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Study on the Chemical Composition, Nutritionally Valuable Minerals and Functional Properties of African Baobab, Adansonia Digitata, Seed Flour and Chemical Analysis on the Baobab Seed Oil

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Abstract: The chemical composition, nutritionally valuable minerals and functional properties of the African baobab, *Adonsonia digitata* seed flour were investigated in tandem with the chemical analysis on the baobab seed oil. The analysis was done using standard procedures. The chemical compositions showed that the seed flour contains protein (25.14±0.79)%; crude fat (29.60±0.31)%; Crude fiber (2.96+-0.02)%; total ash (8.17±0.18)%, moisture content (8.31±0.22) and carbohydrate by difference (29.111.46)%.The nutritionally valuable minerals analysis showed the following minerals content (mg/kg): Sodium (0.04±0.01); Potassium (35.00±5.00); Calcium (22.50±2.50); Magnesium (15.50±0.500); Iron (0.39±0.09); Copper (0.30±0.06); Zinc (2.62±0.40); lead (0.02±0.01); and phosphorus (3.43±0.71); while molybdenum is not detected. The result of the mineral analysis shows that the seed flour is edible as compared with the World Health Organizations' (WHO) mineral contents in foods permissible unit.

The functional properties analyzed gave the following: The mean particle size (0.15±0.01) mm, bulk density (0.48±0.02) g/cm3; absorption of water and oil (3.83 and 3.55) m/g-l; microstructure of the fruit seed flour (starch granules present); Swelling index (5.10±0.05). These values shows that the seed can be useful in industries and also be a good source of animal feed, and also in the bakery for snacks baking due to its good functional properties. The chemical analysis on the seed oil gave the following: Saponification value (245.00±2.97) mgKOH/g; Iodine value (88.61±0.29) mgI_2/g; acid value (97.80±0.08) mgKOH; free fatty acids value (3.67±0.12) mgKOH/g; peroxide number (9.77±0.64) meq/kg and ester value (237.29±2.74) mgKOH/g which is determined by difference. These values are related to the standard organization of Nigeria (SON) values and the Nigeria Industry Standards (NIS) permissible values for edible oil.

Keywords: chemical parameters compositions, analysis, functional properties, nutritionally valuable minerals, African baobab, *Adonsonia digitata*.

Introduction

The Boabab tree must be one of the most intriguing trees growing on the African continent and is often referred to as the upside-down tree which can have a lifetime (lifespan) of up to 6000years. Botanically, it is known as *Adansonia digitata*, named after the French botanist Micheal Adanson, who studied these trees (Nkafamiya et al; 2007).The baobab belong its own family, bombacacea (Stucki et al; 2005).The tree is found throughout Africa, generally at low altitudes and in the hotter, drier areas. Infact, it is so widely spread that too many people see it as an icon symbolic of the continent itself (Zimba et al; 2005).

Boabab often grow up close to villages (Orwa et al 2009; Icuc, 2002; Bosch et al, 2004; Ecocrop, 2011). *Adansonia digitata* (African baobab) is known locally as Tori (Kuka) in Ngas land, Plateau State, North Central Nigeria. It is also known as dead rat tree, monkey bread tree, etc.

The fruit of the Baobab tree, *Adansonia digitata L,* is oblong, pendulous on long stalks, woody and indehiscent. The large brown seeds are arranged in rows of two to eight locules per fruit. In the Sudan, the pulp is commonly chewed, sucked or made into a drink. The seed kernels are edible and the seed contain 19% oil (Nour et al; 2011).

The Baobab seed powder is prepared in lumps on removal of the Baobab oil and is a much needed recipe in traditional vegetable soup, most common among Ngas people as its nutritional value and taste gives it an edge over the well known locust bean meal(Nengak et al; 2011)

The Baobab seed oil is a semi-fluid golden yellow oil that is gently scented and contain nearly equal amount of saturated (33%), mono-unsaturated (36%) and poly-unsaturated (31%) fatty acids and the essential linoleic acid is of special interest which results in its liquid nature even in a very low temperature (Athar; 2005). The aim of the present research is to determine the chemical composition, nutritionally valuable minerals and functional properties of African Baobab, *Adansonia digitata,* Seed flour and chemical analysis of the Baobab seed oil. The result obtain from this study will provide information on the chemical analysis of the *Adansonia ditata,* seed powder, the composition of the Baobab in a Baobab seed.

Materials and Methods

Sample Collection

The Baobab fruits were collected from different locations in Dilla, Pankshin Local Government Area, Plateau State, Nigeria. The fruits were selected without grouping according to variety or degree of ripeness.

