccator and then reweighed. The percentage of ash was then determined.

$$\text{Ash content (\%)} = \frac{\text{Weight of crucible with ash (g)} - \text{Weight of empty crucible (g)} * 100}{\text{Weight of sample (g)}}$$

Crude Protein Determination

Crude protein of the samples was estimated by using Kjeldahl. A sample of 0.5 g and a blank was estimated in the digestion tube. For digestion at high temperature, 10 ml of concentrated sulfuric acid (H_2SO_4) and 1.1 g digestion mixture were added in the tube. Then the digestion tubes were set in digestion chamber fixing at 420^0C for 45 minutes ensuring water supply, easier gas outlets etc. After digestion the tubes were allowed to cool and 5 ml of sodium thio-sulphate ($Na_2S_2O_3$, 33%) and 30 ml sodium hydroxide (NaOH) solution was added in each tube. Then the distilled extraction was collected with 25 ml of Boric acid (4%) and titrated with standard hydrochloric acid (0.2N). The nitrogen values obtained was converted into percentage of crude protein by multiplying with a factor of 6.25 assuming that protein contains 16% nitrogen.

$$\% \text{ Nitrogen} = \frac{\text{Milliequivalent of nitrogen } (0.014) * \text{titre value (ml)} * \text{strenght of HCL} * 100}{\text{Sample weight (g)}}$$

$$\% \text{ Crude protein} = \% \, Nitrogen * 6.25$$

Crude Fat Determination

Crude lipid was determined by extracting a weighed quantity (3 g) of samples with analytical grade acetone in ground joint Soxhlet apparatus. Extraction was allowed to continue by heating in the electric heater at the temperature of 70^0C until clear acetone (without oil) was seen in siphon, which took about 3 hours. Then the round bottom flask of the apparatus was separated and the extract was transferred to a pre-weighed beaker and left for evaporation of acetone. After the evaporation of acetone, only the lipid was left in the beaker which was later calculated in percentage.

$$\%\text{Crude} = \frac{\text{Weight of beaker with lipid} - \text{Weight of empty beaker (g)} * 100}{\text{Weight of sample (g)}}$$

Crude Fibre Determination

A small amount of finely ground sample (2g) was taken into a filter crucible and was inserted into the hot extraction unit (Hot Extractor, Model-1017). Sufficient amount of pre-heated 0.128M H_2SO_4 was added into the reagent heating system and few drops of octanol were added through the valves. The mixture was digested for 30 minutes. Acid was then removed from it by filtering and washing with boiling water. The residue in the flask was boiled with required amount of 0.223M KOH for 30 minutes and then filtered with subsequent washing in boiling water and acetone. The residual content was then dried in an oven at 105°C for a few hours and then ignited in muffle furnace at 550°C for 3 hours. The loss of weight represented the crude fibre. Then percent crude fibre was calculated by the following formula:

$$\text{Crude fibre (\%)} = \frac{\text{Oven dried weight of sample (g)} - \text{Ash weight of sample (g)} * 100}{\text{Weight of sample (g)}}$$

Determination of Carbohydrate

Carbohydrate (CHO), a soluble carbohydrate was calculated by subtracting the sum of the percentage contents of moisture, crude protein, lipid, ash and crude fibre from 100.

CHO % = {100- (moisture + crude protein + crude lipid + ash + crude fibre)}

Determination of pH

This is done by using Jenway electronic pH meter. The meter was first standardized using the pH buffers 4, 7 and 9. It was after standardization and calibration with the buffers that the pH electrode of the meter was lowered into that of the sample solution to take the pH of the samples.

Mineral Content Determination

The ash determined was dissolved in 10% (v/v) HCL and mark in 100ml standard flask with distilled water. The mineral content of the sample were determined using atomic absorption spectrophotometer BUCK 210 model 200 (Oshodi, 1992)

Statistical Analysis

Data obtained from the chemical analyses were analyzed using analysis of variance (ANOVA). Test of significance of the different treatment variables was estimated using a Randomized Complete Block Design (RCBD) with three replicates each for proximate analysis. LSD was used to separate the means. Differences were considered statistically significant at $p \leq 0.05$.

