https://doi.org/10.31871/WJIR.12.4.10
World Journal of Innovative Research (WJIR)
ISSN: 2454-8236, Volume-12, Issue-4, April 2022 Pages 19-23

Proximate, Nutritional and Phytochemical Analysis of Treculia africana (African Breadfruit) Decne in South-South, Nigeria

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***Abstract*— Treculia africana Decne (African bread fruit) is produced by Treculia, a wild tropical evergreen tree and has immense potential as a nutritional source for man. In this research Treculia africana was collected from Angalabri and Ebedebiri Communities in Sagbama Local Government Area of Bayelsa State, Nigeria and the proximate and bioactive compounds in the seeds and flesh of Treculia africana were investigated. Proximate analysis of the seeds of showed 75.07 % moisture, 1.46 % ash, 4.98 % protein, 5.01 % fat, 12.4 % fibre and 1.08 % carbohydrate whereas the flesh contained 85.77 % moisture, 8.68 % ash, 2.14 % protein, 20.0 % , 4.66 % fibre and 1.75 % carbohydrate. Mineral elements concentrations of K, Fe, Mn, Ca and P were 5174.16 ppm (0.05 %), 10.11 ppm (0.001 %), 1.12 ppm (0.0001 %), 245.51 ppm (0.02 %) and 2117.98 ppm (0.21 %) respectively for the seed and 5703.49 ppm (0.57 %), 8.72 ppm (0.0009 %), 2.91 ppm (0.0003 %), 502.33 ppm (0.05 %) and 1994.65 ppm (0.20 %) respectively for the flesh. Gas chromatography-mass spectrometry (GC-MS) analysis of methanolic extract of the African bread fruit seeds and flesh showed nine bioactive compounds in the seeds and fifteen in the flesh of Treculia african.**

***Index Terms*— Treculia africana , proximate, mineral, bioactive compounds.**

I. INTRODUCTION

A number of tropical plants within the rain forest and semi-arid zones of Nigeria bear fruits, some of which are edible, but with seeds which are largely discarded. Recent studies have shown that some of these plants could find application as food or as precursor for the preparation of other materials [1]. A huge segment of the population in many developing countries suffers from malnutrition, for want of protein of adequate quantity and quality in their diets. The bottom line of nutritional health suggests that there are no nutrients in animal-based foods that are not better obtained in plant foods.

In Nigeria, grains and tubers are the major staple foods. Crops are, however, relatively low in lysine and total protein content [2]. Nutrients are in essence, the proteins, fats and carbohydrates consumed and the vitamins and minerals naturally present in crops [3]. Plant based foods contain more protein than animal-based sources.

They are made up of many complex carbohydrates which are necessary for good health. Plant foods provide the only means of consuming dietary fibre. It also contains unsaturated healthy fats and serve as one of the major sources of antioxidants [4]. Moreover, legumes such as cowpea and groundnut are widely consumed to complement the low protein contents of the grains and tubers.

In the tropics, legumes are the second most important food crops after cereals and are excellent sources of cheap plant proteins and minerals when compared with animal products. Indigenous legumes are an important source of affordable alternative protein to poor resource people in many developing countries most especially in Africa and Asia where the grains constitute part of the daily staple food. Legumes have a special place in the diet of humans, because they contain nearly 2–3 times more proteins than cereals depending on the type [5]. Legumes are also excellent sources of complex carbohydrates which have been reported as beneficial for the prevention and management of cardiovascular diseases and diabetes. They also serve as a large reservoir of bioactives, most especially the phenolics [6]. These bioactives have been positively utilized in the treatment and management of degenerative diseases [7], [8]. Furthermore, they are also good sources of

vitamins (thiamine, riboflavin, niacin, vitamin pyridoxine and folic acid), minerals (calcium, iron, copper, zinc, phosphorus, potassium and magnesium) and are excellent sources of PUFA (linoleic and linolenic acids) [9] - [11]. Therefore, thousands of the lesser-known plant materials might substantially add to the array of available nutrients most especially the protein they will need. These lesser-known legumes are well adapted to extreme environmental conditions and highly resistant to drought, diseases and pest infestation.

Treculia africana Decne commonly known as African breadfruit; wild jack fruit, or African boxwood is a neglected and underexploited tropical tree crop native to many tropical countries like Ghana, Sierra Leone, Nigeria and the West Indies. The tree remains ever green in both rainy and dry seasons producing fruits that have immense potential as a nutritional source for man and other domestic animals [12]. Africana Dec'ne sp is a forest tree up to 27 m high and it has been established that a fruit may contain about 1,500 seeds. They are aromatic and have a flavor much like groundnuts [13]. A mature African breadfruit tree produces up to 50 fruits annually, each fruit yielding 5–10 kg of seed [14]. The mature seed consists of an outer covering or seed coat and an inner edible endosperm [15]. The seeds are popular traditional food item, commonly roasted, cooked, mashed and consumed either directly as snack food or as flour for use in soup

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thickening, cakes, and bread and for food formulations [16].

