Journal of Animal and Veterinary Advances 5 (11): 1022-1025, 2006

Determination of the Nutrient and Anti-Nutrient Components of Raw, Soaked, Dehulled and Germinated Bambaragrounnut Seeds

[1]S.O. Omoikhoje, [2]A.M. Bamgbose and [1]M.B. Aruna
[1]Department of Animal Science, Ambrose Alli University, Ekpoma, Nigeria
[2]Department of Animal Nutrition, University of Agriculture, Abeokuta, Nigeria

Abstract: The proximate and mineral compositions, gross energy, sugars, oligosaccharides and some anti-nutrient substances of raw, soaked, dehulled and germinated bambara groundnut seeds were determined. Crude protein, ash, crude fibre, nitrogen free extract and gross energy values were significantly (p<0.05) highest in Germinated Bambara Groundnut (GBG), compared to soaked and Dehulled Bambara Groundnut (SBG and DBG). Ether extract was significantly (p<0.0) reduced in DBG and GBG samples, but statistically highest in RBG and SBG seeds. Calcium, potassium and magnesium levels were significantly (p<0.05) higher in GBG seeds compared to the values in SBG and DBG. The value of phosphorous in RBG was significantly (p<0.05) reduced by dehulling and germination, but not affected by soaking. Sucrose and glucose levels of processed bambara groundnut seeds were significantly (p<0.05) highest in GBG samples than other processed samples. Whereas, the raffinose, stachyose, trypsin inhibitor activity, haemagglutinin, tannin and phytin contents were significantly (p<0.05) reduced by all the processing methods with the least value recorded in GBG. The results indicate that germination enhanced the nutrient contents and drastically reduced the anti-nutrient components of raw bambara groundnut seeds.

Key words: Nutrients, anti-nutrients, processing, bambara groundnut

INTRODUCTION

It is a known fact that cost of feed accounts for over 70% of the total cost of raising livestock intensively in developing countries. This is primarily due to the dearth and high cost of conventional plant protein feedstuffs such as soyabean and groundnut cake as well as the unhealthy competition for them by man and farm animals[1]. Thus, the quest for alternative plant protein sources that are of less industrial use, cheap, easily obtainable and rarely utilized outside their indigenous areas has become imperative. But, the exploitation of the full potentials of these alternative and underutilized plant protein sources can only be adjudged after a detailed compositional, nutritional and toxicological evaluation. One of such of underutilized plant protein sources is bambara groundnut (*Vigna substerranea* L. Verd C)

The crop is African in origin and can yield in soils with little rainfall and substantial yield under better condition[2,3]. The seeds contain up to 24% crude protein with a good balance of essential amino acids and relatively high proportion of lysine 6.6 and 1.3% methionine[4,5].

Previous studies on the nutritive value and toxic properties of bambara groundnut abound[6,7], but detailed information on the processing alternatives and its toxicological characteristics are scanty. Against this background, the study was designed to assess the effect of soaking, dehulling and germination on the nutrient and anti-nutrient components of bambara groundnut seeds.

MATERIALS AND METHODS

The processing of bambara groundnut seeds and laboratory analyses of the samples for proximate and mineral compositions, oligosaccharides and anti-nutrient substances were carried out in the Department of Animal Science Laboratory of Ambrose Alli University, Ekpoma of Edo State, Nigeria.

Purchase and processing of bambara groundnut seeds: Enough quantity of bambara groundnut seeds was purchased in Idah open market, Kogi State of Nigeria to avoid variation in the quality associated with different batches. The raw seeds were then divided into four batches of 0.5 kg each.

First batch: 0.5 kg of raw bambara groundnut seeds was kept in a black bag in a dry place.

Corresponding Author: S.O. Omoikhoje, Department of Animal Science, Ambrose Alli University, Ekpoma, Nigeria

Second batch: 0.5 kg of the seeds were soaked in 4 litres of water overnight at room temperature before they were sun dried at atmospheric temperature for 5 days by sparsely spreading the seeds on a wide jute mat.