III. RESULTS

Results

Results shown in Table 1forVit.E and Vit.C indicate significant ($p<0.05$) differences between the vegetation zones and also among the states. There are no significant ($p>0.05$)differences between the vegetation zone and among the states for Vit. A. For Vit. B1, there are significant ($p<0.05$)differences between the vegetation zones.

For phenol, there is no significant ($p>0.05$) difference between the vegetation zones while there is significant ($p<0.05$) differences among the states. For flavonoid, there is also no significant ($p>0.05$) differences between the vegetation zones butwith significant ($p<0.05$)difference among the states. On the contrary, there is significant ($p<0.05$)differences between the vegetation zones for Dpph while there is no significant ($p>0.05$)differences among the states.

The results from the antioxidant analysis of *B.sapida*, as presented in Table 2, revealed that Oyo state has the highest content of DPPH (63.81±0.08) and and Vit.A (1007.97±3.18) while flavonoid (2.35±0.80) and phenol (3.97±0.08) are highest in Osun state and lowest (1.36±0.00, 3.39±0.01 respectively) in Ondo state.Vit.B1 (1.17±0.03) and Vit.C (2.60±0,10)are highest in Osun stateand lowest in Ondo state (0.85±0.00, 2.43±0.00) respectively while Ondo state has the highest content of Vit E (0.09±0.04) and its lowest in Osun state.

Table 1: ANOVA table for Antioxidants composition (mg/g) of *Blighiasapida*

ANTIOXIDANTS	SOURCE OF VARIATION	SUM OF SQUARES	Df	MEAN Sq	F value	SIG
DDPH	VEG.ZONE	307.435	1	307.435	13.702	0.001
	STATE	113.131	2	56.565	2.521	0.102
	ERROR	516.045	23	22.437		
FLAVONOID	VEG.ZONE	2.8	1	2.8	3.2	0.087
	STATE	12.567	2	6.283	7.181	0.004
	ERROR	20.126	23	0.875		
PHENOL	VEG.ZONE	0.032	1	0.032	0.153	0.699
	STATE	4.9	2	2.45	11.887	0
	ERROR	4.741	23	0.206		
VIT. A	VEG.ZONE	40.8	1	40.8	0.001	0.975
	STATE	86207.89	2	43103.95	1.063	0.362
	ERROR	932673	23	40551		
VIT.B1	VEG.ZONE	0.233	1	0.233	10.942	0.003
	STATE	0.69	2	0.034	1.61	0.222
	ERROR	0.491	23	0.021		
VIT.C	VEG.ZONE	1.196	1	1.96	14.084	0.001
	STATE	0.984	2	0.492	5.790	0.009
	ERROR	446199.7	23	19399.99		
VIT.E	VEG.ZONE	0.459	1	0.459	35.531	0
	STATE	0.2	2	0.1	7.715	0.003
	ERROR	0.297	23	0.013		

Table 2: Result of Duncan Multiple Range test of Anti-oxidant properties of *Blighia sapida* Aril across the States.

PARAMETERS	ONDO	OSUN	OYO
DPPH(%)	60.89±0.03[a]	61.77±5.43[b]	63.81±0.08[ab]
FLAVONOID(mg/g)	1.36±0.00[a]	2.35±0.80[b]	1.49±0.00[c]
PHENOL(mg/g)	3.39±0.01[a]	3.97±0.08[a]	3.64±0.01[b]
VITAMIN A(mg/g)	716.06±2.03[a]	947.63±36.39[a]	1007.97±3.18[a]
VITAMIN B1(mg/g)	0.85±0.00[a]	1.17±0.03[a]	0.99±0.00[a]
VITAMIN C(mg/g)	2.43±0.00[a]	2.60±0.10[a]	2.47±0.01[a]
VITAMIN E(mg/g)	0.43±0.00[ab]	0.09±0.04[a]	0.24±0.00[b]

