Journal of Forestry Research and Management. Vol. 18(4).106-115; 2021, ISSN 0189-8418
www.jfrm.org.ng

PROCESSING EFFECTS ON NUTRITIVE VALUE AND ANTI-NUTRIENT COMPOSITIONS OF *ETANDA AFRICANA* GUILL. & PERR. SEED

[1]Ajibade, A.J, *[2, 3]Makinde O.J, [1]Adedeji, A.S., [1]Adeniji, O.A., [1]Sulyman, A., [1]Irunokhai, E.A. and [1]Adetona, A

[1] Federal College of Wildlife Management, P.M.B 286, New Bussa, Nigeria.
[2] Department of Animal Science, Federal University, Gashua, P.M.B. 1005, Nigeria.
[3]Universite de Kisangani, Faculte des Sciences, Department des Sciences Biotechnoloques Laboratoire de Microbiologie et Phytopathologie B.P. 2012, R.D. Congo.
* johyinmak@yahoo.com

ABSTRACT

The rising and unpredictable costs of livestock feed ingredients against the huge untapped potentials of most non-conventional ingredients such as *Etanda africana* seed remained a serious concern. This consequently propelled the current effort at evaluating the nutrient (crude protein, crude fibre, ash, ether extract, energy, potassium, calcium, sodium, magnesium, iron, phosphorus) and anti-nutrient (phytate, oxalate, tannin, saponin and trypsin inhibitor) compositions of raw and processed *Etanda africana* seed. The processing was conducted at the Research laboratory, Federal College of Wildlife Management, New Bussa, Niger State, About 600 g of *Etanda africana* seeds were obtained from the College farm. The raw seeds were boiled at 100^{o}C for 10 min before been roasted for 15 min, milled and taken to the Animal Science Laboratory, Federal University of Agriculture, Abeokuta, Nigeria for nutrients and anti-nutrient analyses using the Official Method of Analysis of the Association of Official Analytical Chemists.The study consisted of two treatments (raw and processed) replicated three times in a completely randomized design (CRD). Data generated were subjected to Analysis of Variance (ANOVA) using the statistical analysis software while significance was accepted at $P < 0.05$. Results revealed that processing significantly decreased the crude protein (40.18>34.86%), crude fibre (13.50>9.00%), ash (3.50>2.00%), and ether extract (4.75>3.50%) contents of the seeds while the nitrogen free extract (29.37<42.64%) and metabolizable energy (2917.85<3089.84 kcal/kg) contents of the seeds increased. There were significant decrease in pottasium (6.70>5.11 %), calcium (2.04>1.28 %) and sodium (0.44>0.30 %) contents of the processed seed. Phytochemicals such as tannin was reduced by 62.12%, saponin 76.67%, phytate 60.69%, oxalate 76.40% and trypsin inhibitor by 29.79%. It was concluded that *Etanda africana* seed should be boiled before roasting in order to reduce anti-nutritional factors to a tolerable level and enhance the nutritional value of the seed before being included in animal feed.

Keywords- processing, boiling, roasting, nutrients, anti-nutrients, *Etanda africana*

