ISSN: 2347-5129
(ICV-Poland) Impact Value: 5.62
(GIF) Impact Factor: 0.352
IJFAS 2016; 4(3): 458-463

www.fisheriesjournal.com
Received: 24-03-2016
Accepted: 25-04-2016

GG Bake
Department of Water Resources, Aquaculture and Fisheries Technology, School of Agric and Agric Technology, Federal University of Technology P.M.B 65 Minna Niger, Nigeria.

OA Atoyebi
Department of Water Resources, Aquaculture and Fisheries Technology, School of Agric and Agric Technology, Federal University of Technology P.M.B 65 Minna Niger, Nigeria.

IA Abdulkarim
Department of sciences, Ahmadu Bello Academy, Ministry of Science and Technology, Sokoto, Nigeria

A Adam
Department of Aquaculture and Fisheries University of Ilorin. Kwara state Nigeria.

SOE Sadiku
Department of Water Resources, Aquaculture and Fisheries Technology, School of Agric and Agric Technology, Federal University of Technology P.M.B 65 Minna Niger state - Nigeria

Correspondence
GG Bake
Department of Water Resources, Aquaculture and Fisheries Technology, School of Agric and Agric Technology, Federal University of Technology P.M.B 65 Minna Niger, Nigeria.

Evaluation of varying inclusion levels of Toasted Sickle pod (*Senna obtusifolia*) seed meal in the Practical Diet of Catfish (*Clarias gariepinus*) fingerlings in a concrete tanks

GG Bake, OA Atoyebi, IA Abdulkarim, A Adam and SOE Sadiku

Abstract
A feeding trial was conducted for 56 days to evaluate the suitability of toasted Sickle pod (*Senna obtusifolia*) seed meal (TSOM) inclusion in the practical diet of Catfish (*Clarias gariepinus*) fingerlings through their growth performance, nutrient utilization, and body composition. *C. gariepinus* fingerlings (mean initial weight 1.46±0.02 g) were fed with formulated five experimental diets containing different levels of TSOM and were designated as D1 (0% inclusion of TSOM) D2 (10% inclusion of TSOM) D3 (20% inclusion of TSOM) D4 (30% inclusion of TSOM) and D5 (10% inclusion of Raw *Senna obtusifolia* seed meal (RSOM)). Fifteen net hapa (0.5x0.5x1m) were suspended in two outdoor concrete tanks (8mx5mx1.5m) with the aid of kuralon twine tied to plastic poles. The concrete tanks were filled to 5/6 of its volume ($40m^3$) with filtered and dechlorinated tap water, 20 fish were accommodated in each hapa. Each treatment was randomly allocated to three hapa. The results of the growth performance showed that fish fed with D3 had the highest final weight (FW), weight gain (WG), specific growth rate (SGR) and feed intake (FI), and was significantly different from other fishes fed with other experimental diets; while D5 was significantly lower than the other experimental diets ($P<0.05$), although, there was no significant ($P>0.05$) difference between fish fed with D1, and D2, however they were significantly higher than D4. Except for D3 with a higher significant value of feed efficiency (FE) and protein efficiency ratio (PER), fish fed with D1, D2 and D4 were not significantly different from each other but were significantly higher than fish fed D5. Whole body proximate composition of fish fed all diets showed that inclusion of TSOM influenced moisture and lipid contents. This study showed that toasted *Senna obtusifolia* seed meal would be a potential suitable ingredient for *Clarias gariepinus* fingerlings and that it may be included in a diet up to 20 % without any adverse effect.

Keywords: *Clarias gariepinus,* Growth performance, *Senna obtusifolia,* feed processing

Introduction
With the growing population and high demand for animal protein, the need to increase fish production in Nigeria has become most desirable. The high quality and concentration of essential nutrients, especially of well-balanced amino acids, essential fatty acids and energy content makes fishmeal an indispensable ingredient in the diets of the most aquaculture species (Miles and chapman, 2006) [25]. As consequence, a concomitant increase in the demand for fishmeal, fish oil and some other feed ingredients commonly used in fish is expected (Hashim, 2006; Tacon and Metian 2008) [20, 36]. This increase is expected to be at the expense of other animal feed, indicating that technically, the impact of aquaculture expansion on the availability of fishmeal may be marginal and is expected to soar to 70% by 2015 (New and Wijkstrom, 2002) [27]. Consequently, the sustainability of feed-based production systems may be threatened by shortages and price rises of fishmeal and thus steps must be taken to reduce their inclusion levels in aqua feed (Fagbenro and Adebayo, 2005) [13]. Optimal use of fishmeal in practical aquaculture diets is necessary to minimize feeding costs which could account for over 60% or more of operating expenses. Over the years, researchers have embarked on studies to search for the possible replacements to fishmeal (Khan *at al.,* 2003; Sotolu, 2010) [22, 34]. Among the many alternatives that has been examined, plant meal appears to have the great potential (Abdelghany, 2004; Ingweye *et al.,* 2010) [1, 21]. Hence, optimum replacement level of fish meal by plant protein-rich ingredients need to be established in order to formulate nutritionally balanced diet for catfish, based on their nutrient requirement while keeping the cost at the least and environmental friendly. (Olorunfemi *et al.,* 2001) [31].

