Agro-Science
Journal of Agriculture, Food, Environment and Extension
Volume 6, Number 2 June 2007 pp. 73 - 84

ISSN 1119-7455 URL: http://www.agrosciencejournal.com/

CHEMICAL COMPOSITION OF FOUR VARIETIES OF GROUNDBEAN (*Kerstingiella geocarpa*)

Chikwendu, N.J.
Centre for Entrepreneurship and Development Research, University of Nigeria, Nsukka

ABSTRACT
The chemical composition of four varieties of groundbean (Kerstingiella geocarpa) was determined. Groundbean seeds were sorted out into four varieties on colour basis. Each variety was washed and dried at 50^{o}C for 4 h in a hot air oven and milled into fine flours. The flours were analysed for proximate, minerals, vitamins and antinurients composition using standard assay methods. The protein contents of the varieties ranged from 19.91 to 22.36% and the carbohydrate values varied from 68.82 to 70.52%. The varieties had low fat (2.15 to 2.42%) and high fibre (3.99 to 4.9%) levels. The non protein nitrogen (0.42 to 0.70%) and antinutrients (0.07 to 0.55 mg/100g) levels were low. The results showed that groundbean is a good source of iron (9.89 to 13.39 mg/100g), zinc (4.42 to 4.92 mg/100g) and potassium (235.73 to 341.94 mg/100g). The chemical evaluation showed that groundbean has valuable nutritional attributes.

Key words: Groundbean, variety, nutrient, antinutrients .

INTRODUCTION
Legumes are recognized as a major source of dietary protein and energy in the developing countries where cost of animal protein is very expensive. Out of many species of legume in plant kingdom only very few are consumed as food. Cowpea, groundnut, bambara groundnut, soybean, sesame, pigeon pea, African yam bean, and groundbean are consumed in Nigeria. However, some of these legumes are underutilized. The low consumption or under-utilization of some of these legumes are likely due to hard-to-cook characteristic of legumes, lack of information regarding their nutritive values, presence of antinutrients in the legumes, taboos and cultural beliefs, and low production. The compositional evaluation of commonly consumed legumes have been reported by several workers (Elegbede, 1998; Onwuliri and Obu, 2002; Adebawale and Lawal, 2004) while little had been reported about groundbean.

Groundbean is one of the lesser known and under-utilized legume indigenous to West Africa. It is a member of the Fabaceae family, which produces pods inside the ground. The pod contains about 1 to 3 seeds with helium and relatively thick seed coat (NAS, 1979). The tasty nutritious dry seeds of groundbean contain appreciable quantities of some nutrients such as protein–21.5g, carbohydrate–73.9g, and its protein is composed of lysine–6.2% and methionine–1.4% (NAS, 1979). Groundbean is mostly produced and consumed in few rural communities in Northern part of Enugu State. Chikwendu (2005) observed that only 58% Nrobo community in Enugu State produced groundbean. In contrast to the commonly consumed staple legumes, groundbean has not attained national or worldwide importance. This study determined the chemical composition of groundbean flours with a view to providing useful information that could improve its utilization.

MATERIALS AND METHODS
Groundbean was bought from farmers in "Nrobo" Local Market of Enugu State. The seeds were hand picked to remove damaged seeds and then sorted out from a batch on colour basis. Four different colours identified were reddish brown, brown, light brown and deep-cream groundbean. The groundbean varieties were separately washed with tap water, dried for 4h in a hot air oven (Galkenkamp BS Oven 250^{o}C, Model No 320) at 50^{o}C and milled in a laboratory hammermill (Thomas Wiley Mill, Model ED-5) to fine flours (70mm mesh screen). The samples were stored in a separate airtight polyethene bags of about 10cm^{3} capacity till analysed.

