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RESEARCH ARTICLE

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Nutraceutical evaluation of baobab (*Adansonia digitata* L.) seeds and physicochemical properties of its oil

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ABSTRACT

Concerted efforts of converting waste to wealth and the search for alternative protein sources for rural dwellers in sub-saharan African countries is the major focus of this research work. Adansonia digitata L. seeds were subjected to standard chemical analysis to evaluate its nutraceutical properties and the oil extracted from the seeds were also physicochemically characterized. The proximate analysis of the seeds revealed a low moisture content (4.41 ± 0.2%), ash content (7.29 ± 0.08%), crude lipids (20.45 ± 0.05%), crude fibre (12.15 ± 0.05%) and carbo hydrate (25.91 ± 0.54%). The crude protein however dominated the carbohydrates (29.79 ± 0.03%) and true protein (4.59 ± 0.08%). The values of minerals content in mg/g shows Iron (0.004), Magnesium (0.195), Nickel (0.002), Calcium (0.013), Copper (0.033), Zinc (0.003), Cadmium (0.000), Lead (0.000), and Manganese (0.001). The light yellow oil extracted from the seed had the following physicochemical properties: yield (32.0 ± 0.00%), acid value, 2.75 ± 0.14 mg KOH g^{-1}, saponification value 158.62 ± 0.07 mgKOH g^{-1}, unsaponifiable matter 9.46 ±0.25 g kg^{-1} and peroxide value 6.02 ± 0.07 mEq kg^{-1}. The iodine value (54.41 ± 0.94 mg g^{-1}) indicated a preponderance of unsaturated fatty acids. Nevertheless, the antioxidant potential of the oil using 2, 2-diphenyl-1-picrylhdydrazyl (DPPH) was also low compared with standard Vitamin C and Butylated hydroxyl anisole (BHA).

Key Words:- *Adansonia digitata*, Antimycobacterial, Antioxidants, Nutraceutical, Physicochemical, Proximate, Seeds.

INTRODUCTION

Seeds are the reproductive structure in plants that consists of a plant embryo, usually accompanied by a supply of food (endosperm, which is produced during fertilization) and enclosed in a protective coat. Seed embryos contain one or more cotyledons [1]. Propagation of plants by seed and technological use of seed and seed products are among the most important activities of modern society. Specializations of seed structure and composition provide rich sources for industrial exploitation apart from direct use as food. Common products include starches and glutens from grains, hemicelluloses from guar and locust beans, and proteins and oils from soybeans and cotton seed. Drugs, enzymes, vitamins, spices, condiments are obtained from embryos, endosperms, and entire seeds, often including the fruit coat [2]. In recent times, the desire to conserve resources spent on importation of oil for domestic and industrial use gave renewed impetus in the search for novel sources to complement the traditional ones. Attention has therefore, been focused on under-utiliised local seeds for possible development and use. There are several of these

under-exploited plant seeds in Nigeria [3]. Food and agricultural scientists are beginning to screen wild and under-exploited native plants for possible potential sources of food in an attempt to widen the narrow food base [4]. Several reports have also indicated that lots of lesser-known native crop species are high in nutrients and could possibly relieve critical food shortages if given adequate promotion and research attention [5, 6]. Working on the prospects of utilizing such lesser known and neglected plants and their seeds, research reports have revealed that quite a large number have useful qualities either for direct use as animal feed ingredient or as a raw material for seed protein extraction [7, 8].

Adansonia digitata L. Belongs to the malvaceae family [9] and is a deciduous tree native to arid central Africa [10]. It has a large distribution spread across large area of sub-Sahara Africa's semi-arid and sub humid regions as well as in western Madagascar [11]. The baobab tree may grow as high as 18 meters and may have a trunk 9 meters in diameter. The tree has short, stubby branches and a gray, thick bark. Its leaves are compound and their segments are arranged like the palm of a hand. Its flowers, which are white and several centimeters across, hang from the higher branches. Its fruit is shaped like a football, measures up to 45 centimeters long, and is covered with short dense hair. Baobab has a long history of traditional uses. It provides food, clothing, shelter and medicine. Every part of the baobab tree is reported to be useful for mankind [12]. The seeds are commonly used as coffee substitute in some areas . The seeds are also used to thicken soup or pounded to extract vegetable oil used in cooking and cosmetics [13].

