

Effect of Cooking and Roasting on Nutritional and Anti-Nutritional Factors in Kenaf (*Hibiscus Cannabinus* L.) Seed Meal.

[1] K.D. Olawepo, [1]* O.T. Banjo, [1] W.A. Jimoh, [2] W.O. Fawole, [3] O. Orisasona, [1] A.H. Ojo-Daniel.
[1]Fisheries Technology Department, Federal College of Animal Health and Production Technology Moor Plantation, Apata, P.M.B 5029, Ibadan, Oyo-state.
[2]National Biotechnology Department Agency, Bioresources Development Center, Ogbomoso, Oyo-state
[3]Department of Aquaculture and Fisheries Management, University of Ibadan, Ibadan, Oyo-State.
* E-mail of corresponding author: kaskunle2002@yahoo.com. Phone +2348035815870

Abstract
The effect of cooking and roasting on levels of nutrients and anti-nutritional factors in Kenaf (*Hibiscus cannabinus*) seed meal was investigated. Significant ($p < 0.05$) variation existed in the nutrient levels among the raw, cooked and roasted kenaf seed meal. Roasting resulted in a significant ($p < 0.05$) increase in crude protein and mineral composition. The processing methods had no significant ($p > 0.05$) effect on the phytic acid but significantly ($p < 0.05$) reduced the tannin content of the kenaf seed meal. While cooking significantly ($p < 0.05$) reduced the trypsin inhibitors, roasting did not significantly ($p > 0.05$) alter the trypsin inhibitory activities in Kenaf seed meal when compared with the unprocessed kenaf seed meal.
Key words: *Hibiscus cannabinus*; Kenaf seed meal; Cooking; Roasting; Nutrient; Anti-nutritional factors

1. Introduction

In recent years, it is economically nonviable and practically unsustainable for aquaculture industry to depend solely on conventional ingredients most especially ingredients of animal origin (Merino *et al*., 2010; Tacon and Metian, 2008; Sogbesan and Ugwumba, 2008). Limited supply, increasing demand and high price of conventional feed ingredients has been the motivating factors to explore alternative sources for livestock and aquaculture feed production (Odetola and Eruvbetine, 2012, Enujiugha & Ayodele-Oni, 2003,).

Due to lower cost and availability, the use of ingredients of plant sources have been widely explored in aquaculture feed production (Nyina-wamwiza *et al*., 2012; Adewumi,2006). Nonetheless, most of these plant materials especially oilseeds and legumes contain various anti-nutritional factors which compromise the physiological status of cultured fish (Liener, 2003 and; Phengnuam and Suntornsuk, 2013).

Kenaf (*Hibiscus cannabinus* L.) is an annual herb of sub-saharan Africa origin, belonging to the Mallow family (Dempsey, 1975). Kenaf seed has recently received attention in livestock industry as feed ingredient due to its nutritional profile. The seed has higher level of unsaturated fatty acid when compared with soybean (Duke, 2003) and high protein quality (Odetola and Erubvetine, 2013). Odetola and Erubvetine (2013) in their investigation on nutritional value of Kenaf seed meal using rat as a model organism reported the presence of tannin, oxalate and pytic acid as anti-nutritional factors in kenaf seed meal. In order to improve the protein quality of most ingredient of plant source, it is imperative to minimize or eliminate their toxins and anti-nutritional factors (Hefnawy, 2011). This can be achieved through processing involving the use of heat and ionizing radiation (Kumar & Sharma, 2008)); chemicals (Goel *et al*., 2007) and through biological means involving the use of fermentation agents such as *Pseudomonal aeruginose* and fungi (Belewu and Sam 2010 and; Josh *et al*., 2011).

Kenaf (*Hibiscus cannabinus* L.) seed meal is a lesser-known feed ingredient in aquaculture and has not received due attention by the aquaculture nutritionists. Therefore, this study was undertaken to evaluate the effect of different processing techniques on the nutritional and anti-nutritional profile of *Hibiscus cannabinus* seed meal.

