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Full Length Research Paper

Studies on the chemical composition and physico-chemical properties of the seeds of baobab (*Adasonia digitata*)

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The seeds of baobab used in preparation of local condiments was analysed to establish the proximate composition and the physico-chemical characteristics of the oil and effect of storage on the oil. Results obtained showed that the saponification value (SV), iodine value (IV), peroxide value (PV), acid value (AV), percentage free fatty acid (%FFA) and refractive index of the oil are 196 ± 0.05 mg/KOH, 87 ± 0.02 g/100 g, 4.5 ± 0.06 mEq/kg, 0.33 ± 0.03 mgKOH/g, 0.45 ± 0.08 and 1.459 ± 0.13, respectively. Proximate analysis showed that protein (21.75 ± 0.12 g/100 g), ash (5.01 ± 0.07 g/100 g) and fiber (6.71 ± 0.003 g/100 g) were comparable to *Prosopsis africana* seeds (20.54 ± 0.18, 6.67 ± 0.08 and 5.51 g/100g), which is used for the same purpose. The crude lipid content (12.72 ± 0.01 g/100 g) was almost equal to that of *P. africana* seeds (12.74 g/100 g). The major mineral elements present in the seeds included phosphorus, calcium and potassium (6.00 ± 0.02, 58.90 ± 2.34 and 280.00 ± 1.34 mg/100 g, respectively), thereby suggesting that the baobab seeds could contribute partially to the overall daily intake of these elements. The vitamins (A and C) found present in baobab seeds are higher than that of *P. africana* seeds. The antinutritional factors including oxalate, phytate, saponin and tannin (10.31 ± 1.00, 2.00 ± 0.31, 7.16 ± 0.01, 2.84 ± 0.30%, respectively) are also comparable to that of *P.* Africana. The storage property of the oil from baobab seeds studied over a period of four weeks under conditions of light (ambient), darkness (ambient), and refrigeration showed that the iodine value of the oil decreased in all cases but much more so on exposure to light. In contrast, the peroxide value of the oil showed very little change under conditions of darkness and refrigeration over the same period, thus indicating that the oil can withstand storage.

Key words: *Adasonia digitata*, proximate composition, oil, mineral elements, vitamins, antinutritional factors, storage properties.

INTRODUCTION

Edible wild seeds are consumed frequently in Northern Nigeria especially in rural communities where a variety of edible seeds abound. Some of these are cultivated while others grow in the wild. Several of these wild species bear fruits/seeds during the dry season when cultivated fruits/seeds are scarce (Nadro and Umaru, 2004). Wild seeds offer a convenient but cheap means of providing adequate supplies of mineral, fat, protein and carbohydrate to people living within the tropics (Eromosele et al., 1991). In North eastern part of Nigeria where common seed like cottonseeds is in short supply, it is possible for wild seeds like baobab to pro-vide the oil, vitamin and mineral requirement of the local populace.

Baobab is a tree mostly found in Northern part of Nigeria. Both leaves and pulp are used in this region for human consumption. The plant also provides forage for wildlife and domestic animals. The seeds are particularly used in the preparation of local condiment (Issai), a popular product in Higgi land (Michika local Government area of Adamawa State, Nigeria), used for flavoring local soups. Issai (commonly known as dadawa Higgi) is a product obtained by mixing the baobab seeds with cooked

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Table 1. Physio-chemical characteristics of baobab seed oil.

Extractant	SV (mgKOH)	IV (g/100g)	PV (mEq/kg)	AV (mgKOH/g)	%FFA as oleic acid	RI (20°C)
Pet. Ether	196±0.05	87.9±0.02	4.5±0.06	0.33±0.03	0.45±0.08	1.459±0.13

Values are means ± SD for 3 determinations.

Table 2. Proximate composition (g/100g dry weight) of baobab.

Oil %	45.00 ± 003
Moisture	4.71 ± 0.04
Ash	5.01 ± 0.07
Crude lipid	12.72 ± 0.01
Crude protein	21.75 ± 0.12
Crude fiber	6.71 ± 0.03
Carbohydrate (excluding) fiber	52.53
Food energy (kCal/kg)	4465

Values are means ± SD for 3 determinations.

and fermented seeds of roselle calyces and groundnut. Apart from flavoring, this product also increases the aesthetic appeal and taste of soups. Here we present the physio-chemical and storage properties, vitamin, proximate and mineral composition of baobab seeds. This information could be helpful in assessing the actual nutrient contribution of these seeds to the food products obtained from them.

