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Proximate composition of some Nigerian Bambara groundnut (*Vigna subterranea* (L.) Verdc.) accessions

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Abstract

Bambara groundnut (*Vigna subterranea* (L.) Verdc.) is grown for food and income in Nigeria. A total of ten landraces of bambara groundnut with varying seed coat and eye colours were collected directly from farmers in Kogi, Niger and Kaduna States of Nigeria and taken to the Biochemistry Laboratory of Kogi State University, Anyigba, for proximate analysis. The results revealed significant differences among evaluated accessions in all the estimated parameters. Moisture content ranged from 11.00 (Accession 007 and 010) to 13.50 % (Accession 003), ash content ranged from 0.08 (Accession 007) to 2.75% (Accession 003), crude fibre content ranged from 2.63 (Accession 003) to 6.30 % (Accession 007), total fat content ranged from 9.88 (Accession 001) to 15.85% (Accession 006), crude protein content ranged from 12.47 (Accession 007) to 24.61% (Accession 010) and available carbohydrates ranged from 42.17 (Accession 010) to 56.66 % (Accession 001) . The result of this research reveals that the nutritional composition of bambara groundnut falls within Food and Agricultural Organization (FAO) standards and therefore are an excellent source of protein, lipid, carbohydrate and mineral elements. The crop will help to alleviate the problem of malnutrition and contribute to food security in Nigeria, particularly among the poor rural families who cannot afford expensive animal protein.

Keywords: Bambara groundnut; Proximate analysis; Nigeria; Accessions

1. Introduction

Bambara groundnut (*Vigna subterranea* (L.) verdcourt) is a member of Fabaceae Family. It is an under - utilized African legume cultivated mainly by subsistence farmers under the traditional low input agricultural system. It serves as an important source of protein in the diets of a large percentage of the population in Nigeria, particularly to poorer people who cannot afford expensive animal protein [1].

Vigna subterranea, a self-pollinating annual legume, is one of the most cultivated legumes by resource-limited farmers living in rural areas [2]. It is cultivated majorly for its seeds which are produced in pods under the ground [3]. The crop has maturity periods of 16 - 22 weeks after planting [4]. It is characterised with varying seed coat and eye colours such as cream, brown, red, black, dark brown, dark red, etc and it is the third most important legume after peanuts (*Arachis hypogea*) and cowpea (*Vigna unguiculata*) [5]. The crop is said to be tolerant to drought [6] and pests [7]. It also produces a reasonable yield when grown under poor soil conditions [8]. [2] demonstrated that *Vigna subterranean* is resilient to adverse environmental conditions as it tolerates low fertility soils and low rainfall. [9] also reported that *Vigna subterranea* could successfully grow in areas with less than 500 mm of annual rainfall. The drought resistance of local landraces of *Vigna subterranea* was affirmed by [10] and [11]. The authors went on to suggest that *Vigna subterranean* may be a suitable crop for cultivation in marginal areas with low rainfall.

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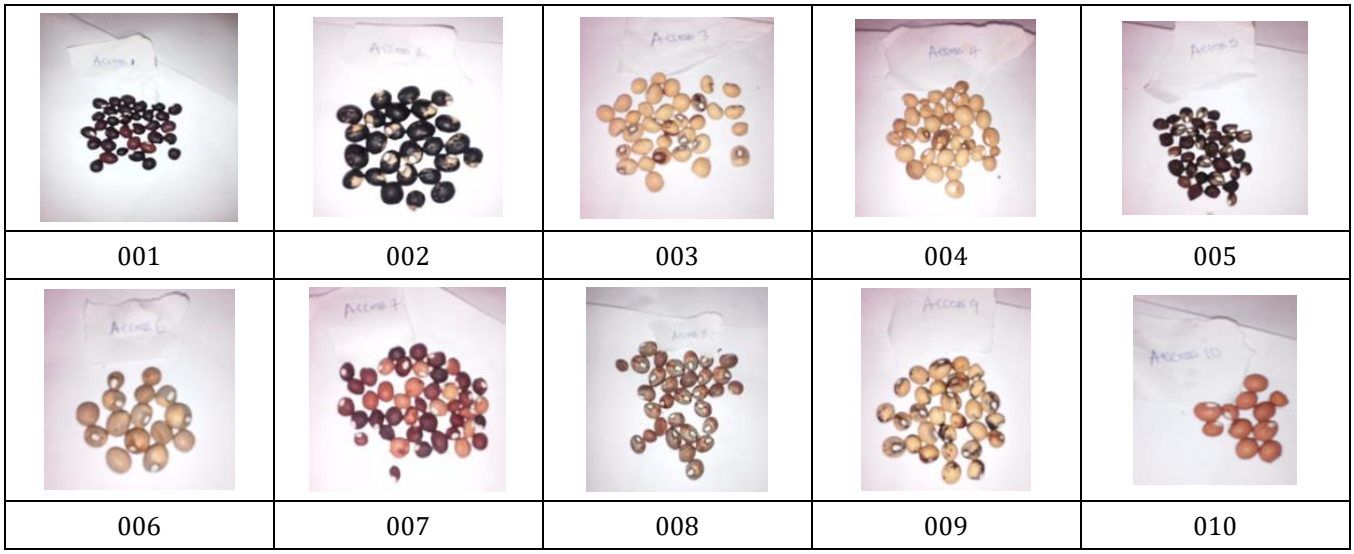
Bambara groundnut is consumed in various ways in Nigeria. The seeds can be eaten fresh when boiled; it can also be boiled after drying. The seeds can be milled and used to make flour. A paste can be made from the flour and then used in the preparation of various fried and steamed products like "akara" and "moimoi" and also a delicious delicacy called "Okpa" [12]. *Vigna subterranea* seed makes a complete feed for both humans and animals. It can also be used as feed ingredients and incorporated in the formulation of animal feeds. It can be easily converted to 'meat', which may meet human needs for animal-protein. *Vigna subterranea* plays an important synergistic role with staple foods both in meeting nutritional requirements and fertilizing the soil. It has nodules in the roots which help to fix atmospheric Nitrogen to the soil. Despite the aforementioned importance of this crop, studies on the nutritional potentials of this crop are still scanty. The objective of this study was to provide information on the proximate analysis of some selected Nigerian bambara groundnut accessions collected from farmers in Nigeria.