The present over dependent on some of the convention plant protein sources e.g. soybean meal and rape seed meal in aquaculture has led to its high cost for poor farmers especially in the tropics as a result of other sector of the economy competing for its utilization (Fasakin *et al.*, 1999) [17] and although, plant proteins (PP) may be cost effective their use are usually limited by deficiencies in essential amino acids and minerals, and the presence of anti-nutritional factors (ANFs) and complex carbohydrates (National Research Council (NRC), 1993; Glencross *et al*. 2007 and Gatlin *et al*. 2007) [26, 19, 18]. In view of this, research work has shifted towards unconventional ingredients e.g. leguminous seed meals, leaves etc. and the use of some food processing techniques to reduce the effect of anti-nutritive factors. Toasting is a simple and cheap method to reduce the anti-nutritional factors and crude fibre contained in the plant by-products, Fapohunda (2012) [16].

Senna obtusifolia is an unconventional plant protein ingredient that may have some potential for aquaculture use especially its seeds. *Senna obtusifolia* leaves are usually used to fatten goat, ram and cattle. When properly processed *Senna obtusifolia*, leguminous seed, has considerable potential as an ingredient in feeds for animal, including fish. It contains 19-29% protein; 2-8% lipid, 45-51% nitrogen free extract (NFE) and 19-32kjg^{-1} gross energy (Ingweye *et. al*, 2010 Dasuki *et. al*, 2014) [21, 10].

Catfish which belongs to the family claridae is one of the most cultured freshwater fish in Nigeria. They are characterized by the ability to grow on a wide range of artificial and natural food, and they grow fast and have high yield potential, hardness and tolerance to dissolve oxygen in other aquacultural routine (Oresegun *et al*, 2007) [32]. The African catfish (*Clarias gariepinus*) are of great importance as esteemed food fishes especially to the rural populace in West Africa especially Nigeria. Hence, emphasis has been on how to increase and improve its productivity.

However, the extent to which these leguminous seeds could be put to use as potential sources of protein and energy in fish feed are limited due to either, the presence of anti-nutritional factors (ANFs), deficiencies in some sulphur containing amino acids and the presence of high level of non-starch polysaccharides (NSPs) (Francis *et. al*, 2001; Fagbenro *et. al*, 2004 Bake *et. al*, 2013; 2014) [7, 8, 14, 15].

Although data about the potential and nutrient composition of *Senna obtusifolia* are available, the data regarding the inclusion levels of toasted *Senna obtusifolia* seed meal in the diet of *Clarias gariepinus* fingerlings is still limited. Hence, it is in this view that this research was conducted to evaluate the growth performance, nutrient utilization proximate composition and haematological assessment of *Clarias gariepinus* fingerlings fed TSOM-based diet.

Materials and Methods

Ingredients and diet formulation

Soybean Meal (SMB)

Raw soybean was purchased from the Bosso market Minna (Niger state). The soybean was processed by toasting the soybean in a frying pan at 80 °C for 60 minutes until the colour changed to golden brown and allowed to cool before milling with the aid of a grinding machine. Crude protein and lipid contents of SMB were 43.63% and 7.00%, respectively as shown in Table1.

Fish Meal

The fishmeal used in this experiment was obtained from the Sauki Fisheries store, 15km along Maikunkele - Zungeru road Minna Niger state Nigeria. The crude protein and lipid content of fishmeal were 65.34 % and 11.36% respectively as shown in Table1.

Senna obtusifolia seed Meal

Senna obtusifolia seed pods were collected manually during the dry season from Rafinyashi, area of Bosso local government, Minna Niger state. It was manually crushed to get the seed. The seeds were soaked in boiled water for 1 hour and later sun dried for a day at ambient temperature before toasting. The seeds were toasted in a frying pan at 80°C for 1 hour until the seeds began to change colour. It was then allowed to cool before grinding into powder using hammer mill. Crude protein and lipid contents of TSOM were 27.68% and 4.28%, while RSOM were 22.15% and 3.19% respectively as shown in Table1.

All the ingredients were separately milled and mixed with warm water to form consistent dough, which was then pelleted, sun-dried, packed in polyethylene bags and stored. The feed composition is shown in Table 2

Experimental Diets

Based on the nutritional requirements of *Clarias gariepinus* fingerlings (NRC 1993), five isonitrogenous and isolipid diets were formulated at 40 % protein and 9.5 % lipids, containing 10-30% toasted *Senna obtusifolia* seed meal at different levels of inclusion and 10% inclusion of raw *Senna obtusifolia* seed meal Table 3.

Experimental System and Fish

The experimental fish, pure- bred *C. gariepinus* fingerlings, with an initial mean weight of (1.45 - 1.47g) were purchased from Tagwai fish hatchery of Ministry of livestock and fisheries development Minna, Niger state. The fish were transferred in a well-oxygenated water plastic container from the hatchery to the Department of Water Resources, Aquaculture and Fisheries Technology experimental fish farm, Federal University of Technology, Minna Bosso campus, where the feeding trial was conducted. Upon arrival they were acclimatized in a transitional tank in the farm for four days and were fed commercial feed (coppense feed) at 40% crude protein once a day before the experiment commenced. Based on our previous studies on *Senna obtusifolia* (Bake *et al.*,2015) [9], the fish were subsequently fed with 40% iso-nitrogenous diet and 9.5% lipid, containing different inclusion level of toasted *Senna obtusifolia* meal, designated as D1 (0% inclusion), D2 (10% inclusion), D3 (20% inclusion), D4 (30% inclusion) and D5 (10% raw *Senna obtusifolia* seed meal) for 56 days. Fifteen net hapa (0.5x0.5x1m) were suspended in two outdoor concrete tanks (8mx5mx1.5m) with the aid of kuralon twine tied to plastic poles. The concrete tanks were filled to