[17] analyzed the physicochemical properties of aqueous and ethanolic extracts of African breadfruit flour and reported that the antioxidant activity was higher in the ethanol extracts. A study on the proximate, physical properties and sensory attributes of cakes and biscuits made from African breadfruit composite flour showed that the moisture content of biscuit ranged from 3.00- 6.79 %, fat 21.93 - 27.37 %, protein 5.5 - 7.08 %, carbohydrate 57.68 - 65.24 % while moisture content in cake ranged from 21.97- 22.26 %, fat 18.93 %. All the tested qualities did not significantly ($p \leq 0.05$) affect the acceptability and preference of the prepared snack. In essence, wheat flour could be substituted with African breadfruit and sweet potato flour up to 20 % level in cake making and 30 % in biscuit improved nutritional and sensory properties [18].

A 100 g serving of African breadfruit meal is composed of 10 % fat, primarily unsaturated fat (the good fat), 12 – 15 % protein, 25 % carbohydrates with 2 % fiber and with only about 240 kcal in this serving amount [19]. African breadfruit is rich in Vitamin C which helps in the production of collagen, a protein which provides elasticity to the skin [20]. The water and ethanoic extracts of the root possess antihyperglycaemic properties. [21] reported trace amounts of heavy metals such as lead, chromium, and nickel in the seed at concentrations that poses no toxicological risk upon consumption of the processed seed. The oil extracted from the seed of Treculia africana were characterized and used in the production of biodiesel using a two-step reaction system [22]. [23] investigated the physical and chemical indices of African breadfruit (Treculia Africana) seed oil extracted with polar (isopropanol, Hexane and butanol) and non-polar (Acetone) solvents and reported 452.35 (Kcal) energy content, suggesting that African breadfruit seeds are a high-energy food.

Inspite the fact that numerous uses of Treculia Africana especially those relative to its medicinal and pharmacological functions have been reported, there is still limited information on the proximate analysis and biochemical profiles of the flesh and seeds of Treculia Africana in various parts of the globe.

II. EXPERIMENTALS

Materials

All chemicals used were of analytical grades and obtained from BDH, Labtech chemicals, Ken Light Laboratories, Kermel.

III. SAMPLES COLLECTION

Matured samples of the African bread fruit (Treculia Africana) were collected from a forest in Angalabri and Ebedebiri, in Sagbama Local Government Area, Bayelsa State, Nigeria and properly identified at the Biological Sciences Department of the University of Africa, Toru-Orua. Seeds were manually removed from the fruits and both the seeds and flesh were air dried for six days. The dried samples were grounded into powder and stored in desiccators prior to analysis.

IV. PROXIMATE ANALYSIS

Standard procedures as described by the Association of Official Analytical Chemists (A.O.A.C., 2005) were used in the determination of moisture, Fat, Ash, Crude fibre, Crude Protein and Carbohydrate Content.

V.MINERAL ANALYSIS

Standard procedures as described by the Association of Official Analytical Chemists (A.O.A.C., 2005) were used to determine Manganese (Mn), Iron (Fe), Calcium (Ca), Phosphorus (P) and Potassium (K).

VI. BIOACTIVE CHEMICALS

GC-MS analysis of methanol extract of the flesh and seeds of Treculia africana was performed with GC (Agilent 6890) and MS (5973 MSD) equipped with Restek capillary column (30 m × 0.53mm; film thickness 0.12µm), using Helium as the carrier gas with a flow rate of 1 mL/min.