The aim of this paper is to determine some nutraceutical properties of *Adansonia digitata* seeds such as proximate analysis, elemental analysis as well as physicochemical characterization and anti oxidant capacity of the seed oil.

FIGURE 1: *A. digitata* Tree

FIGURE 2: *A. digitata* Fruit

FIGURE 2: *A. digitata* seeds

MATERIALS AND METHODS

Sample Collection and Processing:
The *Adansonia digitata* seeds were purchased in a local market (Gujungu) in Jigawa state, Nigeria. The seeds were sorted out, washed and dried. Some of the seeds were crushed for proximate analysis while the rest were kept in a black polythene bag, sealed and stored in a dark cool place until required for analysis.

Extraction of A. digitata Seed Oil:
Some of the seeds were pulverized using a grinding machine. The oil was extracted using hexane by adopting the method described by Association of Official Analytical Chemist [14], which entailed using a soxhlet extractor to extract. 200g of the ground *Adansonia digitata* seeds were packed in a muslin cloth and inserted into the soxhlet extractor and hexane was used as the extraction solvent for a period of eight hours. At the end of the period, the solvent was recovered by rotary evaporator and residual oil was oven dried at 75^{O}C for one hour. The extracted oil was then transferred to a desiccator and allowed to cool before analyses.

Proximate Analysis:
Determination of the proximate composition of *Adansonia digitata* seed powder was carried out in the Chemistry Advanced laboratory, SHESTCO. The moisture content, ash, crude fibre, and crude protein contents of the pulverized fine powder was determined using official methods [15]. The proximate analyses were carried out in triplicates and the results obtained were the average values. 100g of the powder was weighed in hot air oven at 105 ^{O}C to a constant weight, the difference in weight was recorded as the moisture content. 3g of the powder was placed in a pre-weighed porcelain crucible and ignited in an ashing furnace maintained at 6000 ^{O}C. The ash content was determined as soon as white ash was obtained and a constant weight was maintained. The nitrogen content was determined by micro-kjeldahl method and multiplied by 6.25 to estimate the crude protein content. Carbohydrate content was also determined by difference as described by AOAC, 2000.

Elemental Analysis:
Mineral analysis was carried out after 2g of the seed sample was ashed and 10ml of Conc. HNO_3 was added to it and digested until a clear solution was obtained. The digest was allowed to cool and then transferred into a 100ml standard flask and made up to mark with de-ionized water. The mineral elements were analyzed with atomic absorption spectrophotometer (GBC Avanta Ver 2.02 Model, Australia) equipped with air-acetylene flame.

Determination of the Physicochemical Properties of the Oil:
The acid value, saponification value, iodine value and unsaponifiable matters were determined using the procedures described by [16], while the procedure described by [17] was adopted for the determination of specific gravity. Viscosity measurement (in centistokes, cst) was performed by using an Oswald Kinematics Viscometer with an attached water bath and a thermometer.

RESULTS

TABLE 1: Proximate composition of *Adansonia digitata* seeds

Constituents	Percentage Composition
Moisture	4.41±0.25
Ash	7.29±0.08
Crude lipids	20.45±0.05
Crude fibre	12.15±0.05
Crude protein	29.79±0.03
True protein	4.59±0.08
Carbohydrate	25.91±0.54

±*Values are mean standard deviation of Triplicate.*

TABLE 2: Mineral composition of *Adansonia digitata* seeds

Minerals	Concentration (Mg/g)
Fe	0.004
Mg	0.195
Ni	0.002
Ca	0.013
Cu	0.033
Zn	0.003
Cd	0.000
Pb	0.000
Mn	0.001