2. Materials and Methods

2.1 Source of Kenaf Seed Sample

Kenaf seeds (*Hibiscus cannabinus*) were purchased from the Institute of Agricultural Research and Training (IAR&T) Moor Plantation (South West, Ibadan, Oyo-State, Nigeria, West Africa).

2.2.1 Processing Methods

The kenaf seeds were hand sorted to remove extraneous materials and subjected to cooking and roasting.

2.2.2 Cooking
100 g of Kenaf seeds were cooked in distilled water until softened on squeeze between fingers (30 minutes). The cooked seeds were drained and sundried.

2.2.3 Roasting
100 g of kenaf seeds were roasted on a hot iron pan at a temperature of (75 – 85^{o}C). The seeds were continuously stirred until the seed turned brown. The roasted seeds were allowed to cool down and stored.

2.3 Preparation of Kenaf Seed Meal
50 g of both processed and unprocessed (raw) seed samples were powdered to 0.5mm size. The samples were stored in air-tight glass bottle until further use.

2.4 Biochemical Analysis
2.4 .1 Proximate Analysis
The proximate analyses of the samples for moisture, crude fat, crude fibre and total ash were carried out in duplicate according to the methods of Association of Official Analytical Chemists (AOAC, 2000). Nitrogen was determined by the micro-kjeldahl methods described by Humphries (1956) and the percentage nitrogen converted to crude protein by multiplying by 6.25.

2.4.2 Mineral Analysis
All the metals were determined by Atomic Absorption Spectrophotometer (Solar 969 Unicam) with exception of sodium and potassium that were determined using a flame photometer (Model 405, Corning United Kingdom).

2.4.3 Analysis of Anti-nutritional compounds
Tannin content was estimated using the Vanillin-HCl method modified by Price *et al.* (1978). Phytic acid was estimated according to the method of Reddy and Love (1999) and the method of Kakade *et al.* (1974) was adopted in estimating the trypsin inhibitory activity.

2.5 Statistical Analysis
The data collected were recorded as Mean ± standard error and subjected to analysis of variance (ANOVA) using SPSS 17 ® statistical software (SPSS Inc., Chicago IL, USA). Significance differences in biochemical data were accepted at $p < 0.05$ and Duncan multiple range test was used to separate means.

3.0 Result and Discussion

3.1 Effect of Cooking and Roasting on Proximate Composition

The proximate compositions of raw and processed kenaf seeds are presented in Table 1. The processing methods had no significant (p > 0.05) effect on the moisture content of kenaf seed. Similar result was observed by Hefnaway (2011) when *Lens culinaris* seeds were subjected to cooking. Seena *et al*. (2005) on the contrary, reported a decrease in the moisture content of cooked *Canavalia cathartica* seeds when compared with the roasted *Canavalia cathartica* seeds. Roasting did not significantly (p > 0.05) change the crude protein of kenaf seeds when compared with the raw kenaf seed. However, cooking significantly (p < 0.05) reduced the crude protein level of kenaf seed. This result contradicted an increase in crude protein reported by Yagoub *et al.* (2008), when *Hibiscus sabdariffa* seeds were subjected to cooking, soaking and sprouting and; Wang *et al*. (2010) when *Phaseolus Vulgaris* seeds were subjected to cooking. Seena *et al*. (2005) reported a decrease in crude protein of cooked *Canavalia cathartica* seeds when compared with the roasted *Canavalia cathartica* seeds. The crude fiber of dry plant seeds increase when cooked due to formation of protein-fiber complex (Bressani, 1993). This might be the reason for a significant (P < 0.05) increase in the crude fiber of cooked kenaf seed observed in this study. However, there was no significant (p > 0.05) change in the crude fibre of kenaf seeds subjected to roasting when compared with the raw seeds. Cooking in water reduces the ash and fat content of seed due to diffusion of minerals into the cooking water (Wang et al., 2009; Seena *et al*., 2005). In this study, the crude fat of kenaf seed significantly (P < 0.05) reduced when subjected to either cooking or roasting. Cooking did not significantly (p > 0.05) altered ash content while roasting significantly (p < 0.05) increased the ash content of kenaf seed. Wang et al. (2008) reported a decrease in ash content of peas seed subjected to cooking. Cooking and Roasting significantly (p < 0.05) increased the nitrogen free extract of kenaf seed. The increase in the Nitrogen free extract might be attributed to loss of soluble solids which increased the concentration of the starch.