VII. RESULTS AND DISCUSSION

Results of the various analyses carried out on the flesh and seeds of Treculia africana are presented as follows

Table 1: Result of proximate analysis on the flesh and seeds of *Treculia africana*

Proximate analysis (%)	**Variety / species**	**of the samples**
Moisture	Africa Breadfruit Seeds Africa Breadfruit flesh	75.07 85.77
Ash	Africa Breadfruit Seeds Africa Breadfruit flesh	1.46 3.68
Protein	Africa Breadfruit Seeds Africa Breadfruit flesh	4.98 2.14
Fat	Africa Breadfruit Seeds Africa Breadfruit flesh	5.01 2.00
Fiber	Africa Breadfruit Seeds Africa Breadfruit flesh	12.4 4.66
Carbohydrate	Africa Breadfruit Seeds Africa Breadfruit flesh	1.08 1.75

Table 2: Result of mineral content in the flesh and seeds of *Treculia africana*

Mineral composition (%)	**Variety / Species**	**% of the samples**

Potassium (P)	Africa Breadfruit Seeds Africa Breadfruit flesh	 0.52 0.57
Iron (Fe)	Africa Breadfruit Seeds Africa Breadfruit flesh	 0.001 0.0009
Manganese (Mn)	Africa Breadfruit Seeds Africa Breadfruit flesh	 0.0001 0.0003
Calcium (Ca)	Africa Breadfruit Seeds Africa Breadfruit flesh	 0.02 0.05
Phosphorus (P)	Africa Breadfruit Seeds Africa Breadfruit flesh	 0.21 0.20

Table 3: Result of bioactive components analysis on the seeds of the African breadfruit

S/N	Retention time	Name of Compound	Molecular formula	Molecular weight	Peak area percent
1	1.913	N-(1-Hydroxy-4-oxo-1-phenylperhydroquinolizin-3-yl) carbamic acid, benzyl ester	$C_{23}H_{26}N_2O_4$	606	3.821
2	2.170	(Bicyclopentyliden)-2-ol	$C_{13}H_{24}OSi$	537	4.241
3	3.096	Silane, ethoxytriethyl-	$C_8H_{20}OSi$	593	2.896
4	4.085	Trehalose	$C_{12}H_{22}O_{11}$	593	2.012
5	4.697	Diglycerol	$C_6H_{14}O_5$	735	37.812
6	4.988	α-D-Galactopyranose, 6-O-(trimethylsilyl-, cyclic 1,2:3,4-bis (butylboronate)	$C_{17}H_{34}B_2O_6Si$	606	1.212
7	5.080	Doconexent	$C_{22}H_{32}O_2$	590	1.139
8	12.269	n-Hexadecanoic acid	$C_{16}H_{32}O_2$	780	18.380
9	13.938	Trilinolein	$C_{57}H_{98}O_6$	694	28.487

Table 4 Result of bioactive components analysis on the flesh of the African breadfruit

S/N	Retention time	Name of Compound	Molecular formula	Molecular weight	Peak area percent
1	1.913	Olean-12-ene-3,15,16,21,22,28-hexol, (3β, 15α, 16α, 21β, 22α)-	$C_{30}H_{50}O_6$	664	3.651
2	2.170	Trilinolein	$C_{57}H_{98}O_6$	694	4.052
3	3.096	Hexadecanoic acid, 1a,2,5,5a,6,9,10,10a – octahydroxy -4-(hydroxymethyl)-1,1,7,9-tetramethyl-	$C_{36}H_{58}O_6$	656	2.768
4	4.085	n-Hexadecanoic acid	$C_{16}H_{32}O_2$	780	1.923
5	4.697	(-)-Mellein	$C_{10}H_{10}O_3$	665	36.131
6	4.982	β-Acorenol	$C_{15}H_{26}O$	687	1.158
7	5.040	Andrographolide, tri(trimethylsilyl)-	$C_{29}H_{54}O_5Si_3$	584	0.626
8	5.074	Doconexent	$C_{22}H_{32}O_2$	590	1.088
9	5.142	Acetic acid, 2,2'-[Oxybis(2,1-ethanediyloxy)]bis-	$C_8H_{14}O_7$	577	0.898
10	7.560	α-D-Galactopyranose, 6-O-(trimethylsilyl-, cyclic 1,2:3,4-bis(butylboronate)	$C_{17}H_{34}B_2O_6Si$	606	0.573
11	9.749	Diglycerol	$C_6H_{14}O_5$	735	0.733
12	12.269	Trehalose	$C_{12}H_{22}O_{11}$	593	17.563
13	12.950	Silane, ethoxytriethyl-	$C_8H_{20}OSi$	593	0.572
14	13.938	(Bicyclopentyliden)-2-ol	$C_{13}H_{24}OSi$	537	27.22
15	17.825	N-(1-Hydroxy-4-oxo-1-phenylperhydroquinolizin-3-yl) carbamic acid, benzyl ester	$C_{23}H_{26}N_2O_4$	616	1.044

