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Effects of Different Processing Methods on the Nutrient Composition of Kapok (*Ceiba pentandra*) Seed Meal

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Abstract

The following parameters: proximate composition, mineral composition and anti-nutritional factors were used to study the nutritive value of raw and differently processed kapok seed meal. The raw and differently processed kapok seed were sundried, milled and chemically analysed. The result of the proximate composition showed that crude protein (CP) content of raw and processed kapok seed meal ranged from 22.59±0.04 to 34.82±0.33%. Ether extracts (EE) varied from 6.56±0.23 to 10.05±0.06%, while the crude fibre (CF) ranged between 9.28±0.89 and 18.333±0.33. The metabolisable energy of cooked and fermented kapok seed were significant (P<0.01) higher than raw, toasted and soaked kapok seed meal. The result also revealed that minerals composition (both micro and macro) of cooked kapok seed meal were significant (p<0.01) higher than raw and other processed kapok seed meals. Furthermore, cooked kapok seed meal recorded significant (p<0.01) lower values of anti-nutritional factors in all the parameters measured, higher value of crude protein, minerals and appreciable amount of metabolisable energy. The study therefore recommends cooked kapok seed meal for livestock ratio due its higher value of crude protein, comparable metabolisable energy, appreciable macro and micro nutrients and higher percentage reduction in anti-nutritional factors

Keywords

Kapok Seed, Nutritive Value, Processing Methods

1. Introduction

Livestock farmers in most developing countries are faced with the challenges of inadequate and high cost of feedstuffs [1]. This is as a result of increasing demand for feedstuffs between humans and animals [2; 3] thus farmers are unable to meet livestock feeds demand. Consequently, forced to shut down their farms or operate on a very low capacity [4]. The resultant effect of these challenges is the shortage of animal protein production and high cost animal products. It is therefore imperative to search for alternative feedstuff that is readily available, cheap and has less competition between humans and animals [5].

Kapok is a tropical tree of the order *Malvales* and the family *Malvaceae* native to Mexico, Central America and the Carribean, Northern South America and to tropical West Africa. The tree is also known as the Java cotton, Hara kapok, Silk cotton or Ceiba [6]. Phytochemical screening conducted by several studies revealed that kapok seed contain anti-nutritional factors such as cyanogenic glycoside, trypsin inhibitors, hemagglutinin inhibitor, phytate and oxalate, saponin, phenol, gossypol trypsin [7, 8, 9 and 10]. The potentials of this seed is limited due to the presence of anti- nutritional factors (ANFs). There is the need therefore to process kapok seed to achieve its potentials in livestock production. Various processing methods such as toasting, cooking, soaking, fermenting have been reported to improve legume seeds [3, 11, 12].

The study was therefore carried out to investigate the effect of processing methods (cooking, toasting, fermenting and soaking on the nutritive composition of kapok seed meal.

2. Materials and Methods

2.1. Location of the Study

The study was conducted at the Department of Animal Science and Range Management, Modibbo Adama University of Technology Yola. Yola lies between latitude 7° and 11°N and longitude 11° and 14°E. Maximum temperature in the state can reach up to 40°C particularly in April, while minimum temperature can be as low as 18°C between December and January [13].

2.2. Collection and Processing of Kapok Seed Meals

Kapok seeds were procured from local market in Shelleng, Adamawa State Nigeria. The seeds were screen of stones, dirts then processed using four different processing methods: Cooking, toasting, fermenting and soaking in water. Toasting, the seeds were toasted in a metallic fry pan for 30 minutes with constant stirring to maintain uniform heating until the whitish endosperm turns to light brown. Soaking, was achieved by placing the seeds in a container filled with tap water for 48hours, thereafter removed and sun dried. Fermentation was carried out by cooking the seeds in tap water for 30 minutes, decant and placed in an air tight container for 48hours to allow natural fermentation. Cooking was achieved by introducing kapok seed into a metallic cooking pot at the point of boiling. The seed were cooked for 30minutes before the seed were decanted and sundried on a concrete floor for seven days.