Table1: Effect of cooking and roasting on proximate composition of kenaf seed (g/100g dry weight basis)

	Treatment		
	Raw	Cooked	Roasted
Moisture	4.65 ± 1.65	5.80 ± 0.00	5.20 ± 0.10
Crude protein	25.12 ± 0.02[a]	24.16 ± 0.00[b]	25.13 ± 0.06[a]
Crude fat	18.89 ± 0.07[a]	12.40 ± 0.01[b]	12.37 ± 0.04[b]
Crude fiber	25.61 ± 0.03[b]	27.70 ± 0.09[a]	25.30 ± 0.12[b]
Ash	4.40 ± 0.03[b]	4.30 ± 0.06[b]	4.98 ± 0.08[a]
Nitrogen free extract	19.79 ± 0.16[c]	25.64 ± 0.14[b]	27.03 ± 0.33[a]

Mean in the same column with different superscripts are significantly ($p < 0.05$) different.

3.2 Effect of Cooking and Roasting on Mineral Content

The mineral content of raw and processed kenaf seeds are presented in Table 2. Copper (Cu) content of kenaf seeds were not significantly ($p > 0.05$) affected by cooking and roasting. Wang et al. (2010) reported similar result when beans and chicken peas were subjected to cooking. Cooking in water was reported by Haytowitz and Matthews (1983) and Wang *et al.* (2008) to cause great loss in minerals of cooked pulse. Kenaf seed subjected to cooking in this study did not have significant ($p > 0.05$) effect on Calcium (Ca), Magnesium (Mg), Sodium (Na), Iron (Fe) and Manganese (Mn). However, roasting significantly ($p < 0.05$) increased all the mineral content of Kenaf seeds assessed with the exception of sodium (Na) that significantly ($P < 0.05$) reduced. Hamed *et al.* (2008) reported a similar significant increase in total and extractable minerals in roasted pumpkin seeds.

Table 2: Effect of cooking and roasting on mineral content of kenaf seed (g/100g dry weight basis)

	Treatment		
	Raw	Cooked	Roasted
Calcium	251.88±3.12[b]	253.52±2.49[b]	280.52±0.55[a]
Magnesium	172.69±1.69[b]	170.53±0.48[b]	191.30±1.29[a]
Potassium	368.52±2.15[c]	343.18±2.96[b]	483.75±0.49[a]
Sodium	17.11±0.90[a]	20.69±0.38[a]	8.81±0.19[b]
Copper	0.44±0.01	0.48±0.02	0.49±0.02
Iron	2.99±0.01[ab]	2.69±0.05[b]	3.39±0.17[a]
Manganese	2.40±0.01[b]	2.31±0.03[b]	2.68±0.03[a]
Phosphorus	147.72±0.06[b]	139.64±1.33[c]	158.49±0.59[a]

Mean in the same column with different superscripts are significantly ($p < 0.05$) different.

3.3 Effect of Cooking and Roasting on Anti-Nutritional Factors

The anti-nutritional factors of raw and treated kenaf seeds are presented in Table 3. Anti-nutritional factors such as inhibitors, tannin, anti-vitamin, lectins are heat-labile (Liener, 2003). In this study, cooking and roasting significantly ($p < 0.05$) reduced the tannin in kenaf seed. Similar result was reported by Wang *et al*. (2009) when Lentis seeds were cooked. Trypsin inhibitory activity significantly ($p < 0.05$) reduced by cooking while roasting had no significant ($p > 0.05$) effect on the trypsin inhibitor. Hefnawy (2011) also reported a significant reduction in the level of trypsin inhibitor in cooked Lentis seeds. Heat treatment alone is relatively ineffective in reducing the phytate content of plant materials (Liener, 2003). In this study, cooking and roasting had no significant ($p > 0.05$) effect on the phytic acid content of kenaf seeds. No significant effect of cooking on phytic acid of beans and chickpeas was reported by Wang et al. (2010). Similar result was reported by Yagoub et al. (2008) when Roselle (*Hibiscus sabdriffa*) seed was subjected to cooking.