Introduction

In Nigeria the level of animal protein consumption is low. It was estimated to be about 8g per caput per day, about 27 g less than the minimum requirement recommended by the National Research Council of the United State of America (Ojewole and Ewa, 2005; Abdu, 2012). This low level of animal protein intake by Nigerians has been generally attributed to the short fall in its production due to closure of many livestock farms. Madubuike and Ekenyem (2006) reported that the persistent decline in the livestock industry and its consequences on the sub-optimal animal protein consumption by Nigerians has a dangerous signal to imminent animal protein malnutrition. Esonu *et al*. (2001) had earlier reported that 50% of the Nigerian livestock farms have closed down and another 30% were forced to reduce their production capacity because of shortage of feed. The feed shortage has been blamed on high cost of conventional sources of ingredients which takes about 70-80% of total cost of livestock production(Makinde, 2016). Hence the need to source for alternative but promising feedstuffs. One of such alternative is *Entada africana.* Itbelongs to the family *Fabaceae* which is popularly known as legumes and it is the third largest order of seed-plants containing about 600 genera with 12,000 species (Sharma and Kumar, 2013). In Nigeria, it is commonly known as “Tawatsa” in Hausa Language and “Ogurobe” in Yoruba (Burkill, 1995). Nutritionally, the seed of *Entada Africana* was reported to contain 39.81 % crude protein, 80.00 % dry matter, 15.50 % crude fibre, 17 50 % ether extract, 4.88 kcal/kg metabolizable energy, 39.00 % acid detergent fibre and 53.00 % neutral detergent fibre (Belewu *et al.*, 2008). The authors also reported the mineral contents of the seeds to be 7.66 % calcium, 0.20 % sodium, 45.42 % magnesium, 44.92 % potassium, 0.17 % iron (Belewu *et al.*, 2008). Similarly, Olanrewaju and Ahmed (2014) reported that *Entada africana* leaves contain 4.20 % moisture content, 13.30 % ash, 10 %crude lipid, 18.56 % crude fibre, 14.60 % crude protein and 38.44 % carbohydrate.

However, qualitative phytochemical studies conducted on the seeds of the plant revealed high concentration of saponins and condensed tannins while the quantitative analysis indicated 6.00 and 0.17 % of saponins and tannins, respectively (Belewu *et al.,* 2008). Similar phytochemical screening of the leaf and stem bark extract of *Entada africana* revealed the presence of glycosides, saponins, tannins, flavonoids, coumarins, triterpenes and sterols (Baidoo *et al.,* 2018). Different traditional processing methods such as roasting, cooking, soaking and fermenting were reported to reduce anti-nutritional factors and raise bio-availability of nutrients in *Daniella oliveri* seed meal (Obun and Adeyemi, 2012), tallow (*Detarium microcarpum*) seed meal (Jiya, 2012) and African star apple (*Chrysophyllum albidum*) Kernels (Makinde *et al.,* 2019).Also, Abdullahi *et al.* (2018) evaluated the effect of different processing methods (soaking, boiling, roasting and fermentation) on the anti-nutritional factors of Desert date (*Balanite aegyptiaca)* fruit. The authors reported a drastic decrease in phytochemicals such as oxalate, saponin, phytate and tannin of the fruit.This study was carried out to determine the processing effect on nutrient and anti-nutrient compositions of *Entada africana* seed with a view to providing preliminary information towards effective utilization of this seed in livestock feed.

Materials and Methods

The study was conducted at the Research laboratory, Federal College of Wildlife Management, New Bussa, Niger State, which has been previously described by Okunade *et al.* (2015). About 600 g of *Etanda africana* seeds were obtained from the College farm. The seeds were handpicked so as to eliminate all unwanted particles. The seeds were then air-dried for 48 hr at 25^oC and divided into 2 lots; (i) raw and (ii) boiled and roasted. About 300 g seeds were boiled at 100^oC at a seed: water ratio of 1: 10 w/v. for 10 min in an aluminium pot on a Gallenkamp thermostat hot plate (Ahamefule *et al.*, 2008; Makinde *et al.*, 2019). The water was drained and the boiled seeds were air-dried at 25^oC for 72 hr. The boiled seeds were further roasted in an open pan under the controlled temperature at 65^oC for 15 minutes. The seeds were continuously stirred until the seeds cracked and their endosperm turned brown with toasty sweet odour. All the seed samples (raw and processed) were ground and sieved through a 2 mm sieve before analysis. Samples were subjected to laboratory analysis to determine the nutrients (proximate and minerals) and anti- nutrients (saponin, tannin, phytate, oxalate and trypsin inhibitor) compositions according to AOAC (2006) at the Animal Science Laboratory, Federal University of Agriculture, Abeokuta, Nigeria. The metabolizable energy was estimated by the method outlined by Panzenga (1985):

Metabolizable Energy ME (Kcal/kg) = 37 x % CP + 81.8 x % EE + 35.5 x %NFE.