MATERIAL AND METHODS

Collection and treatment of samples

Dried seeds of baobab were collected from Nkafamiya Wulla, Michika local Government Area of Adamawa State, Nigeria. They were cleaned to remove dirt, sun-dried for three days and finally ground in an electric mill (National Food Grinder, Model MK308, Japan). It was then passed through a 40 mesh sieve and stored in a refrigerator at 5°C.

Analysis of the samples

The oil from the seeds of baobab was soxhlet extracted with petroleum ether (40 - 60°C) and was then characterized by standard method for oil and fat analysis (AOAC, 1980). All reagents used for the analyses were of analytical grades and were not subjected to further purification. Refractive index was measured with an Abbe Refractometer at 25°C and corrected to 20°C as described by AOAC, 1980. Ash, crude lipid, crude fiber and protein were determined by AOAC methods (1980). The carbohydrate content was calculated by difference. Energy value (kcal/kg) was calculated by multiplying the values obtained for carbohydrate, protein, fat and adding up the values as describe by Robson et al. (1972) and Maragoni and Ali (1987). For mineral analysis, 2 g of the dried, ground sample were mixed with 20 ml of nitric/perchloric acid (5:1, v/v). The mixture was allowed to stand overnight and then heated to 80°C on a hot plate for approximately 2 - 3 h after which a clear solution was then heated to dryness and reconstituted with deionized water. The concentration of the iron, zinc, and calcium were determined using atomic absorption spectrophotometer (Philip Model sp9, UK). Sodium and potassium were determined by flame emission techniques, while phosphorus was by the phosphomelybdonavandata method (AOAC, 1980). The content of β-carotene in the seeds was determined using the chromatographic procedure described by Ranagana (2004). Vitamin A was calculated using the relationship; 0.6 µg of β-carotene = 0.3 µg pf pure vitamin A (Robson et al., 1972). The vitamin C content was determined spectrophotometrically (λ = 760 mm) as describe by Paul and Pearson (2005).

Total oxalate was determined according to Day and Underwood procedure (1986). Saponin was determined using the method of Birk et al. (1963) as modified by Hudson and El-Difrawi (1979). While phytate was determined using Reddy and love (1999) method. Tannin was however determined using the method of Trease and Evans (1978). The storage property of the oil was examined by periodic measurements of the iodine values and peroxide values of the oils over a period of four weeks after exposure to light, darkness and refrigeration (8°C).

All analysis was carried out in triplicate and data were analysed by Analysis of Variance (ANOVA). Duncan's Multiple Range Test was used to compare mean variance. Significance was accepted at 5% level of probability following Steel and Torric (1980) procedures.

RESULTS AND DISCUSSION

Table 1 represents a collection of some physico-chemical characteristics of the oil from the seeds of baobab. The high saponification value (SV) of the oil (196 ± 0.05 mg KOH) is within the range of some edible oils such as palm oil (196 - 205), groundnut oil (188 - 196), and corn oil (187 - 96) (Eromosele and Eromosele, 1993). The iodine value (IV) is 87.9 ± 0.02 g/100g and is comparable with those of groundnut oil (84 - 99), olive (79 - 90), and caster oil (81 - 91) and may be classified as non-drying oil. The PV of the oil is relatively low (4.5 mEq/kg) and was determined immediately after the extraction of the oil. This indicates that the oil has not gone bad (Magnus, 1992). The RI of the oil (1.459 ± 0.13), is also within the range of some edible oils like cottonseeds and groundnut (Kamal and Kamal, 1992). The acid value (AV) of the oil is low (0.033 ± 0.03 mgKOH/g) and the corresponding percentage free fatty acid (%FFA) as oleic acid is 0.45 ± 0.08. The low AV and %FFA indicates that the oil may have long shelved life (Passera, 1981). Hence judging by SV and AV, the oil may be suitable for soap making.

The proximate components of the seeds of baobab are presented in Table 2. The seeds contained 21.75 ± 0.12,

Table 3. Vitamin A, C and mineral composition (mg/100g [dry weight]) of baobab

Phosphorus	6.00 ± 0.02
Calcium	58.90 ± 2.34
Potassium	280.00 ± 1.34
Sodium	6.07 ± 0.04
Zinc	3.60 ± 1.42
Iron	6.36 ± 0.42
*Vitamin A	5.26 ± 0.03
Vitamin C	6.71 ± 0.04