2.3. Chemical Analysis

The raw and processed kapok seed meals were analysed for proximate composition using the methods described by [14]. Metabolizable energy was calculated using the formula of [15]. Nitrogen free extracts was determined by the difference of the sum of all the proximate composition from 100%. The mineral content of the raw and processed kapok seed meals were determined using the atomic absorption spectrophotometer (AAS-Buck 205). Phosphorous was determined by Vaadomolybdate (Yellow) spectrometry described by [16]. Potassium and sodium were determined by flame photometry as described by [17]. Calcium and Magnesium contents were determined as described by the method of [14]. Total oxalate was determined according to [18] procedure. Phytate was determined using the method described by [19]. Saponin was determined using the method of [20] as modified by [21]. While tannin was determined using the method of [22]. All determination were done in triplicates

2.4. Statistical Analysis

Data generated during the study were subjected to Analysis of Variance (ANOVA) described by [23]. Means were separated using Duncan Multiple Range Test [24].

3. Results and Discussion

3.1. Proximate Composition of Raw and Processed Kapok Seed Meal

The proximate composition of raw, fermented, soaked, cooked and toasted kapok seed are shown in Table 1. All the parameters measured were significantly (P <0.01) different between the raw and differently processed kapok seed meals. The raw seed has a crude protein (CP) content of 22.59±0.04%, while fermented, soaked, cooked and toasted values were 32.90±0.02, 28.40±0.12, 34.82±0.11 and 29.26±0.06% respectively. Cooked kapok seed meal recorded the highest value 34.820.11%. These values fell within the range of 32.1-34.6% reported by [8]. The crude protein observed in this study is similar to 30.60% mucuna seed and 34.88% groundnut [25]. However the CP content is higher than of lima bean 21.50%, pigeon pea 23.15 –25.31%, *Canavalia plagiosperma* 24.21% [26, 27]. This implied that kapok seed meal has potentials as a good source of protein. The dry matter (DM) content of the raw and differently processed kapok seed ranged from 83.77±0.67 – 91.43±0.56%. The high dry matter content of the raw and differently processed kapok seeds is an indication that they can be stored for a long time and less prone to microbial attack during storage [1]. The ether extract of the raw, fermented, soaked, cooked and toasted seed were 10.05±0.06, 7.76±0.12, 7.65±0.06, 6.56±0.23 and 9.56±0.03% respectively.

These values are higher than other alternative protein sources such as pigeon pea 2.33%, sword bean 2.94% and *mucuna cochinchinensis* seed 4.52% reported by [28, 29, 30]. The crude fibre (CF) obtained for raw, boiled and toasted RSM was 5.88%, 4.47% and 4.95% respectively. The nitrogen free extract (NFE) for raw and processed kapok seeds ranged from 35.73±0.34 to 44.08±1.34% with soaked seed showing a higher value of 44.08±1.34%. These values were higher than the NFE values obtained for conventional protein source such as soya bean meal (28.60%) and groundnut cake (23.84%) [25], which implies that the seed meals has total digestible nutrient. Raw, fermented, soaked, cooked and toasted kapok seed meal metabolisable energy (M.E) Kcal/g were 3.18±0.17, 3.28±0.44, 3.23±0.33, 3.26±0.38 and 2.12±0.14 Kcal/g respectively. These values are lower when compared with some alternative protein sources such as *canavalia spp*. (4.48 kcal/g), velvet bean (4.49 kcal/g), castor oil seed (5.93 kcal/g), linseed cake (5.2 kcal/g) and lima beans (4.12 kcal/g) [30,31]. This suggests that kapok seed meal is a good source energy.

Table 1. *Proximate composition of raw and processed kapok seed meal (Mean ±SD) (% DM).*

Processing methods						
Parameters(%DM)	**Raw**	**Fermented**	**Soaked**	**Cooked**	**Toasted**	**SEM**
Dry matter	89.51±0.63	91.43±0.56	83.77±0.67	90.76±0.13	90.81±0.04	0.82^{ns}
Crude protein	$22.59±0.04^{e}$	$32.90±0.02^{a}$	$28.40±0.12^{d}$	$34.82±0.11^{a}$	$29.26±0.06^{d}$	0.04^{**}
Crude fibre	$17.45±0.06^{b}$	$9.28±0.89^{e}$	$12.37±0.54^{c}$	$10.14±0.03^{d}$	$18.33±0.33^{a}$	0.13^{**}
Ether extracts	$10.05±0.06^{a}$	$7.76±0.12^{c}$	$7.65±0.06^{c}$	$6.56±0.23^{d}$	$9.56±0.03^{b}$	0.06^{**}
Ash	$6.53±0.09^{b}$	$7.53±0.01^{a}$	$7.50±0.03^{a}$	$7.78±0.17^{a}$	$7.12±0.45^{a}$	0.07^{**}
NFE	$43.38±0.67^{b}$	$40.53±1.09^{c}$	$44.08±1.34^{a}$	$40.70±0.91^{c}$	$35.73±0.34^{d}$	0.40^{**}
*ME kcal/g	$3.18±0.17^{d}$	$3.24±0.44^{a}$	$3.23±0.33^{c}$	$3.26±0.38^{a}$	$3.12±0.46^{d}$	0.03^{**}

