NUTRIENT QUALITY OF DETOXIFIED JACKBEAN (*Canavalia ensiformis* L. DC) SEEDS COOKED IN DISTILLED WATER OR TRONA SOLUTION AND EVALUATION OF THE MEAL AS A SUBSTITUTE FOR SOYBEAN MEAL IN PRACTICAL DIETS FOR NILE TILAPIA, *Oreochromis niloticus*, FINGERLINGS

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Abstract

Jackbean (*Canavalia ensiformis*) seeds were detoxified using six different wet thermal processing (detoxification) methods either in distilled water or 5% (wt./vol.) or trona ($NaCO_2.NaHCO_3.2H_2O$) solution. The effects of the six detoxification methods on hemagglutinating, antitryptic and urease activities, and on the digestibility coefficient of crude protein and gross energy in the jackbean seeds were investigated. Cracked jackbean seeds cooked (100^oC) in trona solution for one hour proved to be more effective as a method of inactivating the anti-nutritional factors in jackbean seeds. Dry detoxified jackbean seed meals derived from cracked jackbean seeds cooked in distilled water or trona solution were later incorporated as protein source in dry practical diets (300 g crude protein, 100 crude lipid and 18.0 MJ gross energy/kg diet) providing 20% or 30% of total protein and fed to Nile tilapia (*Oreochromis niloticus*) fingerlings (mean weight, 6.7 g) twice daily to apparent satiation for 70 days. Mortality was low (< 5%) and no abnormal fish behaviour was noted even when the detoxified jackbean meals provided 30% of total protein in diet. Growth and feed utilization indices were similar ($P > 0.05$) in *O. niloticus* fingerlings fed diets in which cracked jackbean seeds cooked in water provided 20% of total protein and in diets in which cracked jackbean seeds cooked in trona solution provided 20% or 30% of total protein. Carcass composition and hepatosomatic index showed no definite trend among *O. niloticus* fingerlings fed the experimental diets.

Introduction

Greater emphasis is placed on research into the use of alternative plant protein feedstuff in fish nutrition, due to the high prices of the conventional plant protein source, soybean; and due to its use in other animal feeds. Although grain legumes or pulses have not been widely used in fish feeds, they represent good dietary protein and energy sources (De la Peña *et al*. 1987; Jauncey 1998). The genus *Canavalia* comprises 48 species of underutilized annual legumes widely distributed and indigenous to the tropics, it is rarely edible to man and under optimal agronomic conditions; total yield of dry seeds can reach up to 2.5 tons ha^{-1} (Okonkwo and Udedibie 1991). Raw *Canavalia* seeds contain about 300 g kg^{-1} protein and 600 g kg^{-1} carbohydrates (Rajaram and Janardhanam 1992) hence, they have great potential

as dietary protein feedstuff for monogastrics and poultry (Herrera *et al*. 1981, Montila *et al*. 1981, D'Mello *et al*. 1985, Wyss and Bicjel 1988, Udedibie 1990, Udedibie and Nkwocha 1990). As with other legume seeds, a major drawback to the use of *Canavalia* seeds in animal feeding is the presence of several endogenous toxic antinutritional factors (Carlini and Gumaraes 1981), which include thermo-stable factors (canavanine, concanavalin, canavalin, canatoxin) and thermo-labile factors (protease inhibitors, lectins, phytic acid). These antinutritional factors are solubilized nitrogenous compounds which require deactivation by moist heat treatment and/or extraction prior to use as feedstuffs (Bressani and Sosa 1990, D'Mello and Walker 1991, Ogunsanwo *et al*. 1994, Carlini and Udedibie 1997, Udedibie and Carlini 1998a, 1998b).