2. Material and methods

2.1. Sample collection and preparation

A total of ten bambara groundnut accessions with varying seed coat colours and eye colours (Figure 1) were collected at the same time from local farmers in Kogi, Niger and Kaduna states of Nigeria (Table 1). The different bambara groundnut accessions were carefully cleaned and freed from broken and extraneous matters. The seeds were milled into fine flour and screened using sieve having 0.4 mesh.



001	002	003	004	005
006	007	008	009	010

Figure 1 Bambara Groundnut accessions used in the study

Table 1 Source and description of Bambara Groundnut Landraces used in the study

Accession	State	Local Government	Seed coat colour	Seed eye colour	Seed size
001	Kogi	Ofu	Dark red	Plain	Medium
002	Niger	Chanchaga	Black	Cream	Large
003	Niger	Bida	Cream	Ash/brown	Medium
004	Niger	Kuta	Cream	Brown	Medium
005	Niger	Kotangora	Black	Ash	Medium
006	Niger	Kuta	Cream purplish spots	Ash	Medium
007	Kaduna	Zaria	Red	Plain	Medium
008	Niger	Kwaruru	Brown	Ash	Medium

009	Kaduna	Zaria	Cream	Black	Medium
010	Kogi	Dekina	Brownish red	Plain	Medium

2.2. Determination of Moisture Content

The moisture content was determined according to the method of AOAC, [13]. 2 g of well mixed samples were weighed accurately in clean preheated moisture dish of known weight by using weighing balance. The uncovered sample and dish were kept in an oven provided with a fan at 105 ^{0}C and left to stay overnight. The dish was covered and transferred to a desiccator, and weighed after cooling to room temperature. The dish was heated in the oven for another two hours and was reweighed. This was repeated until constant weight was obtained. The loss of weight was calculated as percentage of weight and expressed as moisture content.

$$\text{Moisture content (\%)} = \frac{W1 - W2}{\text{Sample Weight}} X\ 100$$

Where:
W1 = Weight of sample + dish before oven drying.
W2 = Weight of sample + dish after oven drying.

2.3. Ash Content determination

A crucible was weighed empty, and then accurately two grams of dry samples were weighed. Then placed in a muffle furnace at 550 ^{0}C for 3 hrs or more until white grey or reddish ash was obtained. The crucible was removed from furnace and placed in a desiccators to cool, then was reweighed. The process was repeated until constant weight was obtained.

$$\text{Ash content (\%)} = \frac{W2 - W1}{Ws} X\ 100$$

Where:
W 1 = weight of empty crucible
W2 = weight of crucible + sample after ashing
Ws = weight of dry sample

2.4. Crude Fibre determination

2g of dry defatted seeds of each accession were weighed. 150 ml of the H_2SO_4 (conc. 7.3 ml/L) were added and then heated to boiling. The mixture was boiled for 30 minutes and then filtered. The residue was washed three times with hot water. 150 ml of pre-heated KOH (12.89 g/L) were added and heated to boiling for 30 minutes and then filtered. The residue was washed three times with hot water, dried under suction and then in an oven at 105^{o}C overnight and then weighed (W1). The residue was ashed in a muffle furnace at 550 ^{0}C for three hours till a light grey ash was formed, then re-weighed to give W2. The percentage of the crude fibre was calculated using the following equation:

$$\text{Crude fibre (\%)} = \frac{W1 - W2}{Sample\ weight} X\ 100$$

Where:
W1 = the weight of oven dry sample after treatment by $H_2SO_4$and KOH
W2 = the weight of the treated sample after ashing.