Third batch: 0.5 kg of the seeds were soaked in 4 litres of water for 30 min at room temperature. Thereafter, the seed coats were removed (dehulled) and sun dried as in second batch.

Forth batch: 0.5 kg of raw and viable bambara groundnut seeds were selected and soaked in 4 litres of water for 3 h, after which they were spread on jute mat for 3-4 days. During this period, the seeds were sprayed with water on every 24 h to facilitate germination[8]. The growth of the sprouted seeds were terminated by sun-drying at atmospheric temperature for 5 days. All the samples were then milled, sieved in a 1.55 mm mesh and three samples were taken from each batch and analysed chemically in triplicates.

Analytical procedures: The proximate composition and gross energy of the raw and processed bambara groundnut seeds were determined[9]. Nitrogen free extract was determined by subtracting the summation of all other proximate fractions from 100%. Crude protein was determined as percentage nitrogen x 6.25 using the micro Kjeldahl distillation unit.

Amongst the minerals, sodium and potassium were analysed using the flame photometer, while phosphorus was determined by the phosphovanadomolydate method[9]. Other mineral constituents were determined after a wet digestion with a mixture of trioxonitrate (v) acid (HNO_3), tetraoxosulphate (vi) acid (H_2SO_4) and hydrochloric acid (HCl) using Atomic Absorption spectrophotometer. Gross energy was determined in an adiabic 'bomb' calorimeter[9]. Oligosaccharides such as stachyose, raffinose and verbascose as well as glucose and sucrose, trypsin inhibitor, haemagglutinnin, phytic acid and tannin were determined[10-13].

Statistical analysis: Date obtained were subjected to a one-way analysis of variance (ANOVA) and significant means were compared using the Duncans multiple range test[14,15].

RESULTS AND DISCUSSION

Date on proximate composition of the raw and processed bambara groundnut seeds as reflected in Table 1 showed significant ($p<0.05$) variation between the raw and processed bambara groundnut seeds. Crude protein level of the raw sample 19.61% was significantly ($p<0.05$) decreased by soaking 18.03% and dehulling 16.90%, but increased significantly ($p<0.05$) to 22.66% due to germination. The higher crude protein content of germinated bambara groundnut seeds is in consonance with the reported increase in crude protein of germinated cowpeas[6]. Ether extract values were significantly ($p<0.05$) reduced by dehulling and germination, while soaked sample statistically had similar value with that of the raw seeds. Similarly, soaking and dehulling significantly ($p<0.05$) reduced the crude fibre values of raw bambara groundnut seeds with least value recorded in dehulled seeds, while germination significantly ($p<0.05$) increased the crude fibre content of the intact seeds. The values of ash and nitrogen free extract were significantly (<0.05) highest in germinated samples compare to the values in other treatment groups. While, both soaking and dehulling significantly ($p<0.05$) reduced the levels of ash and nitrogen free extract with the lowest value recorded in dehulled samples. However, the gross energy values of both the raw and processed samples followed a similar pattern with that of ash and nitrogen free extract except that the value obtained in soaked samples did not significantly ($p>0.05$) differ from that of the raw seeds. The significant effect of processing on these nutrients particularly germination lend support from these reports[16,17] on the effect of processing methods on phytic acid level and some constituents in bambara groundnut and pigeon pea, the effect of cooking, germination and fermentation on the chemical composition of Nigerian cowpea.

