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Effect of Different Processing Methods on the Nutrient, Anti-nutrient and Metabolizable Energy Composition of Raw *Leucaena leucocephala* Seed Meal

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ABSTRACT: The effect of different processing methods on the nutrient and anti-nutrient composition of raw *Leuceana leucocephala* seeds meal was determined using proximate composition, gross energy, mineral composition and metabolizable energy as parameters. The samples were of raw, toasted, boiled and fermented *Leuceana leucocephala* seeds meal. The samples were sun-dried, milled and used for both chemical analysis as well as for metabolizable energy determination. The experiment was carried out in a Completely Randomized Design (CRD). The result of the proximate analysis of the seeds meal showed that the crude protein (CP) values for the raw was significantly higher ($P<0.05$) than the others. The result of macro-minerals showed that the boiled seeds values for Sodium (Na), Calcium (Ca) Phosphorous (P) and Potassium (K) were significantly higher than others. The same sequence was observed in the values of the boiled *Leuceana leucocephala* for the micro-minerals of Zinc (Zn), Iron (Fe), Copper (Cu) and Manganese (Mn) which were significantly higher ($P<0.05$) than the raw, toasted and fermented samples. For the gross energy composition, the values of the raw were significantly higher ($P<0.05$) than all the other samples. The true metabolizable energy (TME) and the true metabolizable energy corrected to nitrogen equilibrium (TME_n) of the boiled samples were significantly higher ($P<0.05$) than the other samples. The anti-nutritional factors indicate that toasted *Leuceana leucocephala* seeds meal had the highest reduction followed by boiling. Conclusively, boiled *Leuceana leucocephala* seeds meal had the highest value for proximate composition, minerals (Macro and Micro), metabolizable energy (both TME and TME_n) gross energy and metabolizable energy thereby making boiling the best processing method.

Keywords: *Leuceana leucocephala* seed meal, broiler birds, processing, diets

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INTRODUCTION

In most developing nations of the world, there has been a short supply of animal protein for the populace. The conventional plant protein sources such as soybean and groundnut for poultry production are highly competed for by humans and other industrial users. This has led to high cost of feed, accounting for 70-80% cost of poultry production and hence decline in production (Obioha, 1992, Ogunfowara, 1994). It has therefore become needful, exigent, pertinent and imperative to search for other alternative sources of plant protein that are less

competitive, more available, less expensive and equally been able to supply the requirements of the animals. The unconventional legumes especially those indigenous to the tropics make up major alternative sources of nutrients such as protein, lipids, carbohydrates and other important substances such as fibre, minerals and vitamins which are necessary for human and monogastric nutrition (Deshpande, 1992, Akinmutimi and Iboro, 2012). *Leuceana leucocephala* seeds meal is among the tropical legumes that can serve as an unconventional alternative plant protein sources for poultry nutrition. However, it contains a number of anti-nutrients, the major which is mimosine, others include tyrpsin inhibitors, tannins, hydrogen cyanides and pytates. The raw *Leuceana leucocephala* seeds need to undergo processing or detoxification in order to inactivate the anti-nutritional factors for safe and effective usage of the seeds for broiler nutrition. Toasting, boiling and fermentation constitute major processing methods and therefore attract attention in this study. Also, of importance is the metabolizable energy of feedstuff in poultry. The need then for the determination of the metabolizable energy of both the raw and the processed *Leuceana leucocephala* seeds meal. The objective of this study is to determine the best processing method using proximate composition, gross energy, anti-nutrients, metabolizable energy (TME and TME_n), and mineral composition (both macroand micro minerals).

MATERIALS AND METHODS

Source and processing of the raw seeds

Leuceana leucocephala matured seeds were collected from the fallow area in Uyo Local Government Area of Akwa Ibom State in Nigeria. Sample one was the raw and samples 2,3, 4 respectively were the toasted, boiled and fermented seeds samples. 3kg of seeds were toasted for 30minutes. 3kg of the seeds were boiled for 60 minutes and 3kg were fermented for 48 hours. Both the raw and processed seeds (toasted, boiled and fermented seeds) were cooled, dried and milled and sieved with 1.5mm mesh sieve and used for chemical analysis.

Analytical procedure

The proximate constituents of both the raw and the processed *Leuceana leucocephala* seeds meal were determined using the procedure of the Association of Official Analytical Chemists (AOAC, 1995). The gross energy was determined using Gallen Kamp Bomb Calorimeter (AOAC 1995). Mineral Determination: The milled and the processed seeds were subjected to wet digestion with hydrochloric and nitric acids by Johnson and Ulrich method (1959). Sequel to the digestion, the macro-minerals (Sodium (Na), Potassium (K) and Calcium (Ca)) were determined by flame photometry using Genway Digital Flame Photometer. The micro-minerals- Copper (Cu), Zinc (Zn) and Manganese (Mn) were determined by atomic absorption spectro-photometer using, buck 600 AAS. Phosphorus was determined by spectronic 21D digital spectrophotometer. Mimosine was determined spectrophotometeriically according to the method of Lalitha *et al* (1993). Tannin determination was carried out according to the method of Maga (1982). Phytate contents were determined using the method of Young and Greaves (1940) as adopted by Lucas and Markakes (1975). Determination of Trypsin inhibitors was carried out according to the procedure of Kakade *et al* (1969). The true metabolizable energy (TME) of the raw and processed ingredients were determined using modified method of Sibbald (1976) while the true metabolisable energy corrected to nitrogen equilibrium (TME_n) was determined using the method of Parsons *et al* (1982).