2.5. Crude Fat determination

The fat was determined using 2 g of oven dried seeds of each bambara groundnut accession. Extraction of the fat from each sample was carried out by Soxhlet extractor using n- hexane as a solvent for 8 hrs. After recovery of the solvent, it was put in an oven at 105 ^{0}C for two hours to give fat free solvent, then it was allowed to cool in a desiccator and finally weighed to a constant weight. The percentage of the crude fat was calculated using the following equation:

$$\text{Crude fat (\%)} = \frac{W2 - W1}{DrySampleweight} X\ 100$$

Where:
W 1 = the weight of the empty extraction flask.
W 2= the weight of the extraction flask with the extracted oil.

2.6. Crude Protein determination

Crude Protein was determined using micro-Kjeldahl nitrogen digestion and distillation method [14] as follows: A 0.2 g of oven dried sample was weighed into 100 ml Kjeldahl flask. 0.4 g of catalyst mixture (96 % anhydrous sodium sulphate + 4 % cupric sulphate) was added to 5 ml of concentrated sulphuric acid. The sample and the contents were heated using an electric heater for 2 hours. The sample was cooled, diluted and placed in the distillation apparatus. 20 mls of 40 % NaOH were added, and distilled for 7 minutes. The ammonia evolved was received in 10 ml of 2 % boric acid solution, contained in a conical flask attached to the receiving end. The trapped ammonia was titrated against 0.02 HCl using a universal indicator (methyl red + bromocresol green). The protein (%) was calculated using the following equation:

$$\text{Crude protein (\%)} = \frac{(\text{ml HCI} - \text{ml HCI Blank}) \times 0.02 \times 14 \text{ x } 6.25 \times 100}{Dry\ Sample\ weight \times 1000}$$

Where:
0.02 = normality of HCI.
14= nitrogen molecular weight.
1000 = to convert from g equivalent to mg.
6.25 = protein conversation factor.

2.7. Carbohydrate determination

The Carbohydrate was determined according to AOAC, [14]. The available carbohydrates were determined by difference according to the following equation:-

Available Carbohydrates = 100 – (moisture content + ash content + fat content + fibre content + protein content

2.8. Data Analysis

Data obtained was analysed using analysis of variance (ANOVA) and Duncan multiple range test to separate between treatments with significant means using SPSS 20 version.

3. Result and discussion

The major nutritional components (moisture, ash, crude fibre, fat, protein and carbohydrates) of the ten Bambara groundnut accessions (Accession 001, 002, 003, 004, 005, 006, 007, 008, 009 and 010) expressed on dry weight basis are presented in Table 2. The moisture content ranged from 11.00 to 13.50%. The highest moisture content (13.50%) was found in Accession 003, which was significantly higher ($P<0.05$) than the other accessions. The lowest moisture content was observed in accession 007 and 010. The range of moisture content obtained in this result is higher than the 10.55 to 11.11 % reported by [15] but similar to that of [16] who observed an average moisture content of 12.59 % among Bambara groundnut landraces grown in Madobi Local Government Area of Kano state, Nigeria. [17] and [18], also observed moisture content of 13.3 % and 11.09 % respectively in Bambara groundnut. Higher moisture content is associated with increased microbial activities which makes it necessary to dry the seeds properly before storage.

The values of ash contents of all accessions of Bambara groundnut studied ranged from 0.08 to 2.75%. Accession 003 contained highest ash content (2.75 %) although not significantly different from accessions 004, 005 and 002 while accession 007 had the lowest ash content. The ash content observed in this studies which ranged from 0.08 to 2.75% is lower than 3.25% observed by[16]. The ash content observed in the bambara groundnut accessions studied indicates the presence of nutritionally important mineral elements in Bambara groundnut.

The crude fibre contents obtained from the ten accessions of Bambara groundnut ranged from 2.63 to 6.30 %. The highest crude fibre was observed in accession 007 (6.30 %) while the lowest was observed in accession 003 (2.63 %) and they were significantly different from all other accessions. This is lower than 6.60 % reported by [17] but similar to the values reported by [16] and [18] who reported crude fibre contents of 5.74 and 5.12% respectively. The crude fibre content of bambara groundnut will enhance bowel regularity and reduce constipation. It will also help to maintain normal cholesterol levels and blood sugar levels hence preventing heart diseases.

