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Effect of Different Processing Methods on Proximate, Mineral and Anti Nutritional Factors Content of Baobab (*Adansonia digitata*) Seeds

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Abstract: Effect of different processing methods on chemical profile of Baobab (*Adansonia digitata*) seed meal was investigated. Raw Baobab seeds were collected for the study. Five different processing methods (Boiling, toasting, soaking, soak and boiling and sprouting) were used. All the processed seeds with the exception of toasted seeds were oven dried before milling for chemical analysis. Result of the study shows that raw baobab seed contains 28.85% CP with a reasonable amount of mineral and energy, it also contain some anti-nutritional factors. Processing significantly reduced crude protein, mineral and anti nutrition factors content but improved energy content. Boiling gave the least percentage reduction of crude protein and highest percentage reduction of anti nutritional factor. Boiling processing is recommended for baobab seed.

Key words: Raw baobab seed, processing, proximate, mineral and anti-nutritional factors

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 (Abdu, 2012; Ojewole and Ewa, 2005; Abdu, 2003). This low level of animal protein intake by Nigerians has been generally attributed to the short fall in its production due to closure of poultry farms, (Madubuike and Ekenyem, 2006) reported that the persistent decline in the poultry industry and its consequences on the sub-optimal animal protein consumption by Nigerians as a dangerous signal to imminent animal protein malnutrition. Earlier (Esonu *et al.*, 2001) had reported that 50% of the Nigerian poultry 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 (Abdu *et al.*, 2006) have rated at 70-80% of total cost of poultry production. Hence the need to source for alternative but promising feedstuffs. One of such alternative is baobab (*Adansonia digitata)* seed. Baobab (*Adansonia digitata*), locally called kuka (Hausa) and luru (Yoruba), which is another non-conventional feedstuff that is readily available and under-utilized but holds much agronomic potentials. The seeds are not utilized by man and the industries. Baobab is a high yielding, draught resistant and all season plant. This gives it an advantage over other legumes that are seasonal, high rainfall and fertilizer demanding crops. There is therefore, the need to assess the potentials of such crop as a feedstuff for poultry production. The use of legumes as a component of poultry feed has been limited by the content of anti-nutritional factors (ANF). Ologhobo *et al.* (1993) revealed that the inclusion of raw plant proteins in diets of growing animals leads to a significant impairment of growth and other undesirable physiological and biochemical alterations. This was attributed to the presence of toxic factors and ANF in legume seeds (Liener and Kakade, 1980). Many efforts have been made to detoxify ANF through the application of heat and other processes but only a few permanent breakthroughs have been made. Dietary quality is an important militating factor to adequate nutrition in poultry production. One aspect of dietary quality with respect to adequacy of micronutrient intake is bioavailability. Several local processing and preparation method can be used to enhance the bioavailability of micronutrients in non- conventional legumes. These methods include thermal processing, mechanical processing, soaking, fermentation, dehulling, germination or combination of two or more methods Ologhobo *et al.* (1993). It was against this back drop that, this study was embarked up on to study the effect of different processing methods on proximate, mineral and anti-nutritional factors content of baobab (*adansonia digitata*) seeds.

MATERIALS AND METHODS

The study was carried out at the animal science laboratory of Abia State University, Umudike location, Abia State.

Processing of baobab seeds: The raw seeds of Baobab were collected from Katsina, Katsina State of Nigeria. The seeds were divided into five parts and processed.

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Processing was carried-out according to the recommendation of Ukachukwu (2000) for *Mucuna cochinchinensis* as follows:

(a) Boiling: Boiling lasted for 60 min with change of water at 20 min interval. In each case, water was brought to boil at 100°C and the seeds were poured into it. Boiling continued at 100-105°C during the interval (i.e. 20, 40 and 60 min) starting from the commencement of boiling. At the end of boiling, water was drained off using local basket. Thereafter, boiled seeds were dried in a forced-draught oven at 60°C.

(b)Toasting: Toasting lasted for 60 min. Seeds were toasted in sand (placed inside a frying pan) at temperatures that fluctuate between 105 and 110°C. The sand was sieved to remove organic matter. The mixture was turned for 3 min at short intervals of 2 min. Temperature was checked at intervals of 5 min. After toasting the sand was immediately sifted out by means of a sieve.

(c) Soaking: Soaking lasted for 24 h Seeds were poured inside plastic buckets. Thereafter, water was added and allowed to stand for 24 h without changes of water. Thereafter, water was drained off by means of local (oil palm bamboo) basket and the seed were dried in a force-draught oven at 60°C.

(d) Soaking and boiling: Soaking lasted for 24 h and water drained off using local basket as in (c). These soaked seeds were boiled for 1 h as in (a) though without changes of water as. Decanting of water and drying of seeds also followed the same process as in (a) above.