Table 1: Proximate composition of raw and processed bambara groundnut seeds

	Processing methods				
Fractions (%)	RBG	SBG	DBG	GBG	SEM±
Dry Matter (DM)	89.88	89.01	90.70	90.20	0.84
Crude Protein (CP)	19.61^b	18.03^c	16.90^d	22.66^a	0.20
Ether Extract (EE)	6.45^a	5.71^a	4.75^b	4.12^b	0.17
Ash	3.41^b	3.38^b	3.30^c	3.65^a	0.02
Crude Fibre (CF)	4.45^b	3.44^c	2.85^d	4.89^a	0.21
Nitrogen free extract	54.95^b	53.97^b	52.11^c	59.66^a	0.61
Gross energy(Kcal kg^{-1})	2557^b	2550^b	2530^c	2617^a	5.16

RBG: Raw bambara groundnut, SBG: Soaked bambara groundnut, DBG: Dehulled bambara groundnut, GBG: Germinated bambara groundnut, a-d: Means in the same row with varying superscripts differ significantly ($p<0.05$)

Table 2 reflects the effects of processing on the mineral content of bambara groundnut seeds. It showed that Calcium (Ca), Phosphorus (P), potassium (K) and Magnesium (Mg) levels of the intact seeds were significantly ($p<0.05$) affected by processing, while the reverse was the case for so sodium (Na), iron (Fe) and copper (Cu) levels of the raw seeds. The Ca content of the raw seeds was significantly ($p<0.05$) reduced by soaking and dehulling, but germination significantly

Table 2: Mineral contents of raw and processed bambara groundnut seeds

	Processing methods				
Contents (%)	RBG	SBG	DBG	GBG	SEM±
Calcium (%)	2.79^b	2.66^c	2.64^c	3.00^a	0.002
Phosphorus(%)	8.00^a	8.00^a	7.00^b	7.00^b	0.002
Potassium(%)	0.79^b	0.79^b	0.76^c	1.01^a	0.003
Sodium(%)	0.005	0.004	0.004	0.004	0.002
Magnesium(%)	0.67^b	0.68^b	0.70^a	0.71^a	0.0005
Iron (ppm)	151	152	150	153	0.26
Copper (ppm)	2.6	2.4	2.4	2.4	0.034

a-d: Means in the same row with varying superscripts differ significantly ($p<0.05$)

($p<0.05$ increased the level of Ca in the intact seeds. Similarly, the level of P was significantly ($p<0.05$) reduced in dehulled and germinated seeds but were similar in the soaked and raw samples. The value of K in the raw seeds was statistically ($p>0.05$) similar to that of the soaked seeds, but was significantly ($p>0.05$) reduced in dehulled seeds. Germinated seeds had a significantly ($p<.05$) higher value in K content. Magnesium levels were significantly ($p<0.05$) increased in dehulled and germinated bambara groundnut seeds, but there was no significant ($p<0.05$) variation between the values in the raw and soaked samples. However, intact seeds of bambara groundnut contain appreciable levels of Ca, P, K, Na, Mg., Fe and Cu. In parallel with the decreased ash values in soaked and dehulled samples, there was a decreased in the Ca, P and K levels relative to the raw bambara groundnut seeds. In addition, the increased ash value of the germinated seeds may have accounted for the increase in the levels of Ca, P, K and Mg in the sample. This observation agrees with the study on the effect of processing on the nutritive value of cowpea and soyabean[18,19].

The percentage sugar and oligosaccharide contents of bambara groundnut seeds as influenced by the processing procedures Table 3 showed that processing had a significant ($p<0.05$) effect on the sucrose, glucose, raffnose and stachyose levels of raw bambara groundnut seeds. The sucrose and glucose levels were significantly ($p<0.05$) higher in germinated seeds, followed by those of soaked and dehulled bambara groundnut seeds. Similarly, germination was more effective in the reduction of raffinose and stachyose levels in the raw form with 74.39 and 83.07% reduction, respectively. Dehulling significantly ($p<0.05$) reduced the raffinose and stachyose levels by 46.32 and 56.61%, while 35.79 and 51.32% reduction levels were obtained in raffinose and stachyose levels respectively in the soaked sample. The significant increase in the sucrose and glucose levels with corresponding decrease in the levels of raffinose and stachyose may be ascribed to the breakdown of and D-galactopyranose residues bound to the glucose moiety of sucrose[20,21].