Each value is a mean of three replicates ± sd. Means within the same column followed by the same letter are not significantly(p≥0.05) different

The result for proximate composition as presented in Table 3 shows that for Zinc, pH, Potassium, Iron, Fat, carbohydrate, there is significant (P ≤ 0.05) difference among the state while there are no significant (P≥ 0.05) differences between the vegetation zones. For Sodium, Ash and Calcium there are no significant(P≥ 0.05)differences among states while there is significant(P≤ 0.05) difference between the vegetation zones. For moisture, Manganese, Magnesium and crude protein, there are significant (P≤ 0.05) differences among the states and the vegetation zones while for crude fibre there are no significant (P≥0.05) differences among the states and the vegetation zones. The result of Duncan multiple range test of proximate composition of*Blighiasapida*aril from of Ondo, Osun and Oyo state are summarized in table 4. These results revealed that moisture content is significantly higher(66.36±3.62) in Oyo state and is significantly lower (54.20±7.51)in Osun state. However, Ondo and Oyo are not significantly different from each other.Fat content is significantly higher(23.92±4.35) in Osun andsignificantly(P≤ 0.05) lower(17.71±3.62) in Oyo state but there is no significant difference between Ondo and Osun state. Crude protein in Ondo state is significantly higher (8.64±0.86) and significantly (P≤ 0.05) lower (6.65±2.18) in Oyo state while the value for carbohydrate is significantly(P≤ 0.05) higher(10.11±3.08) in Osun state and significantly(P≤ 0.05) lower(4.14±2.16) in Ondo state, however there is significant (P≤ 0.05) difference across the three states. Crude fibre for Oyo state is significantly (P≤ 0.05) higher (0.95±0.17) and significantly lower(0.79±0.25) in Osun state but there is no significant (P≥ 0.05) difference across the three states while Ash is significantly(P≤ 0.05) higher(1.30±0.21)in Ondo and significantly (P≤ 0.05) lower(1.22±0.23) in Oyo meanwhile there is no significant difference across the states..

pH is significantly higher (4.37±0.05) in Oyo and significantly (P≤ 0.05) lower (4.23±0.05) in Osun while Zn is significantly (P≤ 0.05) higher (0.45±0.34) Oyo and significantly (P≤ 0.05) lower (0.13±0.08) in Osun. Na is significantly (P≤ 0.05) higher (67.33±17.80) in Oyo state and lower (67.00±1.11) in Ondo state while Mn is also significantly (P≤ 0.05) higher (0.15±0.06) in Oyo state and significantly (P≤ 0.05) lower (0.02±0.01a) in Ondo state. Mg is significantly (P≤ 0.05) higher (29.11±12.33) in Osun state and significantly (P≤ 0.05) lower (17.91±1.32) in Ondo state while K is significantly (P≤ 0.05) higher (80.33±12.62) in Oyo state and significantly (P≤ 0.05) lower (56.50±1.64) in Ondo state. Fe is significantly higher (0.88±0.16) in Ondo state and significantly lower (0.45±0.33) in Oyo state while Ca is significantly (P≤ 0.05) higher (61.50±19.17) in Ondo state and significantly (P≤ 0.05) lower (60.00±26.23) in Osun state.

Table 3: ANOVA table for proximate composition of *Blighiasapida*Aril (%)

PROXIMATE	**SOURCE OF VARIATION**	**SUM OF SQUARES**	**Df**	**MEAN Sq**	**F**	**SIG**
Moisture	STATE	404.284	2	202.142	30.08	0
	VEG.ZONE	130.264	1	130.264	8.429	0.01
	ERROR	355.442	23	15.454		
	TOTAL	102901.664	27			
Fat	STATE	169.396	2	84.698	6.736	0.01
	VEG.ZONE	42.778	1	42.778	3.402	0.08
	ERROR	289.208	23	12.574		
	TOTAL	12913.527	27			
Crude protein	STATE	12.493	2	6.247	4.566	0.02
	VEG.ZONE	49.559	1	49.551	36.219	0