There is justification for *Cannavalia* seed meals being used in fish diets as it will reduce over dependence on conventional protein sources, and may eventually result to a decrease in the cost of fish feeding. *Canavalia* seed meals represent a good dietary protein source in fish feeds. For example, Martinez-Palacios *et al*. (1988) fed raw and free amino acid-extracted jackbean (*C. ensiformis*) seed meals to Mozambique tilapia (*Oreochromis mossambicus*), Akinbiyi (1992) soaked jackbean seeds in water or NaOH for 48 hours prior to autoclaving which was fed to *O. niloticus* and Abdo de la Parra *et al*. (1998) fed raw and autoclaved *C. maritima* seed meals to *O. niloticus*; and they concluded that *Canavalia* seed meals may represent useful plant protein feedstuff in tilapia diets but cautioned that the potential cannot be realized because of residues of thermostable toxins in the meal, which caused lethargic behaviour, poor growth and some mortality of fish. Hence, it is necessary to assess improved methods for total extraction of the toxicants from the jackbean seed meals.

Trona, (sodium sesquicarbonate, $Na_2CO_3.NaHCO_3.2H_2O$), which occurs naturally in several parts of the world (Makanjuola and Beetlestone 1975, Iwunze 1980) is used as a food additive in most African countries. Traditionally, it tenderizes foods and meat and reduces cooking time of cowpeas (Ankra and Dolvo 1978). Two-stage cooking is a practice commonly used locally for preparing certain poisonous foodstuffs, such as jackbeans and swordbean (*C. gladiata*) seeds, for human consumption (Udedibie *et al*. 1996). Soaking jackbean seeds in trona solution (3% wt./vol.) prior to cooking in water or cooking in trona solution (3% wt./vol.) for 30 minutes was not effective in detoxifying the jackbean seeds as to enhance the dietary level of 20% and above in broiler finisher (Esonu *et al*. 2000). According to Montilla *et al*. (1981), soaking jackbean seeds in urea for a week prior to cooking for one hour is best to detoxify jackbean seeds, while Udedibie *et al*. (1994) reported that urea alone was ineffective and that toasting alone resulted in partial detoxification of jackbean seeds. This study investigated the comparative effects of six detoxification processes which involved cooking whole, cracked or sprouted jackbean seeds in distilled water or trona solution, on the nutrient and anti-nutrient quality of jackbean seeds and to evaluate the dry meals derived from detoxified jackbean seeds as protein source in diets for Nile tilapia, *O. niloticus*, fingerlings, using growth response, feed utilization, nutrient digestibility, carcass composition and histopathology of livers.

Materials and methods

Dry jackbean seeds were collected from National Root Crops Research Institute (NRCRI), Vom, Nigeria and were distributed into nine treatment batches thus: (i) raw whole seeds, (ii) whole seeds were cooked at 100^{o}C in distilled water for one hour, (iii) whole seeds were cooked in trona solution (5% wt./vol.) for one hour, (iv) cracked seeds (3-7 coarse pieces/seed) were cooked at 100^{o}C in distilled water for one hour, and (v) cracked seeds were cooked in trona solution at 100^{o}C for one hour, (vi) whole seeds were spread evenly on wet jute bags to facilitate sprouting and the growth was terminated by cooking (100^{o}C) in distilled water for one hour, (vii) whole seeds were spread evenly on wet jute bags to facilitate sprouting and the growth was terminated by cooking (100^{o}C) in trona solution for one hour, (viii) whole seeds were cooked in distilled water for 30 minutes after which the water was thrown out, fresh water was added and cooking continued for another 30 minutes (two-stage cooking method), and (ix) whole seeds were cooked in trona solution for 30 minutes after which the water was thrown out, fresh trona solution was added and cooking continued for another 30 minutes. All the cooked jackbean seeds were oven-dried (60^{o}C) for 24 hours, allowed to cool, solar-dried for 24 hours (1 kW m^{-2}), separately milled into meals using a 2 mm screen and stored at ambient temperature (22.5^{o}C). Triplicate samples of dry jackbean seed meals were analyzed for hemagglutinating and antitryptic activities according to the methods described by Carlini and Udedibie (1997) while quantitative analysis of urease activity and protein solubility were determined using the methods of Chow (1980) and Dale *et al*. (1987), respectively.