Table 4 shows that bambara groundnut seeds contain trypsin inhibitor, haemagglutinnin, tannin and phytin which may limit the nutritional value of the legume, but the processing methods adopted in this study significantly ($p<0.05$) reduced the levels of these anti-nutrient substances. Trypsin inhibitor activity was significantly ($p<0.05$) reduced by 53.48, 64.17 and 69.52% in soaked, dehulled and germinated bambara groundnut seeds respectively compared to the levels in the intact seeds. However, the haemagglutinnin and tannin values followed the same pattern with that of trypsin inhibitor activity. Soaking, dehulling and germination inactivated, the haemagglutinnin and tannin levels by 51.95, 64.94% and 77.92, 54.55, 63.64 and 72.73%, respectively. Phytic acid levels was significantly ($p<0.05$) lowest in germinated seeds, followed by dehulled and soaked samples with 60.61, 31.82 and 24.24% levels of reduction respectively relative to the value in the raw sample. The highest percentage reduction of all the anti-nutrient substances assayed in germinated bambara groundnut seeds may be attributed to the activity of germination to break the intramolecular forces that exist within them[22,8]. This suggests better nutrients availability and utilization in germinated bambara groundnut seeds if used in the formulation of livestock feed or as human food.

Table 3: Percentage sugar and oligossacharide contents of raw and processed bambara groundnut seeds

	Processing methods				
Contents (%)	RBG	SBG	DBG	GBG	SEM±
Sucrose	20.14^c	21.14^c	21.55^b	22.59^a	0.07
Glucose	15.25^c	15.64^b	15.63^b	18.53^a	0.01
Raffinose	2.85^a	1.83^b	1.53^c	0.73^d	0.07
Stachyose	1.89^a	0.92^b	0.82^c	0.32^d	0.04
Verbascose	0.00	0.00	0.00	0.00	-

a-d: Means in the same row with varying superscripts differ significantly ($p<0.05$)

Table 4: Some anti-nutrient substances of raw and processed bambara groundnut seeds

	Processing methods				
Parameters	RBG	SBG	DBG	GBG	SEM±
Trysin inhibitor (mg g^{-1})	18.70^a	8.70^b	6.70^c	5.70^d	0.21
Haemagglutinin (Hu/mgN)	0.77^a	0.37^b	0.27^c	0.17^d	0.02
Tannin (mg 100 g^{-1})	0.11^a	0.05^b	0.04^c	0.03^d	0.02
Phytin (mg (mg100 g)	13.20^a	10.00^b	9.00^c	5.20^d	0.22

a-d: means in the same row with varying superscripts vary significantly ($p<0.05$)

CONCLUSION

The overall results from the study indicate that germinated bambara groundnut seeds is superior to soaking and dehulling in respect to nutrient retention and inactivation of inherent anti-nutrient substances. Therefore, germinated bambara groundnut seeds can be used as source of animal protein for man or livestock.