(e) Sprouting: Sprouting was conducted according to Obizoba and Amaechi (1983).They recommended 6 days of fermentation of raw baobab seeds. Seeds were poured inside a jute bag and placed inside water. Water was changed daily until germination starts. Decanting of water and drying of seeds also followed the same procedure as in (a) above.
All the processed seeds with the exception of raw and toasted seeds were oven dried at 60°C before being milled for chemical analysis.

Chemical analysis

Proximate composition: The Raw Baobab seed meal (RBSM), Toasted Baobab seed meal (TBSM), Boiled Baobab seed meal (BBSM), Soaked Baobab Seed meal (SBSM), Soaked and Boiled Baobab seed meal (SBBSM) and Sprouted Baobab seed meal (SPBSM) were analyzed for proximate composition using the procedures of A.O.A.C (1990). The gross energy was determined using Gallenkamp Ballistic Bomb Calorimeter and metabolizable energy was estimated by the method outlined by Panzenga (1985):

$$\text{ME (kcal/Kg)} = 37 \times \%\ \text{protein} + 81.8 \times \%\ \text{fat} + 35 \times \%\ \text{NFE}$$

Mineral determination: The milled raw and processed seed meals were subjected to wet digestion with hydrochloric and nitric acids by the Johnson and Ulrich (1959) method Following the digestion, the mineral element Na, K and Ca were determined by flame photometry using Jenway Digital Flame Photometer. Cu, Zn and Fe were determined by Atomic absorption spectrophotometer using Buck 600 AAS.
Hydro cyanides were determined according to the method of Knowles *et al.* (1980). The tannin in the test ingredients was determined according to the method of Maga (1982).
The determination of trypsin inhibitors was carried out according to the procedure outline by Kakade *et al.* (1974). The phytic acid was determined using the procedure described by Kakade *et al.* (1974).

RESULTS AND DISCUSSION

Proximate composition: Data on the proximate composition of raw (RBSM), boiled (BBSM), toasted (TBSM), soaked (SBSM), soaked and boiled (SBBSM) and sprouted (SPBSM) baobab seed meals are presented in Table 1. There were significant difference ($p<0.05$) between raw and differently processed Baobab seeds for all the components considered on dry matter basis.
The crude protein values ranged from 28.85% (DM) for raw seed to 18.68% (DM) for toasted seed. The crude protein value for raw seed (28.85%) was higher than 18.40% reported by Magdi (2004). However, it is similar to the range of 22-28% reported by Nour *et al.* (1980) for raw baobab seeds of Madagascar and Burkina Faso. Magdi (2004) attributed these differences to variation in soil, climate and strain.
The highest percentage reduction in crude protein was recorded in the toasted baobab seed meal (-35.25%). The high percentage reduction in crude protein recorded in this work is in agreement with previous findings of Amaefule *et al.* (2003), Akinmutimi (2004) and Emenalom and Udedibie (1998) who obtained similar results with different legumes. This may be partly due to the burning off of some nitrogenous compounds during toasting (Emenalom and Udedibie, 1998) in the contrast, Emiola *et al.* (2002) reported increase in crude protein content of raw kidney beans when subjected to toasting.
The ether extracts value ranged from 2.19% (toasted) to 4.41% (raw) seeds. Toasting significantly reduced (-50.34%) ether extract when compared with other processing techniques. This could possibly be due to volatilization of lipid related compounds. This result is in

Table 1: Proximate composition of raw and differently processed baobab seed meals (on DM basis)

Parameter	RBSM	BBSM	TBSM	SBSM	SBBSM	SPBSM	±SE
Crude protein	28.85^{a}	25.22^{ab} (-12.58)	18.68^{c} (-35.25)	23.23^{bc} (-19.48)	22.76^{b} (-21.10)	23.31^{b} (-19.20)	1.49
Crude fibre	10.78^{a}	7.84^{d} (-27.27)	9.06^{bcd} (-11.57)	10.03^{ab} (-7.39)	9.45^{abc} (-10.18)	8.29^{cd} (-21.44)	0.60
Ether extract	4.41^{a}	2.90^{b} (-34.24)	2.19^{b} (-50.34)	2.82^{b} (-36.05)	2.57^{b} (-41.72)	2.97^{b} (-32.65)	0.36
Ash	8.92^{a}	5.85^{b} (-34.41)	8.80^{a} (-1.34)	5.84^{b} (-34.52)	6.00^{b} (-32.73)	6.12^{b} (-31.39)	0.35
NFE	47.04^{c}	58.17^{b} (+23.66)	61.25^{a} (+36.72)	58.06^{b} (+22.61)	59.21^{ab} (+28.75)	59.28^{ab} (+26.02)	1.41

Figures in parentheses are % reduction or % increases as compared to raw seed

^{a,b,c,d,e}Treatment means with different superscripts are significantly($p<0.05$)different from each other,