Apparent digestibility coefficients of crude protein and gross energy in raw and detoxified jackbean seeds were determined as follows: a purified reference diet (casein 32%, gelatin 8%, α-starch 40%, fish oil 10%, vitamin-mineral mix 9%, and chromium III oxide 1%) and test feedstuff diets containing 70% of the reference diet mixture and 30% of raw jackbean seeds or detoxified jackbean seeds were prepared as previously described (Fagbenro 1998, Adeparusi and Jimoh 2002). *O. niloticus* fingerlings were separately distributed in groups of 15 fingerlings into 20-litre cylindrical plastic tanks supplied with aerated water. Each diet was assigned to duplicate tanks and the fingerlings were fed to apparent satiation twice daily (8.30–9.00h and 16.0–16.30h) for 14 days. On the last day, faeces were collected from each anaesthetized fingerling (2.5ml quinaldine L^{-1} of water) eight hours after feeding using the dissection method. Crude protein content was analysed in triplicate samples of diets and faeces using AOAC (1990) methods and gross energy content was determined by bomb calorimetry. Chromium content of diets and faeces was determined spectrophotometrically (Bolin *et al*. 1952). Apparent digestibility coefficient (ADC) of protein and energy in diets were calculated as: $ADC = 10^2 - [10^2 \times (I_d/I_f \times N_f/N_d)]$, where: N_d = nutrient in diet, N_f = nutrient in faeces; $I_d = Cr_2O_3$ in diet; $I_f = Cr_2O_3$ in faeces. The $ADC_{\text{crude protein/gross energy}}$ in test feedstuff was calculated as: $ADC_{\text{crude protein/gross energy}} = 100/30\ (ADC_{\text{test diet}} - 70/100\ ADC_{\text{reference diet}})$.

Menhaden fish meal and soybean meal (obtained from local feedstuff market in Nigeria), raw and detoxified jackbean seed meals were separately milled, screened to fine particle size (< 250µm), and triplicate samples were analysed for proximate analyses (AOAC 1990). Proximate analyses (moisture, crude protein, crude lipid, crude fibre, ash) according

to AOAC (1990) methods are presented in Table 1. Crude protein was determined using Kjeltec Auto 1030 Analyser after digestion with concentrated H_2SO_4 in a digester. Crude lipid was estimated by extracting in chloroform:methanol (2:1) using a Soxtec extraction HT6 unit. Crude fibre was determined using a Fibretec System 1020 Hot Extractor and ash content was determined by igniting at 550^{o}C in a muffle furnace for 12 hours. Gross energy content was determined using a Gallenkamp adiabatic bomb calorimeter. Essential amino acids (EAA) composition of fish meal, soybean meal and raw jackbean seeds were determined using an LKB 4151 Alpha plus amino acid analyzer after treating samples with 6 mol L^{-1} HCl under reflux for 24 hours at 110^{o}C. Tryptophan content was determined colorimetrically after hydrolyzing samples in 4.2 mol L^{-1} NaOH (Fischl 1960).

Table 1. Proximate composition of practical feedstuffs used in the experimental diets.

Nutrients (g kg^{-1} dry wt)	Menhaden fish meal	Soybean meal	Jackbean seeds				Maize
			raw	cooked	sprouted	two-stage cooked	
Crude protein	680	446	285	253	265	243	98
Crude lipid	104	46	31	46	40	30	43
Crude fibre	10	49	78	77	77	64	29
Total ash	204	58	37	21	41	37	12
Gross energy (MJ kg^{-1})	18.69	17.78	16.89	16.48	16.31	16.10	16.47

Table 2. Essential amino acid composition of practical feedstuffs.

