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Effect of Some Thermal Processing Techniques on the Proximate, Mineral and Anti-Nutrient Compositions of Bambara Groundnut *(Voandzeia subterranea,* (L) Thour) Meal

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Abstract
The effect of some thermal processing techniques on the nutritional potentials and anti-nutritient properties of bambara groundnut were investigated. The results of the proximate composition showed significant differences (P < 0.05) in all the parameters tested except the ether extract. The crude protein (22.35%) and nitrogen free extract (55.83%) of the raw bambara groundnut (BG) were significantly (P<0.05) higher than all thermally treated BG values, but thermally treated BG were significantly (P<0.05) lower in crude fibre contents. The gross energy levels of the boiled BG (with or without potash) were significantly (P<0.05) higher than that of the raw and toasted BG. Result of the mineral composition shows that raw BG had the highest concentration of Mg(0.48%), P(0.58%) and Na(11.49%) followed by potash boiled bambara groundnut (Mg 0.41%, P 0.52% and Na 11.40%). The results indicated the presence of some anti-nutritional factors in the meals. Trypsin inhibitor, tannin and oxalate were significantly (P < 0.05) reduced in the thermally processed meals. The trypsin inhibitor (TU/mg), tannin (mg/100g) and oxalate (mg/100g) of the raw BG were highest (28.60, 0.38 and 0.60 respectively) followed by the toasted BG(22.10, 0.14 and 0.38 respectively). From the results obtained, boiling bambara groundnut in potash solution produced meals with best nutritional values for livestock and reduced the anti-nutritient substances of the seeds.
Keywords: Bambara groundnut, thermal, proximate, mineral, composition, anti-nutrient substances.

1.0 INTRODUCTION

Bambara groundnut is cultivated in some parts of Enugu, Anambra and Ebonyi States of Nigeria (Amefule and Iroanya, 2004). The seed is used in some parts of Nigeria as food by man while the chaff (seed coat) is used as a non-conventional feed ingredient in animal feed production. Bambara groundnut (BG) is cheap when compared with other plant protein sources like soybeans and groundnut. The incorporation of bambara groundnut meal in livestock feed will therefore reduce the cost of feed and invariably the total cost of livestock production. Over the years, a lot of efforts have been made towards increasing food and feed production and indeed the per capita animal protein intake of the average Nigerian. To achieve this, some unconventional feedstuffs like bambara groundnut must be fully exploited. However, Akanji *et al.* (2003) have noted that the seed contains anti-nutritional factors. As such, the seeds must be properly processed to eliminate or reduce their concentration to a level where it will not be harmful to animals. Nutritionists who have worked on different processing methods of some feedstuffs have noted that the processing conditions, especially those relating to the use of steam and temperature, positively influence the quality of the final product and its nutritional value (Omoikhoje and Arojeniwa, 2004; Agbede and Aletor, 1999). This research work is therefore, designed to test the effect of different thermal processing methods on the proximate composition, energy level, mineral content and anti-nutritional factors of bambara groundnut. The use of potash in boiling hard nuts has been an age long practice especially in rural areas. It is expected that the use of potash will not only reduce the length of cooking to make the feed but will also help to reduce or eliminate the anti-nutritional factors in raw bambara groundnut.

2.0 MATERIALS AND METHODS

2.1 Experimental Site

This experiment was carried out in the Department of Animal Science, Delta State University, Asaba Campus, Nigeria.

2.2 Source of Bambara Groundnut

The raw bambara groundnut that was used for the analysis was purchased from Onitsha market in Anambra State, Nigeria.

2.3 Processing of the Nuts

Two kilograms of well screened and clean raw bambara groundnut seeds were divided into four equal parts of 0.5kg each and subjected to four different thermal processing treatments.

2.4 Treatments of Bambara Groundnut

2.4.1 Raw Bambara Groundnut

Half a kilogram of raw bambara groundnut (BG) was milled and kept for analysis without further processing.

2.4.2 Toasting

Another 0.5kg raw bambara groundnut (BG) was mixed with equal quantity of fine river sand (to ensure even toasting) and fried in a medium sized frying pan using fire wood until the nuts turned slightly brown in colour. The nuts were then sieved free of sand and kept aside to cool down.

2.4.3 Boiling in Potash Solution

Half a kilogramme of raw BG was poured into already boiling water containing 2% Trona (potash) and boiling continued for 20 minutes using fire wood. The water was drained off and the nuts sun dried for four days and preserved.