Chemical analysis
Proximate, sugar and mineral composition were analysed according to AOAC (1995). Residual moisture was determined by the hot air oven method as described by Polacchi (1985). The energy content of the samples were determined by introducing 2g of the pelleted sample into an adiabetic bomb calorimeter following the manufacturer's instructions. Carbohydrate

contents were determined by difference. The non protein nitrogen (NPN) was estimated by the method of Singh and Jambunathan (1981). One gramme sample was extracted with 10% tetrachloroacetic acid (Cl_3ACOH) (TCA) after allowing to stand for 30 minutes and centrifuged at 3,000 rpm for 30 minutes. The supernant was decanted and analysed for non-protein nitrogen using micro Kjeldahl method as described in nitrogen determination. The true protein nitrogen (TPN) was obtained by subtracting non-protein nitrogen from total nitrogen while true protein was obtained by multiplying TPN by the nitrogen conversion factor (6.25).

Thiamin, riboflavin and vitamin C were determined using Sharkey *et al.* (1968) methods as described by Pearson (1991). The B-Carotene was estimated using the method of Simpson *et al*. (1987). Trypsin inhibitor was determined by the method of Hammerstrand *et al.* (1981). Tannin contents of the samples were estimated using Price *et al.* (1980) procedure. Phytates were determined by the modified method of Latta and Eskin (1980). Oxalate was determined using the method of Fassett (1973). The saponins were estimated using the method of Bergmeyer (1974). The Cynanide content was enzymatically determined using Cooke (1978) method.

Statistical analysis

Means and standard deviation were calculated for triplicate determination using the SPSS 10 Computer Software Package.

RESULTS

The proximate composition, sugar and energy contents of four varieties of groundbean on dry weight basis are shown in Table 1. The protein values of the varieties varied from 19.91 to 22.36%. Among the varieties the light brown groundbean (LBGB) had the lowest crude protein (19.91%). The deep-cream variety (DCGB) had the highest protein (22.36%) relative to the other varieties.

The total nitrogen (TN) of DCGB was 3.61%. The LBGB had the least value of 3.16%. The non protein nitrogen (NPN) ranged from 0.07 to 0.42%. The range was from 2.46 in LBGB to 2.91% in DCGB. The true protein values ranged from 15.31 in LBGB to 18.31% in BGB.

The fat values ranged from 2.15 in DCGB to 2.42% in RBGB variety. The crude fibre values of the groundbean varieties varied from 3.99 to 4.9%. The LBGB had the highest crude fibre (4.9%) when compared to others. The value was about 22.8% higher than the brown variety (BGB), which had the least value. The ash values ranged from 2.46 to 2.91%. The RBGB ash value was higher than the others.

The Carbohydrate values varied. The LBGB variety had the highest value of 70.52% while the DCGB had the least value (68.82%). The sugar values for groundbean varieties varied. The range was from 0.30 to 0.80g/100g. The energy values, ranged from 1688 to 1713 KJ/100g. The RBGB had the highest value when compared with others.

Table 1: Proximate composition, nitrogenous constituents, sugar and energy values of four varieties of groundbean (dry matter basis)*

	Variety			
Nutrients	**RBGB**	**BGB**	**LBGB**	**DCGB**
Crude Protein (%)	21.58±0.53	20.91±1.04	19.91±0.65	22.36±0.06
Total nitrogen (%)	3.45±0.15	3.35±0.10	3.16±0.06	3.61±0.21
Non protein nitrogen (%)	0.70±0.20	0.42±0.02	0.70±0.20	0.70±0.10
True protein nitrogen (%)	2.75±0.17	2.93±0.46	2.46.0.20	2.91±0.10
True protein (%)	17.19±0.11	18.31±0.30	15.56±0.50	18.19±0.09
Crude fat (%)	2.42±0.07	2.18±0.03	2.21±0.95	2.15±0.57
Crude fibre (%)	4.17±0.40	3.99±0.21	4.9±0.91	4.10±1.00
Ash (%)	2.91±0.08	2.57±0.05	2.46±0.12	2.57±0.07
Carbohydrate (%)	68.92±0.35	70.35±0.03	70.52±0.22	68.82±0.22
Total Sugar g/100g	0.60±0.30	0.80±0.10	0.50±0.02	0.30±0.10
Energy KJ	1713	1705	1688	1697

*Mean ± SD of 3 determinations
RBGB = Reddish-brown groundbean
BGB = Brown groundbean
LBGB = Light brown groundbean
DCGB = Deep-cream groundbean.