Amino acid (g kg^{-1} protein)	Fish meal	Soybean meal	Jackbean seed (raw)
Arginine	61	71	41
Histidine	24	26	24
Isoleucine	47	61	35
Leucine	73	86	64
Lysine	77	65	48
Methionine	29	15	12
Phenylalanine	40	53	45
Threonine	41	40	39
Tryptophan	11	14	10
Valine	53	53	41

Based on the nutrient composition of the protein feedstuffs (Table 1), a control diet and four test diets (300 g crude protein, 100 g crude lipid and 18.0 MJ gross energy kg^{-1} dry matter) were formulated (Table 2) to meet the nutrient requirements of *O. niloticus* (Jauncey 2000). The test diets contained dry meals derived from cracked jackbean seeds cooked in distilled water or trona solution for one hour; formulated to supply 20% or 30% of total protein (Table 3).

Table 3. Ingredient and nutrient composition of the experimental diets.

Ingredients (g kg^{-1} dry wt)	Control diet	Jackbean seed meal diets			
	CD	DW20	DW30	TS20	TS30
Fish meal	240	240	240	240	240
Soybean meal	330	260	220	260	220
Jackbean seeds (cooked in distilled water)	-	120	180	-	-
Jackbean seeds (cooked in trona solution)	-	-	-	120	180
Maize	250	200	180	200	180
Cod liver oil	25	25	25	25	25
Corn oil	35	35	35	35	35
Vitamin-mineral mix	20	20	20	20	20
Cassava starch	100	100	100	100	100
Moisture	82.5	81.0	83.6	82.1	83.0
Crude protein	301.8	302.4	305.5	301.8	303.1
Crude lipid	103.9	107.6	105.2	102.6	104.8
Crude fibre	55.8	56.5	57.0	56.1	57.3
Total ash	60.4	54.1	52.6	52.9	50.7
Gross energy (MJ kg^{-1})	18.03	18.01	18.12	18.06	18.04

Lipid content of all diets was adjusted with corn oil and cod liver oil while gelatinized cassava starch was supplemented to adjust gross energy content. The feedstuffs were blended, moistened, steam-pelleted, oven-dried at 60^{o}C for 24 hours, and the diets were stored in sealed plastic containers at ambient temperature (22.5^{o}C).

O. niloticus fingerlings were acclimated to experimental conditions for 14 days prior to the feeding trial. Groups of 20 *O. niloticus* fingerlings (6.3 ± 0.5 g) were stocked into an indoor system comprising 60-litre capacity cylindrical plastic tanks; supplied with aerated tap water (water flow, 1 L min^{-1}). Each diet was fed to *O. niloticus* fingerlings in triplicate tanks, to apparent satiation twice daily (09.00h, 16.00h) for 70 days. Fish mortality was monitored daily, total fish weight in each tank was determined at two-week intervals, and the amount of diet was adjusted according to the new weight. Growth response and feed utilization indices were estimated (Steffens 1989). Ten (10) and five (5) *O. niloticus* fingerlings per treatment were sacrificed at the start and end of the feeding trial, respectively and analyzed for carcass composition (AOAC 1990). Livers from ten *O. niloticus* fingerlings in each treatment were removed, weighed and used to estimate the hepatosomatic index (HSI).

All data were subjected to one-way analysis of variance (ANOVA). When ANOVA revealed significant differences, Duncan's multiple-range test (Zar 1996) was applied to characterize and quantify the differences between treatment. Statgraphics 5 Plus package for Windows (Statistical Graphics Corp, Maryland, US.) was used as statistical software.