	ERROR	31.467	23	1.368		
	TOTAL	1502.848	27			
Carbohydrate	STATE	149.507	2	74.753	11.845	0
	VEG.ZONE	1.881	1	1.881	0.298	0.59
	ERROR	145.148	23	6.311		
	TOTAL	1931.260	27			
Crude fibre	STATE	0.149	2	0.075	1.615	0.22
	VEG.ZONE	0.001	1	0.001	0.16	0.9
	ERROR	1.069	23	0.046		
	TOTAL	21.944	27			
Ash	STATE	0.092	2	0.046	1.479	0.25
	VEG.ZONE	0.683	1	0.683	21.843	0
	ERROR	0.719	23	0.031		
	TOTAL	44.500	27			
pH	STATE	0.115	2	0.058	25.791	0
	VEG.ZONE	0.006	1	0.006	2.757	0.11
	ERROR	0.051	23	0.002		
	TOTAL	499.410	27			
Zinc	STATE	0.462	2	0.231	5.887	0.01
	VEG.ZONE	0.097	1	0.097	2.478	0.13
	ERROR	0.903	23	0.39		
	TOTAL	3.335	27			
Sodium	STATE	252.312	2	126.156	2.315	0.12
	VEG.ZONE	3554.462	1	3554.462	65.217	0
	ERROR	1253.538	23	54.502		
	TOTAL	131469.000	27			
Manganese	STATE	0.085	2	0.043	10.997	0
	VEG.ZONE	0.062	1	0.062	16.047	0
	ERROR	0.089	23	0.004		
	TOTAL	0.484	27			
Magnesium	STATE	639.487	2	319.743	6.262	0.01
	VEG.ZONE	1055.254	1	1055.254	20.666	0
	ERROR	1174.418	23	51.062		
	TOTAL	21426.777	27			
Potassium	STATE	2940.265	2	1470.133	16.023	0
	VEG.ZONE	47.115	1	47.115	0.513	0.48
	ERROR	210.385	23	91.756		
	TOTAL	119760.000	27			
Iron	STATE	0.721	2	0.361	3.748	0.04
	VEG.ZONE	0.013	1	0.013	0.139	0.71
	ERROR	2.212	23	0.096		
	TOTAL	11.914	27			
Calcium	STATE	82.696	2	41.348	0.707	0.5
	VEG.ZONE	12452.35	1	12452.35	212.92	0
	ERROR	1345.154	23	58.485		
	Total	107880.000	27			

Table 4: Result of Duncan Multiple Range test of proximate composition of *Blighia sapida* Aril (%) across the States.

PARAMETERS	ONDO	OSUN	OYO
Moisture	63.15±0.86b	56.96±5.86a	66.36±3.62b
Fat	21.97±2.61b	23.92±4.35b	17.71±3.35a
Crude protein	8.64±0.86b	6.93±1.89a	6.65±2.18a
Carbohydrate	4.14±2.16a	10.11±3.08c	7.12±1.55b
Crude fibre	0.93±0.15a	0.79±0.25a	0.95±0.17a
Ash	1.30±0.21a	1.28±0.26a	1.22±0.23a
pH	4.35±0.55a	4.23±0.05b	4.37±0.05b
Zinc	0.23±0.02a	0.13±0.08a	0.45±0.34b
Sodium	67.00±1.11a	67.17±14.36a	67.33±17.80a
Manganese	0.02±0.01a	0.10±0.10b	0.15±0.06b
Magnesium	17.91±1.32a	29.11±12.33b	28.09±8.29b
Potassium	56.50±1.64a	58.00±8.89a	80.33±12.62b
Iron	0.88±0.16b	0.52±0.33a	0.45±0.33a
Calcium	61.50±19.17a	60.00±26.23a	60.67±23.44a

