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Chemical Composition and Physicochemical Characteristics of Two Varieties of Bambara Groundnut (*Vigna subterrenea*) Flours

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Abstract: Proximate, mineral composition and physicochemical characteristics of two varieties of bambara groundnut (*Vigna subterranean)* flours were determined using standard techniques. The two varieties (cream coat and dark red coat) of bambara groundnut have comparable mean values of total ash, crude protein and carbohydrate. (by difference) of 4.28 and 3.89%; 11.56 and 11.05% and 73.30 and 73.87%, respectively. But there are little variations in the values of moisture, crude fat and crude fibre. The two varieties were found to be good sources of essential minerals such as Fe, Na, K, Mg and Ca but Cu, Mn and Zn contents were low. Pb, Cd and Cr were not detectable. The results of physicochemical characteristics of bambara groundnut oils showed that they have similar mean values of the following parameters: Free fatty acid, 4.85 and 4.80 mg g^{-1}; Acid value, 0.92 and 0.98; Saponification value, 124.9 and 140.5 mg KOH g^{-1}; Iodine value, 121 and 120 mg iodine g^{-1}; peroxide value, 286 and 290 and specific gravity 0.88 and 0.85 for cream coat and dark red coat, respectively indicating that they are drying oils and edible.

Key words: Bambara groundnut flour, chemical composition, physicochemical

INTRODUCTION

Bambara groundnut (*Vigna subterranean* (L.) Verdc.) belongs to the legumiosae, subfamily papilionoideae. It is commonly known as Gujiya among the Hausa tribes of Nigeria. Bambara groundnut was once said to be the third most important grain legume after groundnut (*Arachis hypogaea* L.) and cowpea (*Vigna unguiculata* (L.) Walp) in Sub-Saharan Africa (Rachie and Silvestre, 1977; Johnson, 1968). It is a major source of cheap dietary phytoprotein for both humans and livestock in the Sudano-Sahelian parts of tropical Africa and Asia where animal protein is expensive (Linnemann, 1994). This legume which was formally popular in the northern part of Nigeria because it is well favoured by dry lands and environmental climatic conditions has been gradually replaced over the course of decades by the groundnut particularly in more productive areas.

The reported works on the Bambara groundnut (BBG) seeds included the evaluation of chemical composition of BBG (Enwere and Hung, 1996; Temple and Aliyu, 1994; Poulter, 1981) investigation of fatty acids composition of BBG seed oils (Gaydolel *et al*., 1983; Ferrao *et al*., 1987) and determinations of functional properties of BBG seed flour (Adebowale and Lawal, 2004; Onimawo *et al*., 1998). Processing treatment which has improved the utilization of BBG has been reported by Akpapunam *et al.* (1996).

This research was undertaken to determine the proximate and mineral compositions and physicochemical characteristics of two common varieties of BBG seed flours producing in Nasarawa state, Nigeria in order to supplement, contradict and/or add to existing data in literature. Such data will be considerable values to dieticians, food scientists and manufacturers, medical personnel, nutritionists and also in the preparation of a much needed food composition table for Nigeria.

MATERIALS AND METHODS

Bambara groundnut seeds were collected from the farm located at Keffi, Nasarawa State, Nigeria during the period of harvesting in December 2004. Two different colour varieties of cream coat (A_1) and dark red coat (B_1) were identified, sorted and screened to remove the bad seeds. Their corresponding dehulled samples labelled A_2 and B_2 were then processed for analysis. The dehulled seeds were dry-milled into fine flours. The removal of the hull and the preparation of the dehulled samples were done according to the method of Oshodi and Ekperigin (1989).

The proximate analyses of the samples for moisture, total ash and crude fibre were carried out in triplicate using the methods described in AOAC (1990). The nitrogen was determined by the micro-Kjeldahl method

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described by Pearson (1976) and the nitrogen content was converted to protein by multiplying by 6.25. Carbohydrate was determined by difference. All the proximate values were reported in %.