Results and discussion

The urease activity (UA) and protein solubility index (PSI) of raw jackbean seeds as well as whole or cracked jackbean seeds subjected to the six wet thermal processing

treatments (detoxification methods) in distilled water or trona solution are shown in Table 4. The raw, unprocessed jackbean seeds had UA value of 20.25 mg/L. The whole seeds cooked at 100^{o}C had reduced UA values and the cracked and cooked jackbean seeds had even more reduced UA values. Generally for both whole and cracked jackbean seeds, seeds cooked in trona solution had lower UA values than those cooked in distilled water to the point that no urease activity was recorded in cracked jackbean seeds cooked in trona solution. Values recorded for hemagglutinating activity (HU), trypsin inhibitor unit (TIU) and PSI followed the same trend as UA. Remarkably, no inhibitory activity was recorded in cracked jackbean seeds cooked in trona solution or two-stage cooked jackbean seeds in trona solution. Protein solubility values ranged from 65.09–76.08%.

Except for sprouted cooked jackbean seeds, apparent digestibility coefficients for crude protein and gross energy in the other cooked jackbean seeds were higher ($P < 0.05$) than those of raw jackbean seeds with cracked and cooked jackbean seeds having slightly higher values ($P > 0.05$) than sprouted cooked or whole cooked jackbean seeds. It is likely that the thermostable antinutritional factors in the jackbean seeds formed a good proportion of the solubilized and removed nitrogenous compounds, which might be partly responsible for the improvement in the nutritive values of processed jackbean seeds. The apparent digestibility coefficient for crude protein and gross energy in sprouted jackbean seeds cooked either in water or trona solution were similar to those of raw jackbean seeds (Table 4). Sprouting initiates three main types of chemical changes in the seed, namely; (i) breakdown of certain minerals, (ii) transport of materials from one part of the seed to another especially from the endosperm to the embryo or from the cotyledons to the growing parts, and (iii) the synthesis of new materials from the breakdown products formed (Esonu *et al*. 1999). It was anticipated that chemical changes that occurred during sprouting of jackbean seeds would modify the toxic constituents so as to improve the nutritive value of jackbean seeds. However, the poor apparent digestibility coefficients in sprouted jackbean seeds suggest that there were other factors responsible other than those assayed and that sprouting alone is not effective as a detoxification method for these unidentified toxic and inhibitory factors in jackbean seeds. This is supported by the report of Liener and Kakade (1969), Babar *et al*. (1988) and Nakatsu *et al*. (1996) that while germination results in the improvement in nutritive value of some legumes, the effects appear unrelated to changes in trypsin-inhibitory activity and polyphenols in the germinated seed.

The optimum conditions of heat treatments to effectively destroy the antinutritional factors without damaging the nutritional quality of legume seed meals have not been well defined. However, many attempts have been made using both chemical (urease activity, trypsin inhibitor value, protein solubility index) and biological indicators (digestibility values, nutrient availability, growth, survival, feed utilization efficiency, gross or sub-clinical abnormal signs) as a means of determining the adequacy of heat treatment. Results suggest that the absence of urease activity in the cracked, cooked and two-stage cooked jackbean seeds in trona solution would be adequate to destroy the antinutritional factors that may be present in both meals (Table 4). According to Akiyama (1989) UA of 0 may already be considered adequate for aquaculture feed. Optimal values of protein solubility for aquaculture fall within the range (60-80%) given by Akiyama (1989). This indicated that the cracking and cooking in trona solution (5% wt./vol.) rendered the jackbean seeds to be

nutritionally acceptable and biologically available to *O. niloticus* fingerlings. However, jackbean seeds soaked in trona solution (3% wt./vol.) prior to cooking in water or trona solution (3% wt./vol.) for 30 minutes was not effective in detoxifying the jackbean seeds (Esonu *et al*. 2000).

Table 4. Effect of detoxification processes on antinutritional properties and digestibility coefficients for crude protein and gross energy contents of jackbean seeds.