Each value is a mean of three replicates ± sd. Means within the same column followed by the same letter are not significantly (p≥0.05)different

IV. DISCUSSION

Antioxidants

Anti-oxidants are essential for human health. During normal metabolism, the oxidants and antioxidants are maintained in equilibrium. It has been noted that supplementing natural anti-oxidants with a balanced diet containing enough anti-oxidants could be most effective in protecting against various oxidative stressors (Cao *et al*., 1996). In recent times, natural antioxidants have raised considerable interest among nutritionists, food manufacturers and consumers because of their presumed safety and potential therapeutic value.

Vitamins

This study revealed that the Vitamin A level of *Blighiasapida* for all study area is the highest which implies that it is a good source of Vitamin A for bright eyes. The value obtained for Vitamin B1 in this study is higher than the value obtained by Akintayo *et al.* (2002) which is 0.1mg. This help to support adrenal function. Vitamin B1 has its highest value in the rainforest zone of the three states due to it is a water soluble mineral. Akintayo *et al.* (2002) noted that *B.sapida* had 65mg content of Vitamin C which is higher than the result obtained. The values obtained in this study are higher than the values of fruit pulp of *Chrysophyllumalbidum* and *Garcinakola* which are 0.50% and 1.25% respectively (Onyekwelu *et al.*2014). This result justifies why consumption of *B. sapida* has the potential to preventing scurvy.

DPPH (1, 1- diphenyl-2 picrylhydrazyl)

DPPH values are high in all the states but higher in rainforest zones than savanna zones. The values obtained in this study are higher than the values of fruit pulp of *Chrysophyllumalbidum* and *Garcinakola* which are 50.4% and 26.8% respectively (Onyekwelu *et. al*,2014). Thus, the DPPH content can be extracted and used as food supplement.

Flavonoid

Sofidiya *et al.* (2012) analysed the stem, leaves and bark of *Blighiasapida* to be Total flavonoid (8.876±0.06) which is very high than the value obtained from its aril. They serve as flavoring ingredient of spices and vegetables which enable *B.sapida* to be used as food (for instance as Jamaica food).

Phenol

Sofidiya *et.al*. (2012) analysed the stem, leaves and bark of *B.sapida* to be Total polyphenol (10.47±2.82) which is higher than the value of its aril. Also, Onyekwelu *et al.* (2014) noted that the phenol value of fruit pulp of

Chrysophyllumalbidum and *Garcinakola* are 10.77% and 9.94% respectively which are higher than the obtained value of this study. They function as free radical terminator and efficient in preventing auto –oxidation.

Proximate composition

Blighiasapida is rich in Na, Moisture, K, Ca and averagely Fat. Comparing the proximate composition of the states, their values differ from one another. According to Akintayo *et. al.* (2002), the composition of 100g of raw aril is approximately: moisture 58g, protein 9g, fat 19g, carbohydrate 10g, fibre 3.5g, Ca 83mg, Fe 5.5mg. These values are closer to the result obtained in this study depending on thelocation.

Ash content

Ash content is useful in assessing the quality grading of fruit and also gives anidea of the amount of mineral element present in the fruit (Smart, 1996). The Ash content reported in this study varies from 1.81% to 1.22% across the study area. The result shows that the ash content reported in the study is lower than that reported by Quattara et al., (2010), who also reported 4.90% in sun dried aril of *B. sapida*.

Crude protein

The values of protein in the States have close value to the protein value (9%) of *B. sapida*reported by Akintayo *et. al*(2002). Theresults therefore suggest that the protein content of these fruits can make significant contribution to dietary intake especially when domesticated food is in short supply.

Fat

The values (21.97%, 23.92%) obtained in Ondo and Osun respectively are higher compared to 19g of *Blighiasapida* (Akintayo *et. al*., 2002) and approximately 9% for seed fat except for Oyo which is approximately 18%. This shows that *Blighiasapida*aril can serve as a fat supplement in food diet.