Values are means ± SD for three determinations.
* Value in µg/100g

5.01 ±0.07 and 6.71 ± 0.03 g/100g of protein, ash and fiber respectively. These values are similar to that of *P. africana* and *Parkia filicoidea* which are most commonly used for preparation of Hausawa daddawa cake (Eka and Isbell, 1984; Barminas, et al., 1998). The crude lipid (12.72 ± 0.01 g/100g) was however lower than that of *P. africana* and *P. filicoidea.* The low crude lipid of this seed gives the seed an extra advantage over the other seeds. The seeds could also be used as protein supplement for-protein foods and seeds such as cereal grains for animals, particularly during the dry session. These seeds become available in large quantities in Northern part of Nigeria between the months of January and April when green/fresh fodder plants are scarce. The seeds could also serve as good source of carbohydrate concentration for all classes of livestock. Furthermore, the seeds can be used to supplement the daily energy intake of the consumers of their food products since they have caloric values above the range of 2500 to 3000 kcal/kg needed by human (Bingham, 1998).

The mineral composition of the seeds is listed in Table 3. Iron and zinc are among the essential elements for humans and their daily requirements for adult are 15 and 18 mg, respectively (Kampali and Pali, 2004). Though the level of iron (6.36 ± 0.42 mg/100 g) and zinc (3.60 ± 1.42 mg/100 g) are low in baobab seeds, the minerals present were higher than that of *P. africana* and comparable to those of cereal grains (Rossell, 1991). This suggests that baobab seeds could contribute partially to the overall daily intake of these elements. The levels of vitamins A and C in the seeds are also shown in Table 3. The seeds had high level of vitamin C (6.71 ± 0.04 mg/100 g) compared to *P. africana* (0.92 ± 0.02 mg/100 g) and low when compared to groundnut (9.8 mg/100 g). Vitamin A (5.26 ± 0.03 µg/100 g) content in the seeds is also higher when compared with that *of P. africana* (0.89 ± 0.01 µg/100 g) (Barminas et al., 1998). Though the vitamin A in baobab seeds is low, it can however help to alleviate symptoms of vitamin A deficiency. Table 4 showed the results of antinutrients present in the baobab seeds.

Table 4. Oxalate, pyhtate,saponin and tannin content (%) of baobab seeds

Oxalate	10.31 ± 1.00
Phytate	2.00 ± 0.31
Saponin	7.16 ± 0.10
Tannin	2.84 ± 0.30

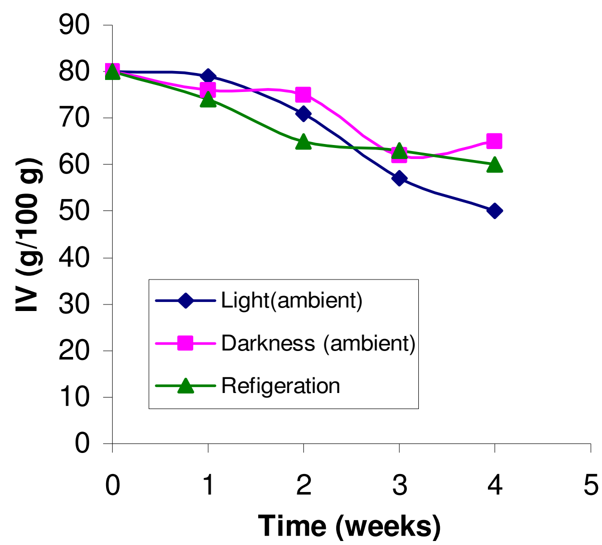

Figure 1. Relationship between iodine value and storage time for baobab oil.

However levels of antinutrients in the analysed baobab seeds are below the established toxic level.

The storage property of the oil was investigated over a period of four weeks at periodic weekly intervals. Specifically, the IV and PV were measured for the oil exposed to light, darkness and refrigeration (8^{o}C). The results are shown in Figures 1 and 2. Figure 1 is a plot of IV versus time (in weeks) and it can be seen that the IV decreased with time possibly due to oxidation. Notably, for the first two weeks, the IV for the refrigerated oil decreased much more rapidly than the values for light and darkness. Beyond two weeks however, the IV for the oil exposed to light at ambient temperature decreased much more sharply. At the end of the fourth week, the IV of the oil was in the order of $IV_{dark}>IV_{frige}>IV_{light}$. The initial rapid fall in the IV for refrigerated oil is probably due to low temperature-activation enzyme-catalysed oxidation of the oil. This indicates that the oil can be best stored in the dark environment. Figure 2 is plot of the corresponding PV of the oil with time under the conditions mentioned above. As can be seen from the plot, the PV of the oil in the dark and in the refrigerator changed only slightly over a period of four weeks while the photo-exposed oil showed marked increase in the PV over the same period. This may be due to an enhanced photocatalysed oxidation of the oil exposed to light.