Experimental design and statistical model

The design was Completely Randomized Design (CRD). The statistical Model for this Design for the experiment was:

$Yij = \mu + T_1 + eij$

Where

Yij = Single Observation
μ = Overall Mean
Ti = Effects of Treatment
eij = Error term, which is independently identically normally described with a zero mean and a constant variance.

The data collected for the design was subjected to analysis of variance (ANOVA) according to Steel and Torrie (1980). The means were separated using the Duncan's Multiple Range Test described by Duncan (1955).

RESULTS AND DISCUSSION

Table 1 shows the proximate composition of the raw, toasted, boiled and fermented *Leucaena lucocephala* seeds meal. The values of raw were significantly different ($P<0.05$) and higher than the processed seeds meal except for crude fibre, where toasted seeds meal was significantly ($P<0.05$) higher than all. The higher values could be ascribed to the loosening or destruction of some nutrients in the seeds as a result of the processing methods. The reduction in crude protein content as a, result of processing agrees with the findings of Emenalom and Udedibie, 1998, Esonu *et al* 1998, Akinmutimi and Onwudike 2002). Boiled seeds meal had the highest

Table 1: Proximate composition of raw, toasted, boiled and fermented *Leucaena leucocephal*a seed meal.

Parameters %	Raw T_1	Toasted T_2	Boiled T_3	Fermented T_4	SEM
Crude Protein %	25.64[a]	21.38 [d]	23.74[b]	23.02[c]	0.044
Ether Extract	2.93 [a]	2.25[d]	2.80[b]	2.60 [c]	0.005
Crude fibre (%)	6.31[b]	7.26[a]	5.36[c]	5.24[d]	0.019
Ash (%)	4.88[a]	3.69[d]	4.26[b]	4.24[c]	0.012
Gross Energy	4.28 [a]	4.22 [d]	4.24 [b]	4.23[c]	0.002

a-d means in a row with different superscripts are significantly different (P<0.05).
SEM: Standard Error of Mean

Table 2: The ant-nutrients of both raw and processed *Leucaena leucocephala* seeds meal.

Parameters	Raw T_1	Toasted T_2	Boiled T_3	Fermented T_4	SEM
Mimosine (%)	0.037[a]	0.021 [d]	0.025[c]	0.030 [b]	0.001
Tannin (%)	0.051[a]	0.024[d]	0.035[c]	0.047 [b]	0.002
Phytate (%)	0.106[a]	0.101[d]	0.103[c]	0.104[b]	0.005
Oxalate	0.107[a]	0.012[d]	0.104[c]	0.013[d]	0.004
Trysin Inhibitor Tiu	2.770[a]	2.311[d]	2.450[c]	2.550 [b]	0.020

a-d means in a row with different superscripts are significantly different (P<0.05).
SEM: Standard Error of Mean.

values as compared to other processed samples. Toasting gave the lowest values which could be as a result of burning off of some nitrogenous compounds during toasting (Emenalom and Udidebia, 1998) and partly due to the loss of lysine as a donor of free amino group in a complex reaction called Maillard reaction that terminates in the brown colour obtained after toasting, Hudson, (1992). The values of EE, crude fibre, ash and gross energy followed similar pattern with the exception of crude fibre for toasted materials in which it is was significantly (p<0.05) higher than the raw values. Also, the above observation may be due to the reason given above i.e processing effect.

Table 2 shows the anti-nutrients in both raw and processed seeds meal. There were significant differences (P<0.05) between the raw and the processed seed meal. There was also a general reduction in the content of the anti-nutrients as a result of the processing methods. In this study toasting method had the highest reduction of the anti-nutrients compared to other processing methods. This was followed by seed subjected to boiling. Among the anti-nutrients in *Leucaena leucocephala,* seed meal mimosine had the most deleterious/toxic effects more on monogastrics than on ruminants. Mimosine exerts its toxic action by blocking the metabolic pathways of aromatic amino acids and trytophan. From the above table the values obtained for mimosine may not be of consequence because the values are very low when compared to 12.3% in the yellow cotyledon and young seeds (6.2%) and about 5.1% in leaves (Akbar and Gupta 1984).