The oil sample was extracted from the seed flours by soxhlet extraction using petroleum ether of Analar grade (British Drug Houses, London), boiling range 60-80°C for 8 h (James, 1996).

The minerals were analysed by dry-ashing the samples at 550°C to constant weight and dissolving the ash in volumetric flasks using distilled, deionised water with a few drops of concentrated hydrochloric acid. Sodium and potassium were determined by using a flame photometer (Model 405, Corning, UK) using NaCl and KCl to prepare the standards. All other metals were determined by atomic absorption spectrophotometer (Perkin-Elmer Model 403, Norwalk CT, USA). All determinations were done in triplicate. All chemicals used were of analytical grade (BDH, London). Earlier, the detection limits of the metals had been determined according to Techtron (1975). The optimum analytical grade was 0.1 to 0.5 absorbance units with a coefficient of variation of 0.87-2.20%. The minerals were reported as mg/100 g.

The physicochemical analysis of the seed oil for acid value, iodine value, saponification value, peroxide value, free fatty acid and specific gravity, were carried out according to the methods of AOAC (1990).

The research study was conducted between February and October 2005 in the Chemistry and Industrial Chemistry Laboratories of Nasarawa State University, Keffi and Federal University of Technology, Akure respectively.

RESULTS AND DISCUSSION

The data on the proximate composition, energy and fatty acid values of the cream coat (A_2) and dark red coat (B_2) of Bambara groundnut seed flowers are shown in Table 1.

Table 1: Proximate composition of two varieties of BBG seed flours (%)

Parameter	A_2	B_2
Moisture	2.07±0.01	3.04±0.02
Total ash	4.28±0.13	3.89±0.43
Crude fat	6.72±0.30	4.10±0.1
Crude fibre	2.07±0.05	4.05±0.01
Crude protein	11.56±0.24	11.05±0.01
Carbohydrate by difference	73.30	73.87
Fatty acids	5.36	3.28
Energy [b] KJ/100 g	1691.26	1595.34

Values are mean±standard deviation of triplicate determinations, [a] Calculated fatty acids (0.8 × Crude fat), [b] Calculated metabolisable energy (KJ/100 g) (Protein x 17+Fat × 37+Carbohydrate × 17)

The percentages of moisture content, total ash, crude protein and carbohydrate (by difference) of the two varieties (A_2 and B_2) are comparable with a difference of less than 1.0 while difference of about 2.0% are observed in the percentages of crude fat and crude fibre.

The moisture content values were generally low but are within the range expected of most legumes (Olaofe and Sanni, 1988; Oyenuga, 1968). The low moisture content will afford a long shelf-life for BBG dehulled seeds. B_2 seed flour with higher moisture content would imply higher susceptibility to microorganism attack than the A_2 seed flour.

The crude fat content value of A_2 compares favourably with the value of 6.0% of bambara groundnut as reported by Elegbede (1998). But this crude fat content does not qualify BBG as oil-rich legume when compared with soybean (22.8 and 23.5%) reported by Salunkhe *et al.* (1985) and Paul and Southgate (1980); pumpkin seed (49.2 and 47.0%) by Aisegbu (1987) and Fagbemi and Oshodi (1991) and *C. vulgaris* (47.9-51.1%) by Ige *et al.* (1984).

The crude protein values of the two varieties which are nearly the same are not comparable with 24% for BBG reported by Poulter (1981); 175-21.1% by Onimawo *et al.* (1998); 22.2% by Ferao *et al.* (1987) and 16.6-18.2 g/100 g by Amarteifio and Moichubedi (1997). The reason for the differences may be due to the genotype and the environment conditions under which they are grown (Salunkhe *et al.*, 1985; Aremu *et al.*, 2005). The crude fibre, total ash and carbohydrate content values are comparable with some reported works in the literature (Poulter, 1981; Amarteifio and Moichubed, 1997; Shils and Young, 1988).