CP = Crude protein, EE = Ether extract, NFE = Nitrogen free extract

Statistical Analysis

The study consisted of two treatments (raw and processed) replicated three times in a completely randomized design (CRD). Data collected were subjected to Analysis of Variance (ANOVA) using the statistical analysis software, version 9.3 (SAS, 2015). Significance was accepted at $P < 0.05$. Data were represented as mean and pooled standard error of mean (SEM).

Results

Table 1 shows the proximate composition of the raw and processed *Etanda africana* seed. There were significant differences in all the parameters determined except dry matter content of the seed. The crude protein, crude fibre, ash and ether extract contents of the seeds decreased while the NFE and metabolizable energy contents of the seeds increased by the processing methods.

Table 1: Summary of Analysis of Variance forProximate composition of raw and processed *Entanda africana* seed meal

Parameters, %	Raw	Processed	SS	Df	F-val.	P-val.
Dry matter	91.30	92.00	0.74	Treatment 1	1.46	0.2941
				Error 4		
				Total 5		
Crude Protein	40.18^a	34.86^b	42.45	Treatment 1	4.25	<.0001
				Error 4		
				Total 5		
Crude fibre	13.50^a	9.00^b	198.38	Treatment 1	3.93	<.0001
				Error 4		
				Total 5		

Ash	3.50[a]	2.00[b]	45.38	Treatment 1 Error 4 Total 5	8.99	<.0001
Ether extract	4.75[a]	3.50[b]	2.34	Treatment 1 Error 4 Total 5	4.64	0.0007
NFE[2]	29.37[b]	42.64[a]	264.14	Treatment 1 Error 4 Total 5	2.64	<.0001
Metabolizable energy (Kcal/kg)	2917.85[b]	3089.84[a]	4437.08	Treatment 1 Error 4 Total 5	4.44	<.0001

abc= means with different superscripts on the same row are significantly different @ $p<0.05$,
P = Probability value. SS=sum of squares,
NFE[2]= Nitrogen Free Extract =100-(%CP+%CF+%EE+%Ash).

Table 2 shows the mineral composition of the raw and processed *Etanda africana* seed. There were significant differences in the parameters determined except magnesium, iron and phosphorus contents of the seed. Generally, processing methods significantly decreased the mineral contents of the seed.

Table 2: Summary of Analysis of Variance forMineral composition of raw and processed *Entanda africana* seed meal

Parameters, %	Raw	Processed	SS	Df	F-val.	P-val.
Potassium	6.70[a]	5.11[b]	3.81	Treatment 1 Error 4 Total 5	7.51	<.0001
Magnesium	1.68	1.50	0.07	Treatment 1 Error 4 Total 5	9.62	0.0653
Calcium	2.04[a]	1.28[b]	0.87	Treatment 1 Error 4 Total 5	8.66	<.0001
Sodium	0.44[a]	0.30[b]	0.05	Model 1 Error 4 Total 5	5.82	<.0001
Iron	0.12	0.09	0.01	Treatment 1 Error 4 Total 5	1.35	0.0905
Phosphorus	1.89[a]	1.75[b]	0.03	Treatment 1 Error 4 Total 5	2.02	0.0001

abc= means with different superscripts on the same row are significantly different @ $p<0.05$,

P = Probability value. SS=sum of squares,

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www.jfrm.org.ng

Table 3 shows the anti-nutrient compositions of the raw and processed *Etanda africana* seeds. There were significant differences (P<0.05) in all the anti-nutritional factors determined. Generally, processing methods significantly reduced the anti-nutrient contents of the seed.