Table 3: Effect of cooking and roasting on the antinutritional factors of kenaf seeds (dry weight basis).

	Tanin	Trypsin inhibitor	Phytic acid
Raw	1.18 ± 0.01 [a]	0.10 ± 0.01 [a]	0.14 ± 0.11
Cooked	1.06 ± 0.03 [b]	0.07 ± 0.00 [b]	0.27 ± 0.01
Roasted	0.98 ± 0.01 [b]	0.11 ± 0.00 [a]	0.30 ± 0.00

Mean in the same column with different superscripts are significantly ($p < 0.05$) different.

4.0 Conclusion

As shown in this study, cooking and roasting affect the nutritional and anti-nutritional composition of kenaf (*Hibiscus canabinus*) seed meal. Nutritional value of roasted Kenaf seed meal appeared to be higher when compared with cooked Kenaf seed meal. Roasting resulted in significant increase in crude protein, mineral and Nitrogen free Extract (NFE). However, roasting appeared to be inefficient in reducing the trypsin inhibitory activity in Kenaf seed meal.

References

AOAC. (2000). Official method of AOAC International. 17th ed. Association of Official Analytical Chemists. Washington, DC.

Adewumi A. A. (2006). The growth and gonadal maturation of the African catfish, *Clarias gariepinus* (Burchell) broodstock fed differently heated soybean based diets, *Aquaculture Nutrition*, 12: 267–274.

Belewu, M.A. and Sam, R. (2010b). Solid state fermentation of *Jatropha curcas* kernel cake: Proximate composition and antinutritional components. *Journal of Yeast and Fungal Research.* 1(3): 44 – 46.

Bressani, T. (1993). Grain quality of common beans. *Food Review International*, 9, 237 – 297.

Dempsey, J.M. (1975). Fiber crop. University Press, Gainesville, Florida USA. Pp 203 – 304.

Duke, J.A. (2003)**.** *Hibiscus cannabinus* L. Handbook of Energy Crops. Unpublished.
http://www.hort.purdue.edu/newcrop/duke_energy/Hibiscus_cannabinus.html.

Enujiugha, V. N., & Ayodele-Oni, O. (2003). Evaluation of nutrients and some antinutrients in lesser known, underutilized oilseeds. *International Journal of Food Science and Technology*, 38, 525–528.

Goel, G. Makkar, H.P.S., Francis, G and Becker, K. (2007). Phorbol esters: structure, biological activities and toxicology in animal. *International Jorunal of Toxicology* 26(4): 279 – 288.

Hamed, S.Y., El Hassan, N. M. and Hassan A., B. (2008). Nutritional evaluation and physichochemical properties of processed Pumpkin (*Telfairia occidentalis* Hook) seed flour. *Pakistan Journal of Nutrition*, 7 (2), 330 – 334.

Haytowitz, D. B., & Matthews, R. H. (1983). Effect of cooking on nutrient retention of legumes. *Cereal Foods World*, 28(6), 382–384.

Hefnawy, T.H. (2011). Effect of processing methods on nutritional composition and anti-nutritional factors in lentils (*Lens culinaris*). *Annals of Agricultural Science.* 56 (2), 57 – 61.

Humphries, E. C. (1956). Mineral composition and ash analysis. In K. Peach & M.V. Tracey (Eds). Mordern methods of plant analysis (Vol. 1. pp. 468 – 502).

Joshi, C. Mathur, P. and Khare, S.K. (2011). Degradation of phorbol esters by *Pseudomonas aeruginosa* PseA during solid-state fermentation of deoiled *Jatropha curcas* seed cake. *Bioresources Technology,* 102: 4815 – 4819.