The calculated free fatty acids for the two varieties is moderate enough which suggest that BBG seeds oil is suitable for edible purposes and can also be utilized for industrial purposes. The calculated metabolisable energy values of 1691.26 KJ/100 g and 1595.34 KJ/100 g for A_2 and B_2, respectively showed BBG seeds have energy concentrations favourably comparable to cereals.

Table 2 represents mineral content of two varieties of BBG seed flours. The values recorded for the two varieties are comparable with little variations in some minerals.

Lead (Pb), cadmiun (Cd) and chromium (Cr) were not detected in any of the varieties indicating that BBG seeds are free from toxic and undesirable minerals which are harmful to the body. The least and abundant minerals in the two varieties of BBG seed flours were Cu and Ca, respectively. Calcium is important in blood clotting, muscle contraction and in certain enzymes in metabolic processes. Magnesium is the next highest mineral composition in both varieties. It has been reported that Magnesium is an activator of many enzyme systems and maintains the electrical potential in nerves (Ferrao *et al.*, 1987). The values obtained for Na and K are reasonably high in both varieties and may satisfy the nutritional needs of the consumers. Sodium and potassium are required to maintain the osmotic balance of the blood

Table 2: Mineral content of two varieties of BBG seed flours (mg/100 g of sample)

MINERAL	A_2	B_2
Fe	5.9±0.1	4.7±0.2
Cu	0.12±0.2	0.12±0.3
Pb	ND	ND
Mn	1.8±0.1	2.3±0.2
Cd	ND	ND
Zn	5.3±0.13	3.9±0.1
Na	7.4±0.1	10.6±0.2
K	33.5±0.1	42.7±0.2
Na/K	0.22±0.1	0.25±0.2
Mg	57.3±0.2	58.0±0.1
Ca	60.2±0.3	63.8±0.4
Cr	ND	ND

Values are Mean±Standard deviation of triplicate determinations, ND = Not Detected

Table 3: Physicochemical characteristics of two varieties of BBG Seed oils

Parameter	A_2	B_2
Free Fatty acids (mg g^{-1})[a]	4.85±0.10	4.80±0.2
Acid Value (mg KOH g^{-1})[a]	0.92±0.2	0.98±0.3
Saponification Value (mg KOH g^{-1})[a]	124.80±0.1	140.50±0.3
Iodine value (mg iodine g^{-1})[a]	121.00±0.05	120.00±0.2
Peroxide value[a]	286.00±0.5	290.00±0.2
Specific gravity (25°C)	0.88	0.85
Unsaponifiable matter (%)[a]	2.35±0.1	2.25±0.3

[a] Values are mean±standard deviation of triplicate determinations

fluids, pH of the body, regulate muscle and nerve irritability and control of glucose absorption (Fleck, 1976; Pike and Brown, 1967). The ratio of sodium to potassium, Na/K, in the body is of great concern for prevention of high blood pressure. Na/K ratio less than one is recommended. Table 2 further shows the Na/K ratios for the two varieties of BBG seed flours. The values obtained which were < 1 show that the food under consideration would probably reduce high blood pressure (Nieman *et al*., 1992).

The values of Fe, Mn and Zn which are also shown in Table 2 are evenly distributed between the two varieties. Iron is reported to be very important for normal functioning of the central nervous system (Vyas and Chandra, 1999; Adeyeye and Fagbohun, 2005). Iron also facilitates the oxidation of carbohydrates, proteins and fats. Zinc is present in all tissues of the body and it is a component of more than fifty enzymes. Consumption of meat (or other animal products) with vegetable enhances the absorption of both Iron and Zinc (Bender, 1992; NAS, 1971). Generally the values for most of the minerals in this present study are less than that of some oil seeds reported by Olaofe *et al.* (1994).

The results of the physicochemical characteristics of two varieties of BBG seed flours are shown in Table 3. A_2 (cream coat) seed oil is yellow in colour while B_2 (dark red coat) is light yellow.