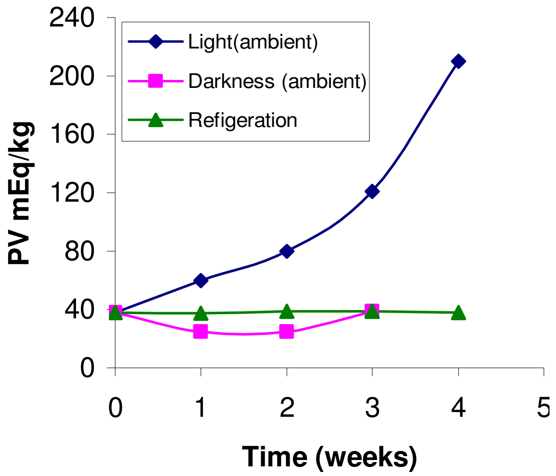

Figure 2. Relationship between peroxide value and storage time for boabab oil.

In conclusion, the oil from boabab shows marked reduction in iodine value on exposure to light, darkness and refrigeration over a period of four weeks but the effect of light is more profound. Analysis of the seed oil of *A. digidata* indicates that the physico- chemical characteristics are comparable with those of many edible oils. The iodine value of the oil is not greater than 88 g/100 g and suggests that the oil is non-drying oil. The saponification value is however high, suggesting that the oil may be suitable for soap making. Proximate and mineral composition of the seeds of *A. digidata* also indicates that they could be alternative sources of human food and could find immediate utility in mixed animal feed. However, amino acid analysis and feeding studies are needed before they can be used this way.

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REFERENCE

AOAC (1980) Officail methods of Analysis. Washinfton, D.C: Assoc. Official Analyt, Chem. pp. 76-86.

Barminas JT, Maina HM, Ali J (1998) Nutrient contents of Prosopis africana seeds. Plant foods Hum. Nutr. (52): 325-328.

Bingham S (1998). Nutrition: A consumer's guide to food eating. London: Transworld Publishers. 123-127.

Birk Y, Bondi A, Gestetner B, Ishaya IA (1963). Thermosatble hemolytic factor in soyabeans. Natural 197: 1089-1090.

Day RA, Underwood AL (1986). Quantitative analysis. 5th ed. pp. 701. Prentice- Hall publication.

Eromosele IC, Eromosele CO, Kuzhkuha DM (1991). Evaluation of mineral elements and ascorbic acid contents in fruits of some wild plants. Plant Food Hum. Nutri. 41: 151-154.

Eromosele IC, Eromosele CO (1993). Studies on the chemical composition and physico-chemical properties of seed of some wild plants. Plant Food Hum Nutr. (42): 251-258.

Eka OU, Isbell B (1984). Nutrient content of cottonseeds from varieties of cotton grown in Nigeria. Nig. J. Tech. Educ. 6: 67-73

Kamal S, Kamal U (1992). Fats and oils. Nigeria J. Sci. 18: 76-78.

Kampali U, Pali U (2004). Composition of the seeds oil of *Mangifera indica L.* Mill. Bull. Chem. Soc. Nigeria. 11: 72-74.

Magnus P (1992). Food Science and Technology. John Wiley and Sons, Inc., USA. pp. 140-146.

Maragoni A, Ali I (1987). Composition and Properties of seeds and pods of the tree legume Prosopis juliflora (DC). J. Sci. Food Agric. 44(2): 99-110.

Nadro MS, Umaru HA (2004). Comparative chemical evaluation of locust bean (*parkia biglobosa)* fruits pulp harvested during the dry and wet seasons. Nig. J. Biotech.15 (4) 42-47.

Paul G, Pearson S (2005s). The vitamins. 2nd edn. Academic press, New York, USA. pp. 31-32.

Passera LS (1981). Oxidation of lipids. Plant Food Hum. Nutri.31: 77-83

Ranagara S (2004). Manual of analysis of fruit and vegetable products New Delhi; Tata/Mc Graw-Hill. pp. 73-75

Reddy MB, Love M (1999). The impacts of food processing on the nutritional quality of vitamins and mineral. Adv. Exp. Med. Bio. 459: 99-106

Robson JKR, Larkin CS, Sandretto AM, Tadayyon B (1972). Malnutrition: its causation and control, New York: Gordon & Breach. pp. 248-249

Rossell B (1991). Nutrition from some edible wild seed plants. Nig. J. Sci.12: 75-78

Steel RGD, Torric JH (1980). The principles and procedures of statistics. New York: Mc Graw-Hill. pp 67-70

Trease GE, Evans WC (1978). A textbook of pharmacognosy. 11th ed. Bailliere- Tindall, London. pp 76.