Experimentals

The pulp was separated from the seeds and the seed samples collected were washed with clean water and air dried for two weeks to obtain the seed kernels. The seed kernels obtained were pulverized into fine powder using mortar and pestle and the powdered seed kernel, about 40g was used for the extraction process of the Baobab seed oil using soxhlet extractor, petroleum ether as the solvent used for the extraction process. The remaining powdered sample is to undergo further analysis such as chemical composition, nutritionally valuable minerals and functional properties. The nutritionally valuable minerals composition was carried out using the principle of Atomic Absorption Spectroscopy (AAS).

The moisture content of the sample was determined by standard official methods of analysis of the Association of Official Analytical Chemists (AOAC, 1984). This involved drying to a constant weight at 100^0C and calculating the moisture as the loss in weight of the dried sample.

The ash of the sample was determined by the method reported in the handbook of AOAC (1984). The need for the determination of the ash level of the food crops is obvious. It represents inorganic remains after the organic carbonaceous portion and other volatile components have been oxidized and evaporated away. Empty crucible was fire polished in a muffled furnace and allowed to cool in a dessicator containing calcium chloride for 20 minutes and then weighed and the ash content was calculated.

The crude fat in food was frequently determined by solvent extraction of the dried food with petroleum ether, diethyl ether or of an aqueous mixture of the food by a mixture of the two solvents. However, for this experiment, the crude fat was determined using soxhlet extraction method of AOAC (1984). The solvent is salvaged by distillation. The flask and its content were left in the oven overnight at a low temperature to completely evaporate the solvent and weighed to obtain the percentage crude fat.

The crude protein content of the sample was determined using the Marco Kjeldahl method of AOAC (1984). The samples were digested with concentrated H_2SO_4 acid, using $CuSO_4$ and potassium sulphate as catalyst to convert

organic nitrogen to ammonium ion and Alkali (NaOH) was added and then liberated ammonia distilled into an excess boric acid solution. The distillate was titrated with 0.1N HCl to determine the ammonia absorbed in the boric acid.

The mineral composition was determined by AAS. The dried samples in triplicate were dry-ashed in muffle furnace at 550^0C for 8 hours until a white residue of constant weigh was obtained. The minerals were extracted from ash by adding 20ml of 2.5% HCl heated in a steam bath to reduce the volume to 7ml, deionized water was added to make up to 50ml stored in clean polyethylene bottles and the mineral content determined by AAS (Perkin-Elmer Model 2380, USA). Statistical analysis, values represented are computed and taken to be the mean and standard deviation of the replicates

Discussion of Results

The result of chemical composition of *Adansonia digitata* is presented in Table 1. The moisture content (8.31 ± 0.02) % is low compared with the work on tiger nut seeds (*Cyperus esculentus)* with a moisture content of 9.47% (Monago and Unwakwe, 2009). This suggests that the seed will have a long shell life (Onyenuga et al, 1998). Since the low moisture content can prevent microbial spoilage and pest attack during storage. The ash content (8.17**±**0.18) % in this seed shows that it could have a reasonable quantity of mineral elements for building healthy bodies and proper functioning of body tissues. The crude protein content (25.14**±**0.79) % is higher than that of tropical tree seed, such as bread nut, 19.25 (Oshodi et al, 1999), *Bombcopsis glara* , 16.56% (Olaofe et al, 2006), Benniseed, 22.5% (Oshodi et al, 1999) and locust bean, 24.10% (Adeyeye and Aye, 2005). The crude fat content (29.60**±**0.37) % is above the range for most legumes, which range between 2.10% in groundnut to 7.60% in kidney beans and was found to be higher than *Parkia biglobosa* se eds (Ihekoronye and Ngoddy, 1985). The high crude fat of the seed could give the seed an extra advantage over some seeds and could show that it is a good source of fat which provide energy. The considerable amount of crude fiber in this seed (2.96**±**0.02) % shows that it is a source of dietary fiber which is essential for good bowel movement and could help in preventing obesity, diabetes, cancer of the colon and other ailments of the gastrointestinal tract of humans. The crude carbohydrate (29.11**±**1.46) could be a good source of energy and thus, a useful supplement in animal feed formulation and human diet.

Table1. *Chemical Composition (Proximate Composition) Of Adansonia Diditata Seed Flour*

Composition	**Mean ± S.D**
Moisture(%)	8.31 **±0.02**
Protein (N × 6.25)(%)	25.14 **±0.79**
Nitrogen (N)(%)	4.02 **±0.13**
Crude fat(%)	29.60 **±0.37**
Ash(%)	8.17 **± 0.18**
Crude fiber (%)	2.96 **±0.02**
Carbohydrate(%)	29.11 **±1.46**

S.D. = Standard Deviation

Results of the elemental contents of *Adansonia digitata* is presented in Table 2. The values indicates high amount of minerals required by the body, Potassium having highest value (35.00**±**5.00)mg/kg. This is also corroborated by Olaofe and Sanni (1998), who reported potassium to be the most abundant mineral in Nigeria agricultural products. High amount of potassium, calcium and magnesium (as macro element) could help to lower the blood

pressure (Ranhotra et al, 1998). Several clinical studies have shown potassium, calcium and magnesium to be effective pressure lowering agents (Osborne and Voogt, 1998; Zewel, 1997). Hence, consumption of this seed may help achieve this purpose. The iron (Fe) content of the seed was (0.39±0.09) mg/kg which shows that it is rich in iron. The mineral contents are within the range when compared with the WHO permissible limits for foods as shown in Table 2.