The values obtained for all the physicochemical parameters are comparable between the two varieties. The free fatty acids values for A_2 and B_2 seed oils respectively are comparable with the value of 4.20 mg g^{-1} reported by Ferrao *et al.* (1987). Free fatty acids can stimulate oxidative determination of oils by enzymatic and/or chemical oxidation to form off-flavour components (Akintayo and Bayer, 2002). The specific gravity for BBG oils (A_2 and B_2) are less that one (<1) indicating that it is less dense than water. The iodine values obtained for the two varieties of BBG oils place them in the drying group oil since drying oils have an iodine value above 100 (Duel, 1951). The acid values for A_2 and B_2 which compare favourably with adenopus brevilorus seed oils (Akintayo and Bayer, 2002) and Hausa melon seed oil (Oladimeji *et al*., 2001) showed that BBG oil is an edible oil. Both oils showed high saponification values suggesting their utilization in production of liquid soaps and shampoos. The unsaponifiable matter values of 2.35±0.15 (A_2) and 2.25±0.3% (B_2) are favourably compared with 2.44% reported by Gaydolel *et al*. (1983).

CONCLUSIONS

The present study indicates that the chemical composition of bambara groundnut is independent of the variety. The crude protein and fat were very low incomparable with soybean and groundnut but they were good sources of essential mineral. The suitability of the oils for domestic use and utilization in production of liquid soap and shampoos are also revealed.

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REFERENCES

Adebowale, K.O. and O.S. Lawal, 2004. Comparative study of the functional properties of bambara groundnut, jack bean and Mucuna bean flours. Food Res. Intl., 37: 355-365.

Adeyeye, E.I. and E.D. Fagbohun, 2005. Proximate mineral and phytate profiles of some selected spices found in Nigeria. Pak. J. Sci. Ind. Res., 48: 14-22.

Aisegbu, J.E., 1987. Some biochemical evaluation of fluted pumpkin seed. J. Sci. Food Agric., 40: 151-155.

Akintayo, E.T. and E. Bayer, 2002. Characterization and some possible uses of *Phikenetia conophora* and *Adenopus brevilorus* seeds and seed oils. Bioresou. Technol., 85: 95-97.

Akpapunam, M.A., S.O. Igbedioh and I. Aremo, 1996. Effect of melting time on chemical composition and functional properties of soybean and bambara groundnut flours. Intl. J. Food Sci. Nutr., 47: 27-33.

Amarteifio, J.O. and E. Moichubedi, 1997. Condensed tannin content in four land races of Bambara groundnut (*Vigna subterrananea* (L.) Verde) Tropenlandwort. Germany, 98: 139-142.

AOAC, 1990. Official methods of Analysis, 15th Edn., Washington DC. Association of Official Analytical Chemists.

Aremu, M.O., A. Olonisakin, I.W. Otene and B.O. Atolaye, 2005. Mineral content of some agricultural products grown in the Middle Belt of Nigeria. Oriental J. Chem., 21: 419-426.

Bender, A., 1992. Meat and meat products in Human Nutrition in Developing Countries. FAO Food and Nutrition Paper. 53 Food and Agriculture Organisation, Rome, Italy.

Duel, H.J. Jr., 1951. The Lipids: Their Chemistry and Biochemistry. Vol. 1 New York Interscience Publishers.

Elegbede, A.J., 1998. Nutritional quality of plant food. Ahmadu Bello University, Zaria, Nigeria, pp: 53.

Enwere, N.J. and Y.C. Hung, 1996. Some chemical and physical properties of bambara groundnut seed and products. Intl. J. Food Sci. Nutr., 47: 469-475.

Fagbemi, T.N. and A.A. Oshodi, 1991. Chemical composition and functional properties of full fat fluted pumpkin seed flour (*Telfairia occidetalis)* Nig. Food J., 9: 26-32.

Ferrao, J.E.M. A.M.B.C. Ferrao and A.M.G. Antures, 1987. Bambara groundnut (*Vigna subterranean)* Aspects of its nutritional value. Garcia deorta, seriede estudos Agronomicos, 14: 35-39.