2.4.4 Boiling without Potash Solution

Another 0.5kg raw BG was poured into already boiling water where boiling continued for 20 minutes. The water was, thereafter, drained off and the nuts sun dried for four days and preserved.

2.5 Preparation of the Samples for Analysis

Each of the four test samples were separately ground to produce meal that can pass through standard sieve of $4mm^2$. The meal of each treatment was further divided into three subsamples, and labeled as replicates accordingly. The samples were then analyzed for proximate composition, mineral assay and anti-nutritional factors.

2.6 Proximate Composition and Energy Level

The samples were analyzed for proximate composition using AOAC (1990) procedures by employing the Kjeldahl method for crude protein determination while the gross energy of the samples was determined by the bomb calorimeter method.

2.7 Mineral Assay Determination

The mineral composition of the samples were determined. Calcium and magnesium content in each sample were determined using the Pearson (1976) method. Potassium, sodium and phosphorus were determined by flame photometry (A.O.A.C. 1984).

2.8 Anti – Nutritional Factors Analysis

The samples were subjected to anti-nutritional factors analysis. The trypsin inhibitor and oxalate were determined using the method of Gupta *et al.* (1988) while the tannin and saponin were determined using the Garg (2002) method.

2.9 Statistical Analysis

Data collected from the three subsamples as replicates of each treatment were subjected to analysis of variance and treatment means were compared by Duncan's Multiple Range Test (Duncan, 1955), using SPSS (10.0) package.

3.0 RESULTS AND DISCUSSION

The results of the proximate composition of test ingredients are presented in Table1. Dry matter content of raw BG (96.64%) and BG boiled with potash (91.94%) were similar ($P>0.05$) but significantly ($P<0.05$) higher than that of toasted BG (85.60%) and BG boiled without potash (79.24%). The crude protein of BG toasted (20.60%),boiled with potash (21.75%) and boiled without potash (20.62%) were similar ($P>0.05$) but significantly ($P<0.05$) lower than that of raw BG(22.35%). The crude protein results indicate that the heat treatment to which bambara groundnut was subjected had a negative effect on the crude protein content. This may be due to the protein denaturation effect of heat during boiling or toasting. The values of crude protein in this study are similar to the findings of Olomu (1995) and Omoikhoje and Arojeniwa (2004). However, the crude protein content of the test meals in this study were higher than that reported by Okah *et al.* (2006) who processed bambara groundnut using different thermal levels. This perhaps makes boiling with potash not only a faster and cheaper means of processing but also the higher protein levels achieved indicate that boiling with potash has milder negative effect on the level and probably the quality of protein in the test meals. Boiling BG with potash could be preferred to other thermal processing methods since the protein in this method suffered lesser thermal damage.

The ether extract content of all test meals were similar ($P>0.05$) with values ranging from the highest of 12.26% for raw BG to the lowest for BG boiled without potash, 12.10%. These values, however, fall within the range of what can be utilized by poultry and livestock and further indicate that bambara groundnut meal is a rich source of vegetable oil among the oilseeds especially when compared with soyabean and groundnut meals.

The crude fibre content of BG that was toasted, boiled with potash and boiled without potash were similar ($P>0.05$) but significantly ($P<0.05$) lower than the crude fibre content of raw BG. The raw meal had the highest value (3.80%) and the nut boiled with potash had the lowest value of 3.20%. These values are low when compared with the crude fibre content of some unconventional feed sources such as groundnut shells, cocoa seed husk, cotton seed husk, paddy husk and palm kernel cake as reported by Odoemelam and Ahamefule (2006). Fibre is important in the diets of livestock since its absence can lead to a wide range of diseases such as colon diverticular, diabetes mellitus, obesity and coronary artery diseases (Oke et al., 1995).

The ash content of the toasted BG and BG boiled with potash were similar (P>0.05) but significantly (P<0.05) higher than those of raw BG and that boiled without potash. The highest value of 2.66% was recorded by the nuts boiled with potash followed by the toasted nuts 2.60% while the raw nuts and those boiled without potash have 2.40% each. The results indicate a high mineral content and compare well with the report of Yayock et al. (1988).