Means on the same row with different subscripts are significantly different (p>0.01) **

*Metabolizable Energy = ME (kcal/kg) = 37 x % CP + 81 x % EE + 35.5 x % NFE. Calculated according to the formula of [15]. NFE = Nitrogen free extracts.

3.2. Mineral Composition of Raw and Processed Kapok Seeds

Table 2 shows the result of mineral composition of raw and processed kapok seeds. There were significant (P < 0.01) differences between the raw and the processed seeds except for zinc, manganese and cobalt. Cooked kapok seed recorded significantly (P <0.01) higher Macro minerals (calcium, potassium and Phosphorus) content. The result of sodium and iron followed similar trend to that of macro minerals with cooked kapok seed having the highest value. The result observed are higher than reported values for conventional and alternative sources of feedstuff such as soya bean, groundnut, *canavalia spp,* mucuna bean, velvet bean, lima bean [32]. These are indications of high biological value of kapok seed meal as feedstuff for livestock

Table 2. *Mineral composition of raw and processed kapok seed meal (Mean±SD).*

Processing methods						
Parameters (mg/kg)	**Raw**	**Fermented**	**Soaked**	**Cooked**	**Toasted**	**SEM**
Calcium (Ca)	$917.50±0.54^{c}$	$1180.00±2.13^{b}$	$1071.10±1.5^{b}$	$1213.00±3.35^{a}$	$1120.10±1.52^{b}$	11.00^{*}
Iron (Fe)	$106.89±1.22^{b}$	$118.08±0.35^{b}$	$111.43±0.20^{b}$	$124.95±0.30^{a}$	$101.56±1.90^{b}$	1.12^{*}
Manganese (Mg)	$139.85±3.12^{c}$	$156.12±0.01^{b}$	$154.15±1.80^{b}$	$232.06±2.11^{a}$	$130.67±0.45^{c}$	1.62^{*}
Zinc (Zn)	$141.66±1.31^{c}$	$170.43±0.26^{a}$	$168.05±2.34^{b}$	$173.43±0.15^{a}$	$169.34±0.78^{b}$	1.64^{*}
Cobalt (Co)	$0.71±0.01^{b}$	$0.83±0.04^{a}$	$0.71±0.01^{b}$	$0.83±0.02^{a}$	$0.54±1.02^{c}$	0.01^{*}
Phosphorous (P)	$614.70±1.52^{c}$	$763.72±3.94^{b}$	$734.67±1.11^{b}$	$1101.80±1.9^{a}$	$689.56±0.98^{c}$	7.80^{*}
Sodium (Na)	$62.78±1.09^{b}$	$69.76±0.23^{b}$	$65.71±0.98^{b}$	$72.90±0.56^{a}$	$61.11±1.20^{b}$	0.66^{*}
Potassium (K)	$986.90±1.21^{d}$	$1025.90±0.9^{b}$	$1011.45±2.01^{b}$	$1212.40±0.09^{a}$	$1191.89±1.89^{b}$	8.81^{*}
Copper	$18.06±0.89^{ab}$	$18.17±1.89^{a}$	$17.89±0.92^{b}$	$18.91±0.15^{ab}$	$16.78±1.08^{c}$	0.17^{*}

Means on the same row with different subscripts are significantly different (p>0.05) **