Table 3: Summary of Analysis of Variance forAnti-nutrient composition of raw and processed *Entandaafricana*seed meal

Parameters, mg/100g	Raw	Processed	% reduction	SS	Df	F-val.	P-val.
Tannin	1.98[a]	0.75[b]	62.12	2.27	Trtmt 1 Error 4 Total 5	1.27	<.0001
Saponin	2.10[a]	0.49[b]	76.67	3.89	Trtmt 1 Error 4 Total 5	7.69	<.0001
Phytate	5.47[a]	2.15[b]	60.69	16.53	Trtmt 1 Error 4 Total 5	1.65	<.0001
Oxalate	3.56[a]	0.84[b]	76.40	11.10	Trtmt 1 Error 4 Total 5	1.11	<.0001
Trypsin Inhibitor (TIU/g)	550.00[a]	386.16[b]	29.79	402.65	Trtmt 1 Error 4 Total 5	8.05	<.0001

abc= means with different superscripts on the same row are significantly different @ p<0.05,

P = Probability value. SS=sum of squares, Trtmt=treatment

Discussion

The dry matter content of the seed (91.30-92.00 %) observed in this study were higher than the values of 80.00% and 87.24% earlier reported by Belewu *et al*. (2008) and Gidado *et al.* (2013) for *Etanda africana* seeds. The crude protein (CP) content of the raw *Etanda africana* seed (40.18%) was similar with the value of 41.00% reported by Jurgens (2002) for mechanically extracted cotton seed meal. This indicates that *Etanda africana* seed is very rich in protein and could be used as a protein source in livestock feed. When compared with other common legumes, the CP content of *Etandaafricana*seed was higher than that of *Phaseolus vulgaris* (20.9%); *Lenus culinaris* (20.6%); *Cicer arietinum* (18.5%); *Canavalia gladiate* (27.48%); *Canavalia ensiformis* (30.62%); *Canavalia plagiosperma* (31.54%); *Canavalia cathartica* (35.5%) and *Canavalia maritime* (34.1%) as observed by Arun *et al*. (2004); Costa *et al*. (2006); Alagbaoso *et al.* (2015). The significant reduction in the values of crude protein from 40.18% to 34.86% as observed in this study was attributed to the burning off of some nitrogenous compounds during processing (Emenalom and Udedibie, 1998). Similar observation was made by Makinde *et al.* (2019), who evaluated the effect of different processing methods on the nutrient and anti-nutrient compositions of African star apple (*Chrysophyllum albidum*) kernel. Gidado *et al*. (2013) however reported the value of 19.69% CP for raw *Etanda africana* seed. The differences in our values may be attributed to variation in soil, climate and variety of the seed used for the analysis. The ether extract content of 4.75% observed for raw *Etanda africana* seed decreased to 3.50% in the processed seed. This could possibly be due to volatilization of lipid related compounds during the processing period. These values indicate that *Etanda africana* seed is not an oil seed when compared to soya bean seed that has up to 20.2% ether extract content (Jurgens, 2002). Though, not an oil seed, the ether extract content were higher when compared to certain common legumes such as *Vigna mungo* (0.45%); *Vigna radiata* (0.71%); *Vigna aconitifolia* (0.69%); *Phaseolus vulgaris* (0.9%); *Pisium*sativum (2.34%); *Lenus culinaris* (2.15%); *Canavalia cathartica* (1.3%) and *Canavalia maritime* (1.7%) as reported by Belmer *et al*. (1999); Arun *et al.* (2004); Costa *et al.* (2006). The reduction observed in crude fibre and ash contents of the seed was as a result of the effect of heat treatment used during the processing period. The values for metabolizable energy (2917.85-3089.84 Kcal/kg ME) were higher when compared with those reported for some legumes such as soyabean meal, 2470 Kcal/kg ME; sesame meal, 2350Kcal/kg ME; cotton seed meal, 2410Kcal/kg ME (NRC, 1994; Jurgens, 2002). Changes in energy values of both raw and processed *Etanda africana* seeds is a reflection of changes in the observed values of other proximate composition.