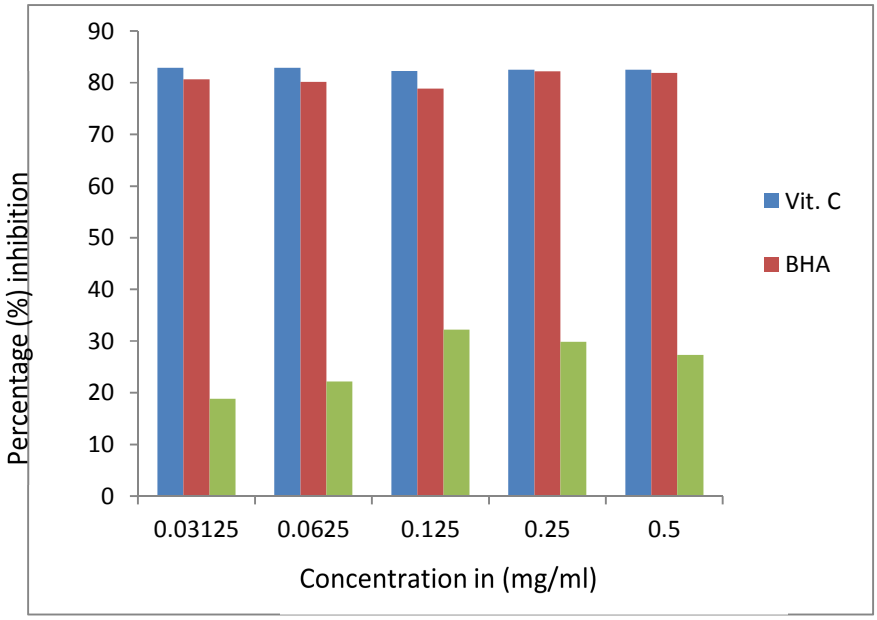

FIGURE 4: Antioxidant Activity of *Adansonia digitata* seeds

Legend: Vit. C = Vitamin C; BHA = Buthylated hydroxyl anisole.; ADS Oil = Adansonia digitata seed oil

TABLE 3: Physicochemical properties of *A. digitata* seed oil

Parameters	Values
Oil content (%)	32.0±0.00
Colour	Light yellow
Moisture content (%)	1.08±0.50
Viscocity (cst)	33.72±1.17
Saponification Value (mg/KOH g^{-1})	158.62±0.07
Unsaponifiable Matter (g kg^{-1})	9.46±0.25
Iodine Value (mg g^{-1})	54.41±0.94
Acid Value (mg KOH g^{-1})	2.75±0.14
Peroxide Value (mEq kg^{-1})	6.02±0.48

±Values are means standard deviation of triplicate (n=3).

DISCUSSION

Table 1 above shows the proximate composition of the *Adansonia digitata* seeds. The moisture content of the *Adansonia digitata* is 4.41±0.25% (w/w). Moisture content is among the most vital and mostly used measurement in the processing, preservation and storage of food [18]. The value gotten indicates that the seed has a good shelf life; hence it can be stored for a long time without spoilage. Fagbohun *et. al*. got a moisture content value of 10.2% for the fruit pulp of *Adansonia digitata*, this shows that the seeds of *Adansonia digitata* will have a higher shelf life than the fruit pulp. Other proximate analysis results showed that *Adansonia digitata* seeds could serve as a good source of energy, dietary fibre, minerals and protein thus contributing to the palatability and supplementation of feed in animal nutrition due to its relatively high carbohydrate, fat, ash and protein content.

The elemental analysis of *Adansonia digitata* seeds (Table 2) shows the presence of iron (Fe), magnesium (Mg), nickel (Ni), calcium (Ca), copper (Cu), zinc (Zn) and manganese (Mn) in the seed samples. Cadmium (Cd) and lead (Pb) were however absent in the seed samples. Certain trace elements such as copper, iron and manganese constitute essential part of any balanced diet. Some of them are micronutrient to the plants and if not present in the right proportion may have adverse effect on human and plants. The concentrations of the essential elements appear to be lower which is within safety limit according to WHO (1996). The lower concentration of iron (Fe), zinc (Zn), and copper (Cu) is an indication of little or no toxicity of the seeds as heavy metals are known to cause cancer, liver and kidney problems [17]. Iron is very important in the formation of haemoglobin in red blood cells and deficiency of iron leads to anaemia. The elements (Mg, Ca, Cu, Mn) are used extensively in chemotherapy and are essential in human and animal health. Copper is very vital in diet because it is involved in the proper usage of iron (Fe) and especially for the synthesis of cytochrome oxidase, which contains both iron (Fe) and copper (Cu). Excess copper can lead to jaundice (Wilson's disease) [19]. Magnesium and calcium are known to help in bone and teeth development [20, 17]. The very toxic elements cadmium (Cd) and lead (Pb) are absent in the analysed seed samples hence showing that the seeds will have very low toxicity.