The mineral and vitamin contents of four varieties of raw groundbean are shown in Table 2. The iron (Fe) content of the groundbean varieties ranged from 9.89 to 13.39 mg/100g. The DCGB had the least Fe (9.89mg). The Copper (Cu) values ranged from 0.35 to 0.92mg. The DCGB value was higher than that of the others. The LBGB had the highest iodine (I_2) value (2.62mg). The values for the other varieties were between 1.49 to 2.25mg. The BGB and the DCGB had the same value (2.25mg). The Zinc (Zn) values ranged from 4.42 to 4.92mg. The DCGB had the least zinc value when compare with the other varieties.

The phosphorus (P) values ranged from 74.42 to 100.13mg. The RBGB had higher P than those of the others. The difference was 34.5% when compared with the UDGB (74.42mg). The Calcium (Ca) values were between 14.54 and 19.74mg. The DCGB had higher Ca than the others. There were slight variations in magnesium (Mg) content of the four varieties. The DCGB had the lowest Mg (21.66mg) as compared to the others. The Mg levels ranged from 21.66 to 31.72mg. The Potassium (K) values ranged from 235.72 to 341.56mg. The LBGB had the highest (341.56mg) K. The difference was 45.1% as compared to the DCGB (235.73mg). The RBGB had the highest sodium (Na) value (10.74mg) and the LBGB had the lowest value (8.17mg).

There were variations in the vitamin contents of the four raw varieties of groundbean. The BGB had the lowest β-Carotene value (1.32mg) while the LBGB had the highest β-Carotene (2.12mg). The thiamin contents of BGB and LBGB were close and higher than those of RBGB and DCGB values. The LBGB contained more thiamin and riboflavin than the other three varieties. The DCGB had the highest vitamin C as compared to the other varieties (3.40mg/100g).

Table 2: The Mineral and Vitamin composition of Four Varieties of raw groundbean (dry weight)*

	Variety			
Nutrients	**RBGB**	**BGB**	**LBGB**	**DCGB**
Iron (mg/100g)	13.39±0.21	12.47± 0.20	13.08±0.02	9.89±0.20
Copper (mg/100g)	0.52±0.02	0.52±0.10	0.35±0.10	0.92±0.01
Zinc (mg/100g)	4.70±0.20	4.87±0.43	4.92±0.18	4.42±0.23
Iodine (mg/100g)	1.49±0.19	2.25±0.15	2.62±0.22	2.25±0.15
Phosphorus (mg/100g)	100.13±0.97	81.86±0.20	92.01±0.99	74.42±0.18
Calcium (mg/100g)	19.27±0.22	15.69±0.30	14.54±0.32	19.74±0.22
Magnesium (mg/100g)	31.49±0.20	31.72±0.18	31.44±0.19	21.66±0.32
Potassium (mg/100g)	307.56±0.40	289.81±0.11	341.94±0.14	235.73±0.17
Sodium (mg/100g)	10.94±0.12	10.81±0.20	8.17±0.11	9.01±0.99
B-Carotene (mg/100g)	1.62±0.08	1.32±0.01	2.12±0.08	1.49±0.03
Thiamin (mg/100g)	0.59±0.02	0.13±0.03	0.16±0.02	0.10±0.001
Riboflavin (mg/100g)	0.11±0.01	0.03±0.00	0.20±0.002	0.06±0.001
Vitamin C (mg/100g)	1.30±0.02	1.40±0.01	2.30±0.20	3.40±0.03

*Mean ± SD of triplicate determinations
RBGB = Reddish-brown groundbean
BGB = Brown groundbean
LBGB = Light brown groundbean
DCGB = Deep-cream groundbean.

The antinutrient composition of four varieties of groundbean are shown in Table 3. The trypsin inhibitor (TI) levels ranged from 0.24 in DCGB to 0.31mg in RBGB and BGB. The tannin values ranged from 0.48 to 0.55mg. The RBGB and LBGB had equal value of 0.52mg. The BGB had higher value (0.55mg) than those of the others (RBGB, LBGB and DCGB). The DCGB had the least (0.48mg). The phytate values varied from 0.13 to 0.21mg. The RBGB and the BGB had equal value of 0.17mg while DCGB had the least (0.13mg). The LBGB had the highest phytate value (0.21mg). The oxalate values differed among the groundbean varieties. The LBGB had the highest oxalate value (0.17mg) and the RBGB had the least value of 0.07mg. The saponin levels of the groundbean varieties varied. The RBGB and the DCGB varieties had almost equal values (0.15 and 0.14mg).