The nitrogen free extract (NFE) values of the raw BG (55.83%) were significantly (P < 0.05) higher than all the processed BG, while the BG boiled with potash (52.08%) were significantly (P<0.05) higher than those toasted (46.80%) and boiled without potash(40.90%). The NFE values of processed BG in this study are in agreement with that reported by Oka et al. (2006) for heat treated bambara groundnut. The gross energy of BG boiled with potash (3.53kcal/g) and that boiled without potash (3.52kcal/g) were similar (P>0.05) but significantly (P<0.05) higher than that of raw and toasted BG (3.46kcal/g and 3.49kcal/g). This indicates that heat processing with moisture increases the available energy. It therefore, follows that heat processing helps to denature the anti-nutritional factors that can hinder energy metabolism (Akinmutimi, 2004). The gross energy values of the test meals are in agreement with that reported by Akinmutimi, (2004).

The results on Table 2 show the mineral content of the nuts as influenced by processing. The calcium and potassium contents of the raw and all processed BG were similar (P>0.05). The magnesium and sodium contents of the raw BG were significantly (P<0.05) higher than that of the processed BG. Among the processed BG, that boiled with potash has the highest magnesium and sodium contents. The phosphorus contents of the raw BG, BG boiled with potash and that boiled without potash were similar (P>0.05) but significantly (P<0.05) higher than that of the toasted BG. The toasted BG had the lowest values of potassium, phosphorus and sodium contents among the processed meals while that boiled with potash had the best values of mineral content among the processed BG. Boiling the nuts with potash solution gave a better mineral retention in the meals. The results indicate that the magnesium and phosphorus contents of the processed BG were significantly reduced by the heat treatment to which they were subjected. The magnesium and phosphorus were more affected because they are volatile elements when heated, while the less volatile minerals such as calcium, potassium and sodium were slightly affected by heat treatment. This is because calcium, potassium and sodium are more heat stable elements and so loses due to volatilization during heat treatment were minimal. The values of minerals content obtained in this study agree with those reported by Agbede and Aletor (1999) and relatively higher than that reported by Oke et al. (1995).

The results of the anti-nutritional factors present in bambara groundnut are presented in Table 3. The trypsin inhibitor, tannin and oxalate contents of the raw BG were significantly (P<0.05) higher than those of the processed BG. Trypsin inhibitor contents decreased from 28.60 TU/mg for raw BG to 20.30 TU/mg for the BG boiled with potash. These trypsin values are low when compared with other unconventional feedstuffs like *Canavalia ensiformis* (1681.50TU/g) and *Canavalia brazilensis* (166.20TU/g) as reported by Udedibie and Carlini (1998). Trypsin inhibitor is an enzyme which is known to interfere with the normal digestive actions of enzymes that breakdown proteins to simpler components (Isikwenu and Bratte, 1999). Tannin contents decreased from 0.38mg/100g for raw BG to 0.10mg/100g for BG boiled without potash.Minari et al. (2012) also obtained significant reduction in tannin contents of toasted and cooked *Leucaena leucocephala* seeds when compared with the raw seeds. The tannin contents in BG are low when compared with whole (0.92mg/100g) and de-hulled (0.85mg/100g) *Canavalia plagiosperma* seeds (Odoemelam and Ahamefule, 2006). Tannin is known to give rise to a dry pickery astringent sensation in the mouth and can depress growth. Tannins have the capability of decreasing the digestibility and palatability of proteins because they form insoluble complexes with them (Osagie et al., 1996). The saponin levels in BG were low and were not significantly (P>0.05) different eventhough raw BG has higher amounts. Saponins are known to be bitter and reduces the palatability of livestock feed and increases the excretion of cholesterol (Price and Butler, 1980). Phytate content was low in raw BG and found only in trace amount in the processed BG, and were not statistically significant (P>0.05). Oxalate contents decreased from 0.60mg/100g for raw BG to 0.30mg/100g for BG boiled with potash. The levels of oxalate in BG is also low when compared with that (0.76mg/100g) reported by Concon(1988). Oxalate is known to decrease the availability of essential minerals such as calcium and at higher levels, causes death in livestock due to its corrosive effects (Bassey *et al.,* 2009). There was a general reduction in the content of the anti-nutritional factors due to processing even though values varies with the methods of processing. The significant reduction in the levels of anti-nutritional factors in processed BG is an indication that heat treatment can help reduce the amount of these substances in feedstuffs and therefore, a means of neutralizing or detoxifying anti-nutritional substances in feed ingredients.