REFERENCES

1. Anele, U.Y., 2002. The effect of raw *Mucuna utilis* extract on broiler birds. B.Sc Thesis, Michael Okpara University of Agriculture, Umudike, pp: 1-2.
2. Linnemann, A.R., 1990. Cultivation of bambara groundnut (*Vigna subterranea* L. Verdc) in Western province, Zimbabwe. Report of a field study. Tropical crops communication No.16. Department of Tropical Crop Science, Wageningen Agricultural University.
3. Collision, C.T., K.P. Sibuga, A.J.P. Tarimo and S.N. Azam-Ali, 2000. Influence of sowing date on the growth and yield of bambaragroudnut landraces in Tanzania. Expt. Agric., 36: 1-13.
4. Heller, I., F. Begemann and J. Mushonga, 1997. Bambara groundnut (*Vigna subterranea* L. Verdc). Promoting the conservation and utilization of underutilized and neglected crops. Proc. 9th workshop on conservation and improvement of bambaragroudnut (*Vigna subterranea* L. Verdc). Harare, Zimbabwe. Institute of plant genetics and Crop Plant Res., pp: 166.
5. Temple, V.J. and R. Aliyu, 1994. Proximate composition of the cream coloured decorticated seeds of bambara groundnut (*Voandzeia substerrenea*) Biosci Res. Comm., 6: 51-54.
6. Obizoba, I.C. and H.I. Egbuna, 1992. Effect of germination and fermentation on the nutritional quality of bambara groundnut (*Voandzeia subteranea L. Thouars)* and its products (milk). Plant Foods Hum. Nutr., 42: 13-23.
7. Marfo, E.R., B.R. Simpson, J.S. Idowu and O.L Oke, 1990. Effects of food processing on phytate levels in cassava, cocoyam, maize, sorghum, rice, cowpea and soyabean. J. Agric. Food Chem., 36: 1580-1583.
8. Esonu, B.O., A.B.I. Udedibie and C.R. Carlini, 1998. Effects of toasting, dry urea treatment and sprouting on some thermostable toxic factors in the jackbean seed. Nig. J. Anim Prod., 25: 36-39.
9. A.O.A.C, 2000. Official Methods of Analysis. Association of Official and Analytical Chemists (17th Edn.) Washington DC.
10. Oke, D.B., O.O. Tewe and A.D. Ologhobo, 1999. Effects of oligosaccharides on intestinal microflora population of rats fed processed cowpea diets. Trop. J. Anim. Sci., 1: 125-130.
11. Kakade, M.L. and R.J. Evans, 1966. Growth inhibitor of rats fed raw navy beans (*Phaseolus vulgaris*). J. Nutr., 90: 191-198.
12. Lucas, G.M. and P. Markakes, 1975. Phytic acid and other phosphorous compounds of navy bean (*Phaseolus vulgaris*). J. Agric. Food Chem., 23: 13-15.
13. Maga, J.A., 1982. Phytate. Its chemistry, occurrence, food interaction, nutritional significance and method of analysis. J. Sci. Food Agric., 30: 1-9.
14. Steel, R.G.D. and J.H. Torrie, 1990. Principles and procedures of statistics. A biometrical approach (3rd Ed) McGraw Hill book Co. New York USA.
15. SAS-Statistical Analysis System, 1998. SAS. Users guide statistics. (Carry, W.C, SAS Institute.)
16. Igbedioh, S.O., K.T. Olugbemi and M.A. Akpapunam, 1994. Effects of processing methods of on phytic acid level and some constituents in bambara groundnut (*Vigna subteranea*) and pigeon pea (*Cajanus cajan*). Food Chem., 50: 147-151.
17. Akpapunam, M.A. and S.C. Achinewhu, 1985. Effects of cooking, germination and fermentation on the chemical composition of Nigerian cowpea (*Vigna unguiculata*). Plant. Food Hum. Nutr., 35: 353-358.
18. Giami, S.Y., 1993. Effects of processing on the proximate composition and functional properties of cowpea (*Vigna unguiculata*) flour. Food. Chem., 47: 153-158.
19. Osho, S.M., H.O. Ogundipe and K. Dashell, 1995. Soyabean processing and utilization in Nigeria. In: *Nutritional quality of plant foodstuffs*. Osagie, A.U. ed. Post Harvest Rsearch Unit, University of Benin, Benin city, pp: 99-115.
20. Akinyele, I.O. and A. Akinlosotu, 1991. Effects of soaking, dehulling and fermentation on the oligosaccharide and nutrient contents of cowpeas. Food Chem., 41: 43-53.
21. Muzquiz, M., C. Rey, C. Cuadrado and G.R. Fenwick, 1992. Effect of germination on the oligosaccharide content of Lupin specis. J. Chromatography, 607: 349-352.
22. Savekoul, F.H.M.G., A.F.B. Van Der Poel and S. Tamminga, 1992. The presence and inactivation of trypsin inhibitors, tannins, lectins and amylase inhibitors in legue seeds during germination. A review. Plant Foods for Hum. Nutr., 42: 71-85.