Table 1 shows the primary metabolites in the flesh and seed of the African Breadfruit. The moisture content of the seed of the African bread fruit (ABF) was 75.07 % while that

of the flesh was 85.77 %. These values were higher than the values reported by [24] – [26] who reported the moisture content of raw African breadfruit seeds as 8.01 %, 8.00 %, and 8.81 % respectively. The differences observed may be due to difference in the species of African breadfruit seed analysed or agro-cultural practices. Moisture content of food is usually a measure of its stability and susceptibility to microbial contamination [27]. The high moisture content in the seed and flesh of the African bread fruit in this study indicates high degree of perishability. The ash contents of the seed and flesh were 1.46 % and 8.68 % indicating that the flesh contains higher organic matter than the seed. The observed value of ash content of the seed of African Breadfruit (ABF) sample was slightly lower compared to the values reported in literature. Nonetheless, the observed value of ash content of the flesh of ABF sample was higher compared to the values reported [24]-[26]. The variations in the ash content could be due to soil conditions at different geographic locations or the variety of ABF used.

The protein content of the seed and flesh of the African bread fruit were 4.98 % and 2.14 % respectively. These values were lower than the value of 12.47 % reported by [24]. The fat content of the seed of the African bread fruit was 5.01 % while that of the flesh was 20 %. This indicates that the flesh contains four times fat content than the seed and thus the flesh is a good source of fat. The observed value of fat content of the seed of ABF sample was similar to the values of 4.23% and 5.27% reported by [24], [26]. The fiber content of the seed of the African bread fruit was 12.4 % while that of the flesh was 4.66 %. The seed contains about three times fiber than the flesh; hence, the seed is a good source of fiber. The values observed were higher than the values, reported by [24] – [26] respectively. The carbohydrate content of the seed and flesh of the African bread fruit were 1.08 % and 1.75 % respectively. Carbohydrate content in the flesh seems to be higher than in the seed. These observed values were lower than the values observed by [24], [26].

Table 2 presents the mineral content of the seed and flesh of ABF. The concentrations of K in the seed and flesh of the African bread fruit were 5174.16 ppm (0.52 %) and 5703.49 ppm (0.57 %) respectively, depicting higher potassium (K) concentration in the leaves than in the seed. These concentrations than the concentration reported by [24]. The concentrations of iron (Fe) in the seed and flesh of the African bread fruit were 10.11 ppm (0.001%) and 8.72 ppm (0.0009 %) respectively.. Higher concentrations were reported in literature [24]. Iron deficiency in the blood can lead to anemia [28]. The concentrations of Mn in the seed and flesh of the African bread fruit were 1.12 ppm (0.0001%) and 2.91 ppm (0.0003 %) respectively. These concentrations were lower compared to report in literature [24]. The concentrations of Ca in the seed and flesh of the African bread fruit were 245.51 ppm (0.02%) and 502.33 ppm (0.05%) respectively. Calcium is a mineral most often associated with healthy bones and teeth, it also plays an important role in blood clotting, helping muscles to contract, and regulating normal heart rhythms and nerve functions. [29].

The concentrations of Ca observed in the seed and flesh of African Breadfruit in this study were higher than the concentration reported by [24]. The amount of P in the seed and flesh of the African bread fruit were 2117.98 ppm (0.21 %) and 1994.65 ppm (0.20 %) respectively. The seed of African bread fruit has higher P concentration than the flesh. Phosphorous is an essential element in the body and is required for ATP synthesis, signal transduction and bone mineralisation [30]. The present study corroborates the fact that ABF contains minerals which are vital for various body functions such as muscle contraction and osmotic regulations.

The identified compounds with their retention time, molecular weight, molecular formula and peak area percentage are given in the Tables 3 and 4. Nine bioactive compounds were obtained for African bread fruit seed extract while fifteen bioactive compounds were obtained for African bread fruit flesh. The maximum peak (37.812) was shown by Diglycerol for African bread fruit seed while the maximum peak (36.131) was shown by (-)-Mellein for African bread fruit flesh. The seeds and flesh could be incorporated into value-added foods and their efficacy can be studied by human supplementation studies.

VIII. CONCLUSION

This research was focused on the proximate, minerals and secondary metabolites in methanol extract of African bread fruit seeds and flesh. Proximate content was high compared to the mineral content in the African bread fruit seeds and flesh but may need to be fortified with Fe and Mn when used in food formulation because of their low inherent levels. Gas chromatography-mass spectrometry (GC-MS) analysis of methanolic extract of the African bread fruit seeds and flesh showed that the African bread fruit seeds contain nine bioactive compounds in the seeds and fifteen in flesh.
Confidently, this research will provide important biochemical information of African bread fruit seeds and flesh collected from Angalabri and Ebedebiri, in Sagbama Local Government Area of Bayelsa State, Nigeria

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