SEM: Standard error of the means

RBSM: Raw baobab seed meal

TBSM: Toasted baobab seed meal

BBSM: Boiled baobab seed meal

SBSM: Soaked baobab seed meal

SBBSM:Soaked and boiled baobab seed meal

SPBSM: Spouted baobab seed meal

Table 2: Mineral compositions of raw and differently processed baobab seed

Mineral	RBSM	TBSM	BBSM	SBSM	SBBSM	SPBSM	±SEM
Ca (%)	0.28^{a}	0.12^{b} (-57.00)	0.16^{bc} (-42.00)	0.17^{b} (-39.00)	0.14^{bcd} (-50.00)	0.31^{cd} (53.00)	0.02
P (%)	0.24^{a}	0.14^{c} (-41.66)	0.18^{b} (-25.00)	0.20^{b} (-16.00)	0.13^{c} (-45.83)	0.19^{b} (-20.83)	0.04
Mg (%)	0.26^{a}	0.17^{c} (-34.61)	0.24^{b} (-7.69)	0.21^{bc} (-19.23)	0.18^{bc} (-30.77)	0.21^{bc} (-19.23)	0.07
Na (%)	0.12^{a}	0.08^{bc} (-33.33)	0.07^{c} (-41.66)	0.09^{b} (-25.00)	0.09^{b} (-25.00)	0.06^{c} (-50.00)	0.02
K (%)	0.36^{a}	0.16^{b} (-55.56)	0.18^{b} (-50.00)	0.17^{b} (-52.77)	0.09^{c} (-75.00)	0.14^{b} (-61.10)	0.06
Fe (mg/100 g)	5.01^{a}	4.11^{b} (-17.96)	3.86^{c} (-22.95)	4.01^{bc} (-19.96)	3.54^{b} (-29.34)	4.09^{b} (-18.36)	0.43
Zn (mg/100 g)	4.11^{a}	3.86^{b} (-6.08)	3.47^{b} (-15.57)	3.68^{b} (-10.46)	3.01^{c} (-36.54)	3.92^{b} (-4.62)	0.18
Cu (mg/100 g)	1.80^{a}	1.62^{b} (-10.00)	1.00^{e} (-44.44)	1.21^{d} (-32.77)	1.01^{e} (-43.88)	1.31^{c} (-27.22)	0.09

Figures in parentages are % reduction or % increase as compared to raw seed

^{a,b,c,d,e} Treatment means with different superscripts are significantly ($p<0.05$) different from each other,

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RBSM: Raw baobab seed meal

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agreement with the findings of Akinmutimi (2004) who reported highest percentage reduction of ether extract of toasted sword beans when compared to cook or Akanwu-coooked sword beans. Emiola *et al.* (2002) also observed similar result of highest reduction value of ether extract in toasted kidney beans when compared to soaked, cooked, raw and decorticated kidney beans. The value obtained in this study was slightly higher than the value was reported by Proll *et al.* (1998) who obtained 3.91% ether extract for raw baobab seeds obtained from Burkino Faso. The result was slightly lower than raw mucuna (5.20%) reported by Emiola *et al.* (2002) and 4.52% reported by Ukachukwu and Obioha (1997) but higher than soybeans (3.50%) as reported by Aduku (1999). The result obtained in this study justifies baobab seed classification as a minor oil seed (Proll *et al.*, 1998).

The crude fibre (C.F) values ranged from 10.78 % (raw) to 7.84 % (boiled) seeds. The C.F value of raw baobab seed was significantly reduced by all the processing methods. The C.F values observed in this study were lower then the value of 16.2% CF reported by Magdi (2004). The highest percentage reduction of crude fibre was observed in boiled baobab seed (-27.27%) while soaking (-6.93%) had the least percentage reduction. The value of crude fibre observed in raw baobab seed in this trial is similar to 9.02% CF reported by Okoye *et al.* (1980) for raw baobab seed obtained from Maiduguri in north-eastern Nigeria. The high percentage reduction in crude fiber observed in boiled baobab is in agreement with the finding of Akinmutimi (2004) who reported 50% reduction of crude fibre in sword beans when subjected to cooking, Emiola *et al.* (2002) also reported highest percentage reduction in crude fibre when kidney bean was subjected to cooking. The values of percentage reduction of crude protein observed in boiled baobab seed in this study makes boiling techniques a suitable technique of processing raw baobab seeds.

Mineral composition: The result of mineral composition of raw and different processed baobab seed is presented in Table 2. There were significant ($p<0.05$) differences between the raw baobab seeds and the differently processed baobab seeds in all the minerals investigated. The raw baobab seed is moderately high in its content of potassium, calcium and phosphorus but a poor source of iron, zinc and copper.