Table2. *Some Nutritionally Valuable Minerals Contents Of Adansonia Digitata Seed Flour*

Element	Concentration(Mg/Kg)	WHO permissible limits (mg/kg)
Sodium (Na)	0.041 **± 0.01**	1000.00
Molybdenum (Mo)	Not detected	Negligible
Potassium (K)	35.00 **± 5.00**	422.00
Calcium (Ca)	22.50 **± 2.50**	1200.00
Iron (Fe)	0.39 **± 0.09**	2.50 – 5.00
Copper (Cu)	0.30 **± 0.06**	10.00
Zinc (Zn)	2.62 **± 0.40**	50.00
Magnesium (Mg)	15.50 **± 0.50**	615.00
Lead (Pb)	0.02 **± 0.01**	0.20
Phosphorus (P)	3.43 **± 0.71**	950.00

The functional properties of *Adansonia digitata* seed flour, converted to percentage is presented in Table 3. The oil absorption capacity is 38.3%, the value is lower than the value for pigeon pea flour (89.7±0.41) % and unripe plantain flour (225.00±2.10) % (Oshodi and Ekpeigen, 1998) and (Fagbemi, 1999) respectively. The not too rich oil absorption capacity of the sample flour may not make it important in food processing involving fat absorption such as bakery products, the bulk density (0.48±0.02) g/cm^3 shows that it has a poor bulk density as it cannot be used as a filter in food processing industry. The water absorption (3.83 m/g-l) and mean particle size (0.15±0.01) is of a typical local fruit seed that can yield oil for industrial purposes

Table3. *Some Functional Properties Of Adansonia Digitata Seed Flour*

Functional properties	Mean **± S.D.**
Mean particle size	0.15 **± 0.01(mm)**
Bulk density	0.48 **± 0.02(g/cm^3)**
Water absorption capacity	3.83 **m/g-l**
Oil absorption capacity	3.55 m/g-l

The saponification, Iodine, ester, peroxide and acid values are 245.00±2.79 mgKOH/g; 88.61±0.29mgI_2/100g; 237.29±2.74mgKOH/g; 9.77±0,64meq/kg and 7.80±0.08 as presented in Table 4. The results are compared with the Standard Organization of Nigeria (SON) and Nigeria Industrial Standards (NIS) permissible limits for edible oil. The result is a pointer to the industrial usage of the baobab seed oil, as it can be used for cosmetics products such as creams and soap. The saponification, iodine, ester, and acid value exceed the permissible limit, while the peroxide value is within the permissible limit which is a pointer to the non-edibility of the baobab seed oil. Though, it can be consumed when exposed to very high temperature, in order to reduce the level of acidity.

Table4. *Some Chemical Analysis On The Adansonia Diditata Seed Oil*

Parameter	Mean ± S.D.	SON/NIS Standards
Acid value (mg KOH/g)	7.80 **± 0.08**	7.00
Free fatty acids (mg KOH/g}	3.67 **± 0.12**	3.50
Saponification (mg KOH/g)	245.00 **± 2.79**	195.00 - 205.00
Iodine value (mg I_2/100g) or Wij	88.61 **± 0.29**	45.00 – 53.00
Ester value (mg KOH/g)	237.29 **± 2.74**	190.00 – 200.00
Peroxide value (meq/kg)	9.77 **± 0.64**	10.00

Conclusion

Chemical composition had been carried out on *Adansonia digitata* seed flour obtained from Dilla, Pankshin Local Government Area of Plateau State which shows a high level of protein, crude fat and carbohydrate.

Atomic Absorption Spectroscopy had been used to determine the mineral composition of *Adonsonia* seed flour. As many as nine mineral elements were detected and qualified accordingly. The rich mineral content of *Adonsonia digitata* seed makes it a useful mineral source for indigenous African communities in which *Adansonia digitata* trees are found.

Adansonia digitata seed flour was analyzed to find out the functional properties. The extracted oil was found to contain about 30% of oil using n-hexane and about 37% of oil using petroleum ether. The analyzed oil was found to have high saponification value which gives it an advantage in soap making process, cosmetics and candle making. Its high iodine value gives the level of unsaturation of the fatty acid present in the baobab seed oil. The ester value further qualifies its saponification value and shows its high industrial importance.

The result of this research shows that the baobab seed is of great economic value in terms of protein, fat and energy contents. It is also a good and cheap source of macro and micro elements and the baobab oil is edible only when it is exposed to a very high temperature.

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