Table 3: Antinutrient composition of four varieties of groundbean (dry weight)*

	Variety			
Antinutrients	RBGB	BGB	LBGB	DCGB
Trypsin inhibitor (mg/100g)	0.31±0.01	0.31±0.01	0.28±0.02	0.24±0.11
Tannin (mg/100g)	0.52±0.10	0.55±0.22	0.52±0.08	0.48±0.01
Phytate (mg/100g)	0.17±0.02	0.17±0.02	0.21±0.00	0.13±0.01
Oxalate (mg/100g)	0.07±0.02	0.12±0.02	0.17±0.02	0.10±0.01
Saponin (mg/100g)	0.15±0.02	0.14±0.02	0.12±0.02	0.10±0.01
Cyanide (mg/100g)	0.17±0.02	0.18±0.01	0.19±0.01	0.16±0.03

* Mean ± SD of triplicate determination
RBGB = Reddish-brown groundbean
BGB = Brown groundbean
LBGB = Light brown groundbean
DCGB = Deep-cream groundbean.

DISCUSSION

The protein values of the varieties were within the range (20-40%) found in most edible legume (Elegbede, 1998). The high crude fibre content of groundbean might inhibit absorption of some of the minerals, for example calcium. However, fibre helps in fighting cancer and in reducing serum cholesterol. It also has positive effects on blood glucose and insulin concentration in both normal and diabetics, and increases faecal bulk (Nwokolo, 1996; Enwere, 1998). The high carbohydrate levels showed that groundbean could contain a good quantity of educing sugar.

The NPN, which constitute free amino acids, peptides and many other nitrogen compounds (Sathe, 1996) appears to be low in groundbean. The lower NPN and higher values of TPN and TN indicate that groundbean protein is of high quality. The difference in values among the groundbean varieties might be attributed to seed and soil type and maturity. The energy contents of the varieties were slightly higher than the energy values of most legumes which ranged from 333kcal to 350kcal/100g or 1398.6 to 1470.0 KJ (Latham, 1997). This suggests that groundbean can provide adequate energy to people who consume it.

The mineral values of groundbean were similar to those of other pulses such as chickpea, blackgram, mungbean and pigeon pea except for calcium and magnesium (Sathe, 1996). The mineral level of groundbean showed that it is a good source of iron, zinc, phosphorus, calcium, magnesium and potassium. The low sodium, fat and high fibre observed are desirable attributes inherent in pulses.

The thiamin, riboflavin, ascorbate and β-Carotene contents of groundbean were similar to those reported in chickpea, blackgram, mungbean and pigeon pea. (Sathe, 1996). The ascorbate values were slightly lower than the values reported for some dry beans in literature.

The low antinutrients observed in this study could be due to seed type. This observation are comparable to other reports found in chickpea, blackgram, mungbean and pigeon pea (Sathe, 1996). The levels of phytate and hydrogen cyanide in groundbean is within the safe levels observed in chickpea and pigeon pea. The lower tannin for DCGB variety than chickpea, black gram, mung bean, pigeon pea is very encouraging. It is recognized that the darker the colour of food grains, the higher the tannin levels (Beebe *et al*., 2000). Trypsin inhibitor were low and comparable to other pulses. The slight variation in levels of antinutrient in the four varieties might likely be due to seed colour, storage and level of maturity.

CONCLUSION

The results of the study suggested that groundbean varieties have good nutritional attributes. The high energy, protein and carbohydrate contents suggest that groundbean could be of great importance in alleviating protein energy malnutrition. The minerals and vitamins analysed in groundbean were similar to those of other popular legumes consumed globally. The low levels of antinutrients could enhance absorption of nutrient in groundbean. Further investigations are going on with groundbean for possible use in complementary food formulation.