Kakade, M. L., Rackis, J. J., McGhee, J. E. & Puski, G. (1974). Determination of trypsin inhibitor activity of soy products: A collaborative analysis of an improved procedure. *Cereal Chemistry*, 51, 376 – 382.

Kumar, A. And Sharma, S. (2008), An evaluation of multipurpose oil seed crop for industrial uses (*Jatropha curcas* L.): a review. *Industrial Crops and Products*, Vol. 28, pp. 1-10.

Liener, I.E (2003). Plant antinitritional factors/Detoxification. *Encyclopedia of Food Sciences and Nutrition*. Pg 4587 – 4593.

Merino, G., Barange, M., Mullon, C. and Rodwell, L. (2010). Impacts of global environmental change and aquaculture expansion on marine ecosystem. *Global Environmental Change* 20, 586 – 596.

Nyina-wamwiza, L., Defreyne, P.S., Ngendahayo, L., Milla, S., Mandiki, S.N.M. and Kestemont, P. (2012). Effect of partial and total fishmeal replacement by agricultural by-product diet on gonad maturation, sex steroids and vitellogenin dynamics of African catfish (*Clarias gariepinus*). *Fish Physiology and Biochemistry*, 38: 1287 – 1298.

Odetola, O.M. and Eruvbetine, D. (2012). Nutritional evaluatioin of whole kenaf (*Hibiscus cannabinus* L.) seed meal in Rats. *Journal of Advanced Laboratory Research*. 3 (3) 215 – 220.

Phengnuam, T. and Suntornsuk, W. (2013). Detoxification and anti-nutrients reduction of *Jatropha curcas* seed cake by Bacillus fermentation. Journal of Bioscience and Bioengineering. 115(2), 168 – 175.

Price, M. L., Van, S. S. and Butter, L.G. (1978). A critical evaluation of the vanillin reaction as an assay for tannin in Sorghum grain. *Journal of Agriculture and Food Chemistry*, 26, 1214 – 1218.

Reddy, M.C. & Love, M. (1999). The impact of food processing on the nutritional quality of vitamins and mineral. *Adv. Exp. Biol.* 15, 459 – 1006.

Seena, S., Sridhar, K.R. and Jung, K.(2005). Nutritional and antinutritional evaluation of raw and processed seeds of a wild legume (*Canavalia cathartica*) of costal sand dunes of India. *Food Chemistry* 92, 465 – 472.

Sogbesan, A.O. and Ugwumba, A.A.A. (2008). Nutritional evaluation of Termite (*Macrotermes subhyalinus*) meal as animal protein supplement in the diet of *Heterobranchus longifilis* (Valenciennes, 1840) fingerlings. *Turkish Journal of Fisheries and Aquatic Science*, 8, 149 – 157.

Tacon, A.G.J. and Metian, M. (2008). Global overview on the fish meal and fish oil in industrially compounded aquafeeds: Trend and future prospect. Aquaculture 285, 146 – 158.

Wang, N., Hatcher, D.W., Tyler, R.T., Toews, R. and Gawalko, E.J. (2010). Effect of cooking on the composition of beans (*Phaseolus vulgaris* L) and chickenpeas (*Cicer arietinum). Food Research International* 43:589 – 594.

Wang, N., Hatcher, D.W., Toews, R. and Gawalko, E.J. (2009). Influence of cooking and dehulling on nutritional composition of several varieties of lentils (*Lens culinaris*). *Food Science and Technology* 42, 845 – 848.

Wang, N., Hatcher, D.W. and Gawalko, E.J. (2008). Effect of variety and processing on nutrient and certain antinutrients in field peas (*Pisum sativum*). *Food Chemistry*, 111, 132 – 138.

Yagoub A. G., Mohammed, M.A and Baker, A.A.A. (2008). Effect of soaking, sprouting and cooking on chemical composition, bioavailability of mineral and *in vitro* protein digestibility of Roselle (*Hibiscus sabdariffa* L.) seed. *Pakistan Journal of Nutrition* 7(1): 50-56.