4.0 CONCLUSION

The proximate composition of the processed bambara groundnut meals shows that it has high protein and energy level. As such, it can compete well with most other feed materials. Boiling bambara groundnut in potash solution gave the best proximate composition and mineral content. Bambara groundnut boiled in potash solution detoxified most of the anti-nutritional factors better than the other thermal processing methods. Therefore, this study has shown that thermal processing of bambara groundnut could improve the bioavailability of its nutrients and reduce the anti-nutritional substances present. However, the best thermal processing method of bambara groundnut in this study is the one boiled in potash solution.

5.0 REFERENCES

Agbede, J. O. & Aletor, V. A., (1999). Nutrient and Anti-nutrients of Differently Processed *Leucaena Leucocephala* Seed Flour. *Proceedings of 26th Annual Conference of Nigerian Society for Animal Production, 21st – 25th March, Ilorin, Kwara State, Nigeria,* pp. 75 – 77.

Akanji, A. M., Ologhobo, A. D., Emiola, I. A. & Adedeji, O. S., (2003). Determination of Metabolizable Energy Values of Bambara Groundnut (*Voandzeia Substerranea*) Meals. *Proceedings of 11th Annual Conference of Animal Science Association of Nigeria (ASAN), 2003. Ibadan, Nigeria,* pp. 111 – 112.

Akinmutimi, A. H., (2004). Evaluation of Sword Bean (*Canavalia gladiata*) as an Alternative Feed Resources for Broiler Chickens. *Ph.D. Thesis, College of Animal Science*, Michael Okpara University of Agriculture, Umudike, Abia State, Nigeria, pp. 58 – 68.

Amefule, K. U. & Iroanya, C. O., (2004). Replacement of Soyabean Meal and Maize Offal with Bambara Groundnut Offal in Broiler Diets. *Nigerian Agricultural Journal*, 35:133 – 142.

A. O. A. C., (1984). Official Methods of Analysis. *Association of Official Analytical Chemists*, Washington D. C. USA.

A. O. A. C., (1990). Official Methods of Analysis. *Association of Official Analytical Chemists,* Washington D. C. USA.

Bassey, O., Nsa, E. E., Anya, M. I., Edet, G. D., Umoren, E. P. & Okoh, L. N., (2009). The Phytochemistry, Vitamin and Mineral Content of Dasheen (*Colocasia esculenta*) Leaves. *Proceedings of 34th Annual Conference Nigerian Society for Animal Production, University of Uyo, Akwa Ibom State, Nigeria,* pp. 426 – 428.

Concon, J. M., (1988*). Food Toxicology Parts (Annals.),* Marcel Dekke, New York.

Duncan, D. B., (1955). Multiple Range Test. *Biometrics* 11: 1 – 42.

Garg, A. K., (2002). Estimation of Total Tannins: A Short Course on Role of Unconventional Feeds in Future Livestock Production; Dec. 13th, 2001 – Jan. 2nd, 2002. *CAS in Animal Nutrition.* IVRI, Izatnagar.

Gupta, P. C., Khatta, V. K. & Mandal, A. B., (1988). Analytical Techniques in Animal Nutrition. *Directorate of Pub. HAU*, Hissar.

Isikwenu, J. O. & Bratte, L., (1999). Toxins, Inhibitors and Anti-Nutritional Factors in some Tropical Foods and Foodstuffs. in: Omeje, S.I., *Issues in Animal Science*. Raykenedy Publishing Enugu, Nigeria, pp. 83--100.

Minari, J. B., Odutuga, A. A., Bamisaye, F. A., Dairo, J. O. & Fagbohunda, B. S., (2012). Effect of some processing techniques on the proximate and antinutrients composition of *Leucaena leucocephala* seed. *Pakistan Journal of Nutrition,* 11(4):310-312.

Odoemelam, V. U. & Ahamefule, F. O., (2006). Effects of De-hulling on Proximate Composition, Anti-Nutritional Properties and Mineral Content of *Canavalia Plagiosperma* Seed. *Tropical Journal of Animal Science*, 9 (2): 35 – 43.

Okah, U.; Akinmutimi, H. A. & Onwudike, O. C., (2006). Determination of Metabolizable Energy Values of Bambara Groundnut Meals. *Proceedings of 11th Annual Conference of Animal Science Association of Nigeria, Ibadan, Nigeria,* pp. 111-112.

Oke, D. B., Tewe, O. O. & Fetuga, B.L.A., (1995). The Nutrient Composition of some Cowpea Varieties. *Nigerian Journal of Animal Production*, 22(1):32 – 36.