There was also significant difference in the fat content of the Bambara groundnut accessions studied. The fat content ranged from 9.88 to 15.85 % with Accession 006 having the highest fat content and accession 001 the lowest. This is higher than the values reported by other authors like [15] (7.71%), [16] (7.05%), [19] (7.35%). Dietary fat increases palatability of food by absorbing and retaining flavours [20] although excess of fat causes Cardiovascular disorders [20].

The protein contents ranged from 12.47 to 24.61 %. The highest protein content was found in accession 010, and the lowest was observed in accession 007 and they were significantly different from all other accessions. The results of protein content obtained is similar to those obtained by [16] (18.83 %) and [21] (17.70%) but lower than the value 24.8% reported by [17]. The main function of protein is growth and replacement of worn out tissues in humans. This implies that bambara groundnut can serve as a good source of protein and will enhance growth and repair of tissues when consumed.

The carbohydrate contents of Bambara groundnut accessions ranged from 42.17 to 56.66 %. Accession 001, 002 and 007 had higher carbohydrate content than the other accessions investigated. This value is lower than values reported by [22] (63.37%) and 15 (67.5%). This indicates that bambara groundnut is a good source of carbohydrate hence providing energy when eaten.

The result obtained in this study has revealed that the Nigerian Bambara groundnut accessions studied have good nutritional composition as they are excellent sources of protein, carbohydrate, lipid and fiber. The appreciable fibre content in Bambara groundnut could help in providing roughage that aids digestion. [23]also reported that the fibre could help reduce the risk of cardiovascular diseases caused by high cholesterol level, by decreasing cholesterol levels in the body. Soluble fibres could bind to bile acids in the small intestine which makes them less likely to enter blood circulation. This will reduce cholesterol levels in the blood and normalize blood lipid levels. All the Bambara groundnut accessions studied have good nutritional composition and can be used for further breeding works and to combat the problem of malnutrition and food insecurity in Nigeria.

Table 2 Proximate Analysis of ten selected Nigerian Bambara Groundnut Accessions

Accessions	Moisture (%)	Ash (%	Fibre (%)	Fat (%)	Protein (%)	Carbohydrates (%)
001	12.00±007^{b}	1.75±0.354^{c}	5.50±0.007^{f}	9.88±0.177^{a}	14.22±0.31^{d}	56.66±0.841^{e}
002	11.25±0.354^{a}	2.25±0.007^{cd}	5.03±0.354^{d}	12.00±0.00^{d}	13.67±0.16^{c}	55.81±0.544^{e}
003	13.50±0.007^{d}	2.75±0.354^{d}	2.63±0.177^{a}	11.75±0.354^{cd}	15.97±0.31^{e}	53.41±0.219^{cd}
004	12.50± 0.007^{bc}	2.73±0.354^{d}	5.98±0.035^{g}	11.50±0.00^{c}	14.44±0.31^{d}	53.36±0.467^{cd}
005	12.13±0.007^{bc}	2.50±0.007^{d}	3.78±0.354^{b}	10.78±0.035^{b}	19.80±0.156^{f}	51.03±1.859^{c}
006	11.25±0.354^{a}	1.20±0.070^{b}	4.63±0..177^{c}	15.85±0.041^{h}	13.02±0.16^{b}	54.06±0.445^{cd}
007	11.00±0.007^{a}	0.08±0.035^{a}	6.30±0.070^{h}	15.23±0.354^{g}	12.47±0.31^{a}	54.98±0.304^{de}
008	11.25±0.354^{a}	0.75±0.354^{b}	4.70± 0.354^{c}	14.78±0.035^{f}	23.85±0.3^{h}	44.43±0.693^{b}
009	12.75±0.354^{c}	1.78±0.318^{c}	5.28±0.035^{e}	13.23±0.354^{e}	21.98±0.6^{g}	45.00±0.127^{b}
010	11.00±0.007^{a}	1.15±0.141^{b}	5.25±0.007^{e}	15.83±0.007^{h}	24.61±0.16^{i}	42.17±0.191^{a}

Means ± standard deviation with same alphabet(s) in a column are not significantly different at P>0.05 determined by Duncan Multiple Range test.

4. Conclusion

The proximate analysis, which gives an initial impression of the relative nutritive value, showed that Bambara groundnut contains appreciable levels of protein, carbohydrate, fats and fiber that can help solve the problem of malnutrition and food insecurity. Further researches are needed to determine the amino acid and fatty acid profiles, protein fractionation and the effects of traditional processes on nutritional quality of the bambara groundnut accessions.

Compliance with ethical standards

Acknowledgments

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Disclosure of conflict of interest

No conflict of interest to be disclosed.

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