SEM= Standard error mean

3.3. Anti-nutrients in Raw and Processed Kapok Seed Meal

Table 3 shows the results of anti-nutritional factors in raw and differently processed kapok seed meals. The result showed significantly (P < 0.01) decreased in the anti-nutritional factors. This is in line with the report of [32, 33] who reported similar trend for velvet beans and *Mucuna sloanei* seed when subjected to different processing methods. The phytate content ranged from 0.61± 0.39 in cooked to 1.27±0.04% in raw kapok seed. Cooked kapok seeds had significantly (P < 0.01) lower phytate compared to other processing methods. The phytate content obtained in this study were higher than the values of 0.682–0.719% reported for African yam bean [3; 35]. Total Oxalate content ranged from 0.11±1.01 to 1.12±0.02%. The availability of oxalate in both raw and differently processed kapok seeds is an indication that the processing methods employed had little effect on reducing the content of oxalate in kapok seed. Tannin values showed that cooked kapok seeds had the lowest value (0.26±0.36), followed by fermented (0.65±0.01) while raw had the highest value of 2.52±0.05. The result showed that the values were lower than the value of alternative legume *Mucuna pruriens* (0.80%) [32]. Saponin values for raw and differently processed kapok seed were significant (P< 0.01) different with value ranging from 0.40±1.01 cooked to 1.30±0.04 raw kapok seed meals.

Moist heating (cooking and boiling) has been found to reduce the anti-nutritional factors and thereby improving the nutritional value of legume seeds [33; 36]. Ref [33] reported that 37.50% tannin content was destroyed after 30 min of cooking *mucuna sloanei* seed. Since the tannin and saponin content of cooked kapok seed are significantly (P<0.01) lower when compared with raw and other processing methods; this implies that cooking is an effective method of detoxifying. This finding is in line with earlier reports of [12, 35] on African yam bean and tallow seed respectively. This study recorded high value (17.97±0.71%) of trypsin inhibitor in raw, 0.34±0.12% in soaked seed and zero percent in fermented, cooked and toasted. This result agrees with report of [32] who reported a 100% reduction in trypsin inhibitor when subjected to heat treatments. The author reported that the implication of 100% reduction in trypsin inhibitor was that protein digestibility will not be hampered when heat treated seeds are fed to livestock and poultry.

Table 3. *Anti-nutrients in raw and processed kapok seed meal (Mean±SD).*

Processing methods						
Parameters (mg/100g	**Raw**	**Fermented**	**Soaked**	**Cooked**	**Toasted**	**SEM**
Tannin	2.52±0.05[a]	0.65±0.01[b]	0.95±0.07[b]	0.26±0.36[e]	0.89±0.01[b]	0.01**
Saponin	1.30±0.04[a]	0.55±0.09[d]	0.67±0.07[b]	0.40±1.01[e]	0.76±0.12[b]	0.07**
Alkaloid	3.34±0.03[a]	0.42±0.02[c]	0.87±1.01[b]	0.17±0.11[d]	0.14±1.05[e]	0.09**
Phytate	1.27±0.04[a]	0.70±0.11[b]	0.89±0.21[b]	0.61±0.39[c]	0.78±0.45[b]	0.80**
Trypsin inhibitors	17.97±0.71[a]	0.00	0.34±0.12[b]	0.00	0.00	0.09**
Phenol	2.48±0.04[a]	0.30± 0.25[c]	0.81±1.90[b]	0.22±0.22[d]	0.24±0.12[d]	0.08**
Haemagglutin	1.69±0.52[a]	0.14±1.02[d]	0.20±0.31[c]	0.12±0.02[c]	0.27±0.14[b]	0.04**
Oxalate	1.12±0.02[a]	0.12±0.99[c]	0.72±0.04[b]	0.11±1.01[c]	0.14±1.56[c]	0.05**
Flavonoid	2.95±0.56[a]	0.72±0.46[b]	0.97±0.10[b]	0.37±0.33[e]	0.68±0.46[c]	0.01**
Total gossypol	1.98±1.07[a]	0.66±0.01[d]	0.89±0.13[c]	0.12±0.36[e]	0.73±1.00[b]	0.08**
Free gossypol	0.20±0.21[a]	0.17±1.01[b]	0.12±1.02[b]	0.10±0.25[b]	0.9±0.45[b]	0.02**

Means on the same row with different subscripts are significantly different (p>0.05) **
SEM= Standard error mean

4. Conclusion

Cooked kapok seed meal showed higher value of crude protein, comparable metabolisable energy, appreciable macro and micro nutrients and higher percentage reduction in anti-nutritional factors. Cooked kapok seed meal is therefore recommended for livestock

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