The highest reduction values for macro minerals such as P, K and Na were observed in toasted Baobab seeds while the least reduction due to processed methods were observed in soaked for calcium and potassium and in boiled Baobab seed for magnesium. Micro-minerals such as Fe, Zn and Cu were generally reduced in their percentage quantity as a result of processing. Sprouting led to the highest reduction of Fe, while toasting had the least reduction of Fe, soaked and boiling had the highest reduction of Zn and Cu while toasting had the least reduction of Zn and Cu. The values obtained for both macro and micro minerals were lower than the values reported by Madgi (2004). This

Table 3: Anti-nutritional factors of both raw and differently processed baobab meal

Mineral	RBSM	TBSM	BBSM	SBSM	SBBSM	SPBSM	±SEM
Tannin (mg/g)	0.73[a]	0.64[b] (-25.58)	0.25[e] (-65.75)	0.58[c] (-26.54)	0.31[d] (-42.00)	0.33[d] (-40.00)	0.023
A Alkaloid (%)	0.80[a]	0.74[b] (-10.84)	0.53[c] (-36.14)	0.68[c] (-18.07)	0.41[d] (-50.60)	0.66[e] (-20.48)	0.024
Oxalate (mg/100 g)	0.62[a]	0.47[d] (-24.19)	0.41[e] (-33.87)	0.51[cd] (-17.74)	0.54[bc] (-12.90)	0.57[b] (-8.06)	0.021
H Hcn (%)	0.57[a]	0.52[a] (-8.77)	0.31[c] (-46.00)	0.40[b] (-29.82)	0.30[c] (-47.34)	0.42[b] (-26.31)	0.025
P Phytic acid (%)	1.75[a]	1.68[a] (-5.60)	0.62[b] (-64.57)	0.67[b] (-61.71)	0.60[b] (-65.57)	0.66[b] (-61.71)	0.076
T Trypsin Inhibitor (Tμi/g)	6.62[a]	5.28[c] (-20.24)	4.11[d] (-37.91)	5.81[b] (-12.23)	5.71[b] (-13.75)	5.01[c] (-24.32)	0.138

Figures in parentheses are % reduction or % increase as compared to raw seed

[a,b,c,d,e] Treatment means with different superscripts are significantly($p<0.05$)different from each other,

SEM: Standard error of the means

RBSM: Raw baobab seed meal

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may be partly due to species differences, climate and soil and seed variety (Akinmutimi, 2003). On the average in terms of macro and micro minerals, boiled Baobab seed gave the highest value. The implication of this is that if the seed is only needed as a mineral supplement, boiling is recommended as a processing technique.

Anti-nutritional factors and toxins: Table 3 shows the result of different anti- nutritional factors obtained in both raw and processed Baobab seeds.

There were significant ($p<0.05$) differences between the raw and processed Baobab seeds for all the parameters measured. There was a general reduction in the content of anti-nutritional factors (Tannin, Alkaloid, cyanogenic glycosides, oxalate, phytic acid and trypsin inhibitors) as a result of processing of raw baobab seeds, though this reduction varies in degree with different processing techniques.

The highest percentage reductions in Tannin (65.75%) oxalate (33.87%), trypsin inhibitors (37.91%) were observed when the raw Baobab seeds were boiled followed by soaked and boiled Baobab seeds and then sprouting while toasting gave the least reduction. Highest percentage reductions in Alkaloid (50.60%), HCN (47.34%) and phytic Acid (65.57%) were observed when raw baobab seeds were soaked and boiled.

The low percentage reduction of all parameters observed in toasting in this trial confirms earlier report by other authors (Springhall *et al.*, 1974; Scarbrier and Whitaker, 1982; Emenalom and Udedibe, 1998; Amaefule *et al.*, 2003) that dry heating (toasting) was ineffective against tannins, phytate and oxalate. Udedibie and Carlin (1998) observed residual activities of these anti-nutritional factors when legume seeds were subjected to dry heating.

All parameters observed in this study differ from what was earlier reported by Magdi (2004) who reported that baobab seed has 23% tannins. 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 may also be a reason why this finding is in disagreement with the findings of Akinmutimi (2004) who reported a poor reduction of the anti-nutritional factors in sword beans, even when subjected to different processing techniques. Sprouting produced moderate percentage reduction in all the parameter tested particularly tannins, phytic acid, trypsin inhibitors and alkaloid.

Tannins, HCN, phytic acid, oxalate and trypsin inhibitors, were highly detoxified by boiling when compared with Alkaloid, The high reduction of tannin by boiling 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 cooked seeds are fed. This is because tannic acid is known to adversely affect protein digestibility.

Toasting and soaking were reported to produce low detoxification and hence recommendation of moist heat treatment for some legumes (Ukachukwu and Obioha, 1997; Ukachukwu and Szabo, 2003).However, from the points made above boiling appears to be the best method of detoxification of raw baobab seed.

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