Crude fibre

The fibre content of aril is lowercompared to the values obtained by Akintayo *et. al*. (2002) which may be due to location of samples obtained. This fibre content is lower in aril than that recommended (1.4% to 3.5%) by the Dietary Guideline for American (2005). Fibre is known to make digestion easier and to reduce the serum total cholesterol and LDL-cholesterol level. Then, fibre reduces the risk of cardiovascular diseases (Liu *et al.*, 1999).

Carbohydrate

Across the states, the carbohydrate content is similar to the carbohydrate value noted by Akintayo *et. al*., (2002). However, Quattara *et. al*. (2010) noted that sun dried *Blighiasapida* contains a high quantity of carbohydrate (24.43± 2.24) which is higher compared to the one obtained in this study for the aril.It is known that carbohydrate and fat are the main source of energy in the organism (Legrand *etal*., 2001; Remesy, 2004). This quantity of carbohydrate can therefore justify the use of aril as base food when there is famine or shortage of food.

Moisture

The result revealed that there is high content of moisture recorded for aril but there is significant difference between the moisture content of the ecological zones, this is due to the varying sizes of the aril across the ecological zones.The values obtained are higher than the value obtained from insects which ranges from 7% to 36% as reported by (Adeduntan, 2005). This result suggest that it cannot be stored for a long time without spoilage since higher water content can enhance microbial action thereby causing food spoilage.

pH

Generally, fruits with moderate sourness are preferred. However, the pH of *B. sapida* aril is high (4.37). Nevertheless, consumption of the ripe aril has no side effect when taken directly or cooked with soup.

Minerals

The result showed that *B. sapida*aril is very rich in Sodium, Calcium, Potassium and averagely in Magnesium. The Calcium content across the states ranges from 43% to 61% which is far higher than the calcium content of *Pleurotus sajor cajor, Auricularia judae, Xylaria hypoxylon* whichis 0.29%, 0.28%, and 0.27% consecutively as noted by Adeduntan (2014).Calcium can be used to enhance healthy and strong bone formation in man and animal. Magnesium from this study is far higher than the magnesium content of *Xylaria polymorpha, Pleurotus sajor cajor* and *Trametes vesicolor* is 0.515, 0.468 and 0.447 as reported by Adeduntan (2014). Magnesium is an important mineral in connection with circulatory disease such as heart diseases and calcium metabolism in bone (Zock and Katan, 1992).

The dietary allowance for sodium is 110 mg/100g – 3300 mg/100g for adults, (National Research Council, 1989). The Na values obtained from the samples analyzed are high and can be serving as dietary supplement for Na.

Zinc is known to play a role in gene expression, regulation of cellular growth and participants as co-factor enzymes responsible for carbohydrate protein and nucleic acid, metabolism (Adeboye *etal*., 2004). According to FAO/WHO (2003) standard of zinc 100mg, the samples have low values of zinc (0.14% to 0.25%).

The samples are very low in Fe when compared with Recommended Daily Allowance (RDA) for iron (10 mg to 15 mg) while Mn is very low in *B. sapida.*

IV. CONCLUSION

Blighiasapida contains essential nutrients that are necessary for good functioning of the body.The concentration of anti-oxidants in the species suggests that they can be good sources of natural anti-oxidants, thus they can be used as supplement in food manufacturing.

Vitamin A is the highest concentration of *B. sapida* which is capable of aiding bright eyes.The proximate composition in the species suggests that they can be used as food supplement.Since *B.sapida* is so rich in minerals such as Ca, Mg, Na, K, and then it can also be used by pregnant women together with other fruits that are rich in nutrients lacked by *B.sapida*.

The species could be grown in abundance and its industrial uses should be encouraged thereby harnessing their good nutritional composition. There is need to create more awareness on *B.sapida* because it is not widely known unlike other fruits such as *Garciniakola*,*Chrysophyllumalbidum*among other non-timber forest products. Efforts should also be made towards the domestication of *B.sapida* as its samples are difficult to obtain from the wild. Domestication will also prevent the plant from going to extinction as the timber is currently harvested for its high density wood.