Fleck, H., 1976. Introduction to Nutrition 3rd Edn., Macmillan. New York, USA., pp: 207-219.

Gaydolel, E.M., J.P. Blanchimi and J.V. Rotorohevy, 1983. Triterpene alcohols, methysterols, sterols and fatty acids in five Malagasy legume seed oils. J. Agric. Food Chem., 31: 833-836.

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.

James, C.S., 1996. Analytical Chemistry of Foods. New York. Chapman and Hall.

Johnson, D.J., 1968. The Bambara groundnut: A review. Rhod. Agric. J., pp: 65.

Linnemann, A.R., 1994. Thermal regulation of phonological development and growth bambara groundnut. Ph. D Thesis, University of Wageningen, Netherlands.

National Academy of Science, 1971. Food and Nutrition Board: Zinc in Human Nutrition In: Introduction to Nutrition. H. Felck (Ed.) 3rd Edn. Macmillan. Publishing Co. Inc. New York, USA, pp: 253.

Nieman, D.C., D.E. Butterworth and C.N. Nieman, 1992. Nutrition Winc. Brown Publishers Dubugue, USA., pp: 237-312.

Oladimeji, M.O, A.O. Adebayo and A.K. Adegbesan, 2001. Physio-chemical properties of Hausa melon seed flour. Utra Sci., 13: 374-377.

Olaofe, O. and C.O. Sanni, 1988. Mineral contents of agricultural products. Food Chem., 30: 73-77.

Olaofe, O., F.O. Adeyemi and G.O. Adediran, 1994. Aminoacid and Mineral composition and Functional properties of some oil seeds. J. Agric. Food. Chem., 42: 878-881.

Onimawo, J.A., A.H. Momoh and A. Usman, 1998. Proximate composition and functional properties of four cultivars of bambara groundnut. Plants Food for Human Nutr., 53: 153-158.

Oshodi, A.A. and M.M. Ekperigin, 1989. Functional properties of pigeon pea (*Cajanus cajan*) flour. Food Chem., 34: 187-191.

Oyenuga, V.A., 1968. Nigeria's Foods and Feeding Stuff, 3rd Edn. Ibadan. Ibadan University Press.

Paul, A.A. and D.A.T. Southgate, 1980: The Composition of Foods. McCance and Widdowsen's London. HMSO/Royal Society of Chemistry.

Pearson, D., 1976. Chemical Analysis of Foods 7th Edn., London: ChurchHill Livingstone.

Pike, R.L. and M.L. Brown, 1967. Nutrition. An Integrated Approach. Wiley, New York, USA., pp: 92-93.

Poulter, N.H., 1981. Properties of some proteins fractions from Bambara groundnut. J. Sci. Food Agric., 32: 44-50.

Rachie, K.O. and P. Silvestre, 1977. Grain Legumes In Leaky, C. L. A and J. B. Will (Eds.). Food Crops of the Lowland Tropics. Oxford University Press, Oxford, pp: 41-74.

Salunkhe, D.K., S.S. Kadam and J.K. Chavan 1985. CRC Postharvest Bioetchnology of Food Legumes. Bocaraton, FL. CRC Press.

Shils, M.E.G. and V.R. Young, 1988. Modern Nutrition in Health and Disease. In Nutrition Nieman, D.C., D.E. Butterworth and C.N. Nieman (Eds.). Winc. Brown publishers Dubugne, USA., pp: 276-282.

Techtron, V., 1975. Basic Atomic Absorption Spectroscopy: A Modern Introduction. Dominican Press. Victoria, Australia, pp: 104-106.

Temple, V.J. and R. Aliyu, 1994. Proximate composition of the cream coloured decorticated seeds of bambara groundnut (*Voandzeia subterranean)* (L.) Thoars) Biosci. Res. Commun., 6: 51-54.

Vyas, D. and R.K. Chandra, 1999: Iron nutrition in infancy and childhood. Discov. Innov., 11: 75-81.