The decrease observed in potassium, calcium and sodium contents of the processed seed in this study could be attributed to leaching of minerals into the water during cooking treatment (Alajaji and Eldawy, 2006). The most abundant mineral in the raw *Etanda africana* seed as observed in this study was potassium (5.11 - 6.70 %), while the least concentrated mineral was iron (0.09 - 0.12 %). Belewu *et al.* (2008), however observed that magnesium (45.42 %) was most abundant mineral in the raw *Etanda africana* seed. The authors reported a higher value of 44.92 % for potassium content of the raw seed. The available contents of phosphorus (1.75-1.89 %), calcium (1.28-2.04 %) and magnesium (1.50 - 1.68 %) observed in this study would make the seed more suitable for bone formation in animals. The mineral contents of the *Etanda africana* seed are generally higher than values reported by most authors for some legume seeds such as bambara groundnut (*Vigna subterranean*) seed (Aremu *et al.*, 2008), cranberry bean (*Phaseolus coccineus* L.) seed flour (Aremu*et al.*, 2010) and red kidney bean (*Phaseolus vulgaris)* seed (Audu and Aremu, 2011).

The higher percentage reduction of all parameters observed in the processed seed in this study confirms earlier report by other authors (Ajibade *et al.*, 2018; Makinde *et al.*, 2019) that heat treatment of seed was effective against saponin, tannins, phytate and oxalate. All the parameters observed in this study differ from what was earlier reported by Gidado *et al*. (2013) that *Etanda africana* seed contains 0.184% tannin, 0.131% saponin and 0.002% alkaloids. The variation could be due to reasons reported by Ann and Neena (1982) that species may vary not only in composition of nutrient but in type and amount of toxins, thus results obtained with one species of legume may not necessarily be applicable to another.

Even the length of storage time will also affect certain characteristics. This reason may also be responsible for the difference between our result and that of Akinmutimi (2004) who observed a poor reduction of the anti-nutritional factors in sword beans, even when subjected to different processing techniques. The higher percentage reduction of tannin in the processed seed could be attributed to the ability of the processing techniques to break the linkages formed by tannic acid like other phenol compounds with protein and other macro molecules and to overcome the intra-molecular force existing within the tannin structure (Abdu, 2012). This may mean better digestibility of protein if these processed seeds are fed to animals. This is because tannic acid is known to adversely affect protein digestibility (Makinde *et al*., 2017). The observed reduction of phytate (60.69%) in the processed seeds during heat treatment may be partly due to the heat labile nature of phytic acid and the formation of insoluble complexes between phytate and other components (Udensi *et al*., 2007). Phytates can reduce bioavailability of minerals; impaired protein digestibility caused by formation of phytate- protein complexes and depressed absorption of nutrients due to damage to the pyloric caeca region of the intestine (Francis *et al*., 2001).

A similar trend was observed with respect to oxalate content of *Etanda africana* seed which reduced (76.40%) drastically in the processed seed. The result agrees with the work of Olajide *et al*. (2011) who reported a significant decrease in oxalate content of processed wild Cocoyam (*Colocassia esculenta L. Schott*) Corm. Oxalates bind with calcium and magnesium, and interfere with their metabolism, cause muscular weakness and paralysis (Soetan and Oyewole, 2009). The generally low concentration of ANFs in the processed seed is indicative of the possibility of utilizing the seed meal as a feedstuff without affecting the health of animals consuming such feed.

Conclusion and Recommendations

This findings from this study showed that processing methods had significant effect on nutrient (crude protein, crude fibre, ash, ether extract, energy, potassium, calcium, sodium, iron, phosphorus) and anti-nutrient (phytate, oxalate, tannin, saponin and trypsin inhibitor) compositions of *Etanda africana* seed. It was recommended that *Etanda africana* seed should be boiled before roasting in order to reduce anti-nutritional factors to a tolerable level and improve the nutritional value of the seed before being included in animal feed. Further studies should be conducted on other processing methods such as fermentation, malting, soaking and so on in order to confirm their effects in reducing the anti-nutritional factors embedded in *Etanda africana* seed to a tolerable level.

Acknowledgements

The authors gratefully acknowledge Haruna KL, Kamarudeen AT, Ishola AO, Sodiq, I and Ibrahim AA for their assistance in the collection of data pertaining to this study.

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