	HU[1]	TIU[2]	UA[3]	PSI[4]	Digestibility coefficient (%)	
			(mg/L)	(%)	crude protein	gross energy
Raw whole seeds	13532.8a	1682.7a	20.25a	89.90a	61.8c	67.2c
Whole, cooked seeds						
in distilled water	177.5b	585.7b	0.53a	71.08c	71.8b	71.7b
in trona solution	68.4c	306.1c	0.28b	78.71b	77.5a	74.8a
Cracked, cooked seeds						
in distilled water	61.4c	306.1c	0.29b	73.59c	71.4b	72.9b
in trona solution	13.2e	NI	NA	77.70b	79.7a	78.5a
Sprouted, cooked seeds						
in distilled water	67.3c	354.8c	0.32b	71.63c	60.3c	61.1c
in trona solution	32.6d	108d	0.11c	79.50b	65.5c	67.3c
Two-stage cooked seeds						
in distilled water	70.2c	313.0c	0.28b	71.08c	70.9b	72.1b
in trona solution	13.9e	NI	NA	76.37b	78.2a	74.9a

Mean values in the same column with similar superscript letters are not significantly different (P > 0.05).
NI = no inhibitory activity; NA = no activity
[1] The minimum concentration of protein expressed in mg/ml present in the sample that was able to agglutinate 10^6 cells
[2] Trypsin inhibitor unit was the amount of material (μU/g seed) that was to inhibit 1 mg of trypsin
[3] Urease activity
[4] Protein solubility index

Water temperature ranged from 26.2 to 27.3^{o}C, pH values ranged from 6.9 to 7.10, dissolved oxygen ranged from 6.69 to 6.9 mg l^{-1}, all of which fell within the acceptable range for tilapia culture (Beveridge and McAndrew 2000). Fish mortality was low (< 5%) and no abnormal behaviour was noted when the detoxified jackbean seeds replaced soybean meal. All the *O. niloticus* fingerlings fed the control diet and test diets responded well to feeding. As such, the slight fish mortality recorded was not due to dietary inclusion of detoxified jackbean seeds but might have resulted from fish handling during daily routine management of the experimental system.

Growth performance and nutrient utilization of *O. niloticus* fingerlings fed jackbean seed meal are presented in Table 5. There was no significant difference (P > 0.05) in specific growth rate (SGR) and weight gain (WG) between the fish fed control diet CD and test diets DW20, TS20 and TS30. However, significant differences (P < 0.05) occurred between these diets and diet DW30. Feed utilization indices namely, feed conversion ratio (FCR), protein efficiency ratio (PER) and protein productive value (PPV) at varying replacement levels showed a similar trend as growth response indices (SGR, WG) rendered the jackbean seed to be nutritionally acceptable and biologically available to *O. niloticus* fingerlings. Martinez-Palacios *et al*. (1988) found that when jackbean seed meal was fed to *O. mossambicus* fry (mean weight, 0.37g), growth performance was poor and caused lethargic behaviour, poor

growth and some mortality of fish. They opined that residual effects of thermostable antinutritional factors may have limited the efficient utilization of the diet. Earlier studies aimed at improving the nutritive value of jackbean seeds using different processing methods have indicated partial detoxification not allowing dietary levels beyond 200 g kg^{-1} in tilapia diets (Martinez-Palacios *et al*. 1988, Akinbiyi 1992, Abdo de la Parra *et al*. 1998). Results of this study indicate that whatever was responsible for poor growth and feed utilization by tilapias fed diets containing processed jackbean seeds beyond 200 g kg^{-1} dietary level could be solubilized in trona solution (5% wt./vol.).

Table 5. Growth response and feed utilization of *O. niloticus* fed experimental diets.