REFERENCES

[1] Adeboye, G.B., Ameen, O.M., and Abass, L.T., (2004)Physico chemical properties of biodiesel produced from *Jatrophacurcas* oil and fossil diesel. *Journal of Microbiology & Biotechnology Resources, 1, 12-16.*

[2] Adeduntan, S. A.(2005) Nutritional And Anti-nutritional Characteristics Of Some Insects Foraging In Akure Forest Reserve Ondo State, Nigeria. *Journal of Food Technology*. 3(4) 563-567.

[3] Adeduntan, S. A. (2014) Nutritional and Anti-nutritional Characteristics of Some Dominant FungiSpecies in South Western Nigeria. *The International Journal of Engineering and Science*(IJES). 3(6):2319 – 1805.

[4] Akintayo ET, Adebayo EA, Arogunde, 2002. Assessment of dietary exposure to the naturaltoxinhypoglicin in ackee (*Blighiasapida*) by Jamaican. Food Research International 37:833-838.AOAC. 2000. Official methods of Analysis. 17th end.Association of Official Analysis Chemists,Washington DC.2200 pp.

[5] Arbonnier M, (2002). Arbres, arbustes et lianes des zones sèches d'Afrique de l'Ouest, Edition 2, CIRAD-MNHN 173-179.

[6] Atta-Krah K., Kindi R., Skilton J.N. and Amaral W. 2004.Managing biological and genetic diversity in tropical agro-forestry. Agroforestry system 61:183-194

[7] Bao J. Y., Cai M., Sun G., Wang and H. Corke, (2005). Anthocyanins, Flavonoid and Free Radical Scavenging Activity of thinesBaybery (Myrialrubia) extracts and their colour properties and stability. Journal of Agric Food Chem. 53: 2327-2332.

[8] Benderitter M., Maupoli V., Vergely C., Dalloz, F., Briot and Rochette L (1998). Studies by electron paramagnetic resonance of the important of iron in hydroxyl scavengingproperties of ascorbic acid in plasma: effects of iron chelators. Fundamental and clinical pharmacology; 12:

[9] Cao, G., E. Sofic, and R. L. Prior (1996). Antioxidant capacity of tea and common vegetables. J. Agr. Food Chem. 44: 3426-3431.

[10] Dansi, A., Voduhe, R., Yedomonhan, H., Assogba, P., Adjatin, A., Loko, Y.L., Dossou- Aminon, I., and Akpagana, K., (2012): The scientific world journal; Diversity of the Neglected and underutilized crop species of importance in Benin;*pg19*

[11] Dietary Guidelines for Americans, 2005, U.S. Department of Health and Human Services.U.S. Department of Agriculture.www.healthierus.gov/dietaryguidelines. 27/06/2015.

[12] FAO|WHO, 2003, Protein and amino acid requirement in human nutrition, WHO press. pp. 100-106.

[13] Gyamfi, M.A. ,Yonamine, M. and Aaniya, Y., (1999): Free radical scavenging action of medicinal herbs from Ghana: thonningia sanguine on experimentally induced liver injuries. General Pharmacology., 32: 661 – 667.

[14] Ige, M.M., A.O. Ogunsua and O.L. Oke, 1984. Functional properties of the proteins of some Nigeria oil seeds conophor seeds and three varieties of melon seeds. J. Agric. Food Chem., 32:822-825.

[15] Irvin, F.R., 1965. Botany and medicine in West Africa. Ibadan University Press. Ibadan, pp: 102-130.

[16] Kyari, M.Z., 2008. Extraction and characterization of seed oils. Int. Agrophys., 22: 139-142.L. Popoola, Prevalence of, and Conservation Strategies for Non-timber forest Products in the Sudano-Sahelianzone of Nigeria. Nigerian Journal of Ecology.Vol. 4 (1), 2002 Pp.24 –33.