REFERENCES

Adebawale and Lawal (2004). Comparative study of functional properties of bambara groundnut, jack bean and mucunabean flours. *Food Res. Int. 27*:355-365.

AOAC (1995). *Official Method of Analysis* 16th edn. Association of Official Analytical chemistry, Washington D.C.

Beebee,S., Gonzalez, A.V. and Rengifo, J. (2000). Research on trace element in the common bean. *Fd Nutr. Bull. 21*: 381-39.

Bergmeyer, H.U. (1974). Saponins. In: *Methods of Enzymatic Analysis 3*. Verlag Chemic Weinheim Academic. New York. 1868-1873.

Chikwendu, J.N. (2005). Production and availability of groundbean (*Kerstingiella geocarpa*) in a typical Nigerian Community: Implication for nutrition education and national development. *J. Home Econ. Res. 6(1)*: 135-141.

Cooke, R.D. (1978). An enzymatic assay for the cyanide content of cassava (*Manihot esculanta rantz*). *J. Sc. Fd. Agric. 29*:345-352.

Elegbede, J.A. (1998). Legumes. In: *Nutritional Quality of Plant Foods.* A.U. Osagie and O.U. Eka eds. The Post Harvest Research Unit, Department of Biochemistry, University of Benin. Benin City Nigeria, p. 53-83.

Enwere, N.J. (1998). *Foods of Plant Origin*. Afro. Orbis Publications, Nsukka.

Fassett, D.W. (1973). Oxalates. In: *Toxicants Occurring Naturally in Foods.* National academy of Science, Washington D.C.

Hamerstrand, G.E., Black, L.T. and Glover, J.D. (1981). Trypsin inhibitors in soy products: Modification of standard analytical procedure. *Cereal Chem. 58*:42-43.

Latham, M. (1997). Human Nutrition in Developing World. FAO *Food and nutrition series. No.29.* UN Rome.

Latta, M. And Eskin, M. (1980). A simple and rapid colorimetric method for phytate determination. *J. Agric. Fd. Chem. 29*:1315-1317.

NAS (1979). Tropical Legumes: Resources for the future. National academy of Science, Washington D.C.

Nwokolo, E. (1996). The need to increase consumption of pulses in the developing world. In: *Legumes and Oilseeds in Nutrition.* E. Nwokolo and J. Smart ed. Chapman and Hall, London, p. 1-11.

Onwuliri, V.A. and Obu, J.A. (2002). Lipids and other constituents of *Vigna unguiculata* and *Phaseolus vulgaris* grown in Northern Nigeria. *Food Chem. 78*: 1-7.

Pearson, D. (1991). *The Chemical Analysis of Foods.* 9th edn. Churchill Livingston Publisher, London.

Polacchi,W. (1985). Food composition tables: Recommended method for deriving nutrient values in their preparation. *J. AM. Diet. Assoc. 85*:1134-1136.

Price, M.L. Hagerman, A.E. and Butler, L.G. (1980). Tannin content of cowpea, chickpea, pigeon pea and Mungbean. *J. agric. Fd. Chem. 28*:459-461.

Sathe, S.K. (1996). The nutritional value of selected Asiatic pulses: Chickpea, black gram, mung bean and pigeon pea. In: *Legumes and Oilseeds in Nutrition.* E. Nwokolo and J. Smart eds. Chapman and Hall, London, p.12-32.

Sharkey, M.F., Andres, C.P., Snow, I.W., Major, A., Kram, T., Warner, V. and Alexander, T.G. (1968). Spectrophotometric Data of Vitamins. In *Chemical Analysis of Food.* D. Peason, 1976. 7th Ed. Churchhill Livingston NY, p. 548

Simpson, K.L., Tsou, T.C.S. and Chichester, C.O. (1987). Biochemical methodology for the assessment caroteries: A report of International Vitamin A. Consultative Group (IVACG). 46.

Singh, U. and Jambunathan, R. (1981). Relationship between non protein and total nitrogen in Chickpea (*Cicer arientinum* L.) seed. *J. Agric. Fd. Chem. 29*: 423-424.