Table 3 shows the macro minerals of the raw and processed *Leucaena leucocephala* seed meal in which there were significant differences (P<0.05) between the raw and the processed samples. The higher values of the toasted and boiled seeds could be ascribed to the release of the nutrients in the samples by the processing methods. The higher values of the processed, toasted and boiled *Leucaena leucocephala* seed meal especially for potassium and calcium also implies that these minerals require little supplementation to effect good metabolic processes of the body of monogastric animals. Sodium values for the processed samples in this study are in agreement with those of conventional grain legumes such as soy bean meal with 0.34% (Aduku, 1993). The sodium for processed seeds is closely comparable to the salt added to broiler rations at the minimum of 0.25 or 0.35% (Aduku 1993, Olomo 2011). Therefore, using the toasted, boiled and fermented *Leucaena leucocephala* seed meal, for feed formulation will lead to reduction in the quantity of salt used thereby reducing the cost of production of broilers (Eburuaja, 2010). It appears in all that fermentation reduces macro-mineral values as opposed to other processing methods. In all boiled samples shows superior value to others and is used in ration formulation to reduce the cost of mineral supplementation and hence the cost of production.

Table 4 shows the micro mineral of both raw and processed seed meal. There were also significant differences between the raw and processed seed meal for micro-minerals of *Leucaena leucocephala* seed meal. For both macro and micro- minerals, boiling had the highest values as compared to other processing methods. This could be due to reasons given before for the raw and processed seeds i.e. processing leads to increase in nutrients. Iron (Fe) had the highest values, the values being higher than the processed seeds and the raw. (Aduku, 1993). Manganese and copper values obtained for both the raw and processed seeds meal in this study are lower (Aduku, 1993) than the conventional feedstuff eg (soybean, groundnut).

Table 3: Macro-mineral composition of raw and variously processed *Leucaena leucocephala* seed meal.

Parameters %	Raw T_1	Toasted T_2	Boiled T_3	Fermented T_4	SEM
Sodium	0.377^c	0.387^b	0.397^a	0.370^d	0.0013
Potassium	1.118^c	1.126^b	1.320^a	1.110^d	0.0011
Calcium	0.527^c	0.540^b	0.547^a	0.526^d	0.0012
Phosphorous	0.378^c	0.387^b	0.393^a	0.371^d	0.0012

a-d means in a row with different superscripts are significantly different (P<0.05).
SEM: Standard Error of Mean

Table 4: Micro-mineral composition of raw and variously processed *Leucaena leucocephala* seed meal.

Parameters (mg/kg)	Raw T_1	Toasted T_2	Boiled T_3	Fermented T_4	SEM
Zinc	23.880^c	24.020^b	25.070^a	23.600^d	0.011
Iron %	161.850^c	163.350^b	165.650^a	162.750^c	0.091
Copper	3.700^c	3.813^b	3.940^b	3.633^d	0.014
Manganese	4.250^c	5.610^b	15.730^a	5.160^d	0.015

a-d means in a row with different superscripts are significantly different (P<0.05).
SEM: Standard Error of Mean

Table 5: True metabolizable energy of raw and variously processed *Leucaena leucocephala* seed meal.

Parameters	Raw T_1	Toasted T_2	Boiled T_3	Fermented T_4	SEM
TME (Kcal/g)	2.441^d	2.450^c	2700^a	2.510^b	0.002
TME_n (Kcal/g)	1.300^d	1.315^c	1.600^a	1.320^b	0.012

a-d means in a row with different superscripts are significantly different (P<0.05).
SEM: Standard Error of Mean

This would imply adequate supplementation to prevent deficiencies such as perosis or slipped tendon, anaemia and bone deformation (NRC, 1994, McDonald *et al*. (1995), Banerjee, 2007). Results obtained for both macro and micro-minerals of processed *Leucaena leucocephala* seed meal indicate that boiled seed meal recorded the highest values.

Table 5 indicates the true metabolizable (TME) and true metabolizable energy corrected to Nitrogen Equilibrium (TME_n) of raw and variously processed *Leucaena leucocephala* seed meal. There were significant differences (P<0.05) among the treatment means for raw and processed seed meal. The TME and TME_n for raw *Leucaena leucocephala* seed meal were significantly lower(P>0.05) than the values obtained for processed seeds meals. This trend is in agreement with the reports of Ologhobo and Fetuga (1987; Nsa and Ukachukwu 2007 and Ogwumike (2012). This could be ascribed to the destruction of the toxic constituents of the seeds through processing (Nsa and Ukachukwu 2007, Ogwumike 2012). Considering the processed forms, the seeds subjected to boiling had the highest values for TME, TME_n followed similar trend probably for the same reason. Boiling significantly improved the nutritional value of *Leucaena leucocephala* seed meal and hence resulted in availability of nutrients which when metabolized will yield more energy (Akinmutimi *et al*. 2009).

Conclusion

The effect of the different processing methods showed that both for the nutrients as well as for the anti-nutrients, processing had a significant reductive effect i.e. the raw values were higher than the processed, while for the minerals and metabolizable energy the effect of processing resulted in higher values for the processed seeds meal. Conclusively, boiled *Leucaena leucocephala* seeds meal had the highest values for proximate composition, minerals (both macro-micro) and metabolizable energy (both TME and TME_n); making boiling the best processing method.

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