[17] Legrand P, Bourre JM, Descomps B, Durand G, Renaud S, 2001. Lipides.In : Martin A. (ed)Apportsnutritionnelsconseillés pour la population française. 3eme ed. Editions, Tee &Doc, Paris. 63- 82.

[18] Liu S., Stampfer MJ, Hu FB, Giovannucci E, Rimm E, Manson JE, Hennekens CH, Willet WC, (1999). Whole-grain consumption and risk of coronary disease: results from the nurse's health study. American Journal of Clinical Nutrition 72: 922- 928.

[19] National Research Council, (1989) Recommended daily dietary allowance. Nutrition Review, 31, 373- 395.

[20] Odoemelam, S.A., 2005. Proximate composition and selected physicochemical properties of the seeds of African oil bean (Pentacle thramarcrophylla). Pak. J. Nutr., 4:382-383.

[21] Okwu D.E. and Josiah C. (2006).Evaluation of the chemical composition of two Nigerian medicinal plants.African journal of biotechnology vol. 5(4), pp 357-351.

[22] Oladeji, O.O. (1993). Proximate analysis of the aurilli of ackee apple (*Blighiasapida*,Koenig) and characterization of its oil.B.Sc. Thesis, University of Ibadan, Ibadan, Nigeria.
[23] Olapade,O. (1997). Characterization of oil in the aurilli of ackeeapple (*Blighiasapida*, Koenig). B.Sc. Thesis, LadokeAkintola University of Technology, Ogbomosho, Nigeria.
[24] Omobuwajo et al (2000). Topic: *Research journal of food engeering 45(2000):43-48.*
[25] Onyekwelu J. C., Oyewale F., Stimm B., Mosandl R. (2014). Antioxidant, nutritional and anti-nutrional compositions of *Garcinia Kola* and *Chrysophyllum albidum* from rainforest ecosystem of Ondo state Nigeria. Accepted by Journal of Forestry Research.
[26] Oshodi, A.A, (1992). Proximate composition, nutritionally valuable minerals and functional properties of Adenopusbreviflorusbenth seed flour and protein concentrate. Food chem., 45: 79-83.
[27] Person D. (1975) Chemical Analysis of food, 7thedn. Churchill ligstone, London pp 419-620
[28] Quattara Howale, Niamke Bobele, Dally Theodor and Kati-coulibaly Seraphin (2010); Nutritional Composition Studies of Sun Dried Blighia sapida (K. Koening) Aril from cot d'ivoire; Research Journal of Applied Biosciences 32:1989-1994.
[29] Rémésy C, (2004). Les bonnes calories.Domonos, Flammarion. 127pp.
[30] Simons AJ, Leakey RRB: Tree domestication in tropical agroforestry. Agroforestry Systems 2004, 61-62:167-181.
[31] Singleton V. L., Orthofer R., Lamuela-Raventos R. M. (1999).Analysis of total phenols and other oxidation substrates and antioxidants by means of Folin-Cioalteau Reagents.Meyhods in Enzymol. 299: 152-178.
[32] Smart, J., 1996, Canavaliagladiata (Jacq.) D.C. (Sword bean).Tropical Pulses. Longman Group Ltd, London, p 58.
[33] Sofidiya O.M., Jimoh O. F., Aliero A. A., Afolayan J. A., Odukoya O. A., Familoni O. B. (2011). Evaluation of antioxidant and antibacterial properties of six Sapindaceae members. Journal of Medicinal Plants Research Vol. 6(1), pp. 154-160,
[34] Sofowora, A., 1982. Medicinal plants and traditional medicine in Africa. John Wiley & Sons Ltd., pp: 1-10.
[35] Zock, P.L., and Katan, M.B., 1992, Hydrogenation alternatives: effects of trans-fatty acids and stearic acid versus linoleic acid on serum lipids and lipoprotein in humans. Journal of Lipids Research, 33, 399-410.