	CD	DW20	DW30	TS20	TS30
Initial weight (g)	6.37a	6.31a	6.38a	6.34a	6.37a
Final weight (g)	36.89a	36.34a	30.89b	36.62a	34.91a
Weight gain[1] (%)	479.1a	475.9a	384.2b	477.6a	448.0a
Specific growth rate[2] (%/fish/day)	2.51a	2.50a	2.25b	2.51a	2.43a
Feed conversion ratio[3]	1.47a	1.48a	1.62b	1.48a	1.51a
Protein efficiency ratio[4]	2.44a	2.34b	2.19c	2.38ab	2.34b
Protein productive value[5]	28.37a	27.48a	25.89b	28.02a	27.65a
Survival (%)	97	98	96	96	97

Mean values in the same row with similar superscript letters are not significantly different ($P > 0.05$)
[1]Weight gain = [(final wt. – initial wt.)/initial wt.)] x 100
[2]Specific growth rate = [(ln final wt. – ln initial wt.)/no of days] x 100
[3]Feed conversion ratio = feed intake (g)/body weight gain (g)
[4]Protein efficiency ratio = body wt. gain (g)/protein intake (g)
[5]Protein productive value = [protein gain (g)/protein intake (g)] x 100

The result of carcass composition of *O. niloticus* fed with the experimental diets is presented in Table 6 and it revealed a general increase ($P < 0.05$) in carcass protein and lipid content of *O. niloticus* fingerlings after the feeding trial coupled with corresponding lower moisture content than the initial *O. niloticus* samples. There was no detectable trend in ash content of *O. niloticus* fingerlings in any of the diet treatments. The trend for carcass composition in this study agreed with similar results for cowpea, *Vigna catiang* and black gram, *Phaseolus mungo* seeds in *O. niloticus* diets (Keembiyehelty and De Silva 1993); for *Sesbania grandiflora* seed in *O. mossambicus* diets (Olvera-Novoa *et al*. 1988), and for jackbean seed meal (Martinez-Palacios *et al*. 1988) in *O. mossambicus* diets. Hepasotomatic index did not show any trend relating to diets.

Table 6. Carcass composition of *O. niloticus* fed the experimental diets for 70 days.

Carcass composition (g kg^{-1} dry wt)	Initial fish sample	CD	DW20	DW30	TS20	TS30
Moisture	78.4a	69.1b	69.6b	70.9b	70.2b	70.4b
Crude protein	13.7b	17.2a	17.1a	16.7a	17.1a	17.0a
Crude lipid	4.1b	5.7b	5.4b	5.0b	5.3b	5.4b
Total ash	2.8	3.0	2.9	2.5	2.9	2.5
Hepatosomatic index (%)	1.29	1.21	1.24	1.24	1.23	1.25

Mean values in the same row with similar superscript letters are not significantly different ($P > 0.05$)
[1]Hepatosomatic index = (liver wt./body wt.) x 100.

Martinez-Palacios *et al*. (1988), Mora and Parra (1982), Vierma and Montilla (1982) and Ellis and Bermar (1985) noted that it will be necessary to develop improved methods for detoxifying jackbean seeds so that the potential for its use in animal diets is fully realized. Thermolabile antinutritional factors in *Canavalia* seeds (protease inhibitors, lectins, phytic acid) are easily inactivated by wet thermal processing (Ogunsanwo *et al*. 1994) while the use of trona for reducing tannins and cooking time of grain legumes is well documented (Ankra and Dolvo 1978, Aw and Swanson 1985), as well as the removal of phytic acid by cooking (Lolas and Markakis 1977). The results confirmed that cracking and cooking method apparently eliminated the toxic thermostable antinutritional factors present in the jackbean seeds (canavanine, concanavalin, canilin, canatoxin). This finding was similarly reported by Udedibie and Carlini (1998b). The growth performance, nutrient utilization and bioavailability by *O. niloticus* showed that 20% of total dietary protein can be provided when cracked jackbean seeds are cooked in distilled water and even at higher level of inclusion (30%) when jackbean seeds are cooked in trona solution. The low cost, availability, comparable nutrient composition, great agronomic potential, suitable methods to completely eliminate the metabolic inhibitors and toxic components, coupled with the absence of abnormal fish behaviour, satisfactory fish growth performance, optimal feed utilization by fish, low mortality in fish, thus present jackbean seed meal as protein source in practical diets for Nile tilapia fingerlings.

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