The quality of the oil from the seeds of *Adansonia digitata* was assessed using parameters such as acid, peroxide, iodine and saponification values as well as Unsaponifiable and volatile matters. Oil and moisture contents, colour and viscosity were also determined. The iodine value is a measure of the degree of unsaturation of the fatty acids in an oil and could be used to quantify the amount ofdouble bonds present in the oil which reflects the susceptibility of oil to oxidation. The iodine value for *Adansonia digitata* seeds is 54.41±0.94 mg/g and this reflects the presence of low percentage of unsaturated fatty acids in the seed oil. The value obtained is higher than that for moringa oil but lower than groundnut oil and melon seed oil [21].

Acid values are used to measure the extent to which glycerides in the oil has been decomposed by lipase and other physical factors such as light and heat[22]. Thus, the low acid value of 2.75±0.14 mgKOH/g for the *Adansonia digitata* seed oil suggests that the oil is less susceptible to lipase action. Moreover, the acid value falls within the range recommended for cooking oil which is 0.00-3.00 mgKOH/g [23]. The peroxide assay is a predominant test for oxidative rancidity in oils and fats, this is a measure of concentration of peroxides and hydro peroxides formed in the initial stage of lipid oxidation. Peroxide value is also used as a measure of the extent to which rancidity reactions have occurred during storage. A high peroxide value for any oil shows the fact that the oil has less resistance to lipolytic hydrolysis and oxidation while a low peroxide value shows otherwise. The peroxide value of the *Adansonia digitata* seed oil (6.02±0.48 mEq/kg) is quite low and indicates less susceptibility to oxidation [24]. Again, the peroxide value of the *Adansonia digitata* seed oil is within the range of 0-10mEq/kg stipulated for freshly prepared

oil [25]. Therefore, it is likely that storage for a long time will not lead to rancidity of the oil. The saponification value of the oil is low when compared to Neem seed oil – 213 mgKOH/g [26] and coconut oil - 253.2 mgKOH/g [27], this low value shows that the lauric acid contents of the oil is also low and this is an important determinant of the suitability of the oil in soap making [28]. However, the saponification value still falls within the range of that of *Dennettia tripatala* fruit oil (Pepper fruit) - 159.33 mgKOH/g [29] and African pear oil - 143.76 mgKOH/g which could be good for soap making [30]. This indicates that the oil could also be used in soap making since its saponification value falls within the range of these oils The term "Unsaponifiable Matter" in oils or fats, refers to those substances that are not saponifiable by alkali hydroxides but are soluble in the ordinary fat solvents, and to products of saponification that are soluble in such solvents. *Adansonia digitata* seed oil has a relatively higher unsaponifiable matter value due to its restively lower saponification value. The moisture content of the oil is very low and backs up the fact that storage for a long period of time will not give rise to spoilage due to microbial growth. It also has a high oil content indicating that it is a promising source of oils.

The antioxidant activity of *Adansonia digitata* seed oil as compared with BHA and Vitamin C is shown in Figure 4 above. From the graph, it is clearly shown that the antioxidant activity of *Adansonia digitata* seed oil is very low at all concentrations determined. This may be due to the absence of phenolic compounds and tannins in the oil.

CONCLUSION

In this study, the proximate and elemental analysis of *Adansonia digitata* seeds have been determined. Also, physicochemical characterization and anti oxidant capacity of the seed oil has been analysed. From the results gotten, the seeds have good nutritional composition while the oil has a very good yield with a low degree of unsaturation. This can make it useful in various industries and for human and animal consumption.

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