Olomu, J. M., (1995). *Monogastric Animal Production- Principles and Practice*. Jachem Publication Ltd, Benin, Nigeria, pp. 157 – 159.

Omoikhoje, S. O. & Arojeniwa, A., (2004). Effect of Heat Treatment on Proximate and Mineral Composition of Bambara Groundnut. *Proceedings of 29th Annual Conference Nigerian Society for Animal Production,* pp. 160 – 162.

Osagie, A. U., Muzguiz, M., Burbano, C., Cuadsado, C., Ayet, G. A. & Castano, A., (1996). Some Anti-nutritional Constitution in Ten Staple Food items in Nigeria. *Tropical Science*, 36:109-115.

Pearson, D., (1976). *The Chemical Analysis of Foods*, Churchhill Livingstone, Edingburgh. pp. 383 – 387

Price, M. I. & Butler, L. G., (1980). Tannin and Nutrition Produce. *Univ. Agric. Exp. Stn. No. 272*. West Lafayette, IW.

SPSS 10.0 *Statistical Package for the Social Sciences*. SPSS Inc. Chicago, IL, 60606.

Udedibie, A. B. I. & Carlinic, C. R., (1998). Crack and Cook: A Simple and Quick Process of Elimination of *Concanavalin* A. (Con. A) from Canavalia Seeds. *Journal of Animal Feed Science and Technology,* 74: 179 – 184.
Yayock, T. Y., Lombin G. & Owonubi, J. J., (1988). *Crop Production in Warm Climates*. Macmillian International, pp. 155 – 156.

Table 1: Proximate Composition of Raw, Toasted, Boiled with Potash and Boiled Without Potash Bambara Groundnut (BG) Meal

Components	Raw	Toasted	Boiled with Potash	Boiled without Potash	SEM
Dry Matter (%)	96.64^{a}	85.60^{b}	91.94^{a}	79.24^{c}	0.38
Crude Protein (%)	22.35^{a}	20.60^{b}	21.75^{b}	20.62^{b}	0.08
Ether Extract (%)	12.26	12.15	12.25	12.10	0.02
Crude Fibre (%)	3.80^{a}	3.45^{b}	3.20^{b}	3.22^{b}	0.01
Ash (%)	2.40^{b}	2.60^{a}	2.66^{a}	2.40^{b}	0.34
NFE (%)	55.83^{a}	46.80^{c}	52.08^{b}	40.90^{c}	0.38
Gross Energy (Kcal/g)	3.46^{b}	3.49^{b}	3.53^{a}	3.52^{a}	0.54

a,b,c, Means on the same row with different superscripts differ significantly (P<0.05)

Table 2: Mineral Composition (%) of Raw, Toasted, Boiled With Potash and Boiled Without Potash Bambara Groundnut (BD) Meal

Parameters	Raw	Toasted	Boiled with Potash	Boiled without Potash	SEM
Calcium (%)	0.64	0.58	0.61	0.52	0.02
Magnesium (%)	0.48^{a}	0.32^{b}	0.41^{b}	0.30^{b}	0.05
Potassium (%)	0.21	0.19	0.24	0.20	0.08
Phosphorus (%)	0.58^{a}	0.36^{b}	0.52^{a}	0.42^{a}	0.04
Sodium (%)	11.49^{a}	10.28^{c}	11.40^{b}	11.28^{b}	0.01

a,b,c, Means on the same row with different superscripts differ significantly (P<0.05)

Table 3: Nutritional Factors of Raw, Toasted, Boiled With Potash and Boiled Without Potash Bambara Groundnut (BD) Meal

Parameters	Raw	Toasted	Boiled with Potash	Boiled without Potash	SEM
Trypsin Inhibitor (TUmg^{-1})	28.60^{a}	22.10^{b}	20.30^{b}	21.60^{b}	0.02
Tannin (mg/100g^{-1})	0.38^{a}	0.14^{b}	0.12^{b}	0.10^{b}	0.35
Saponin (mg/100g^{-1})	0.10	0.05	Trace	0.06	0.10
Phytate (mg/100g^{-1})	0.05	Trace	Trace	Trace	0.00
Oxalate (mg/100g^{-1})	0.60^{a}	0.38^{b}	0.30^{b}	0.37^{b}	0.01

a,b, Means on the same row with different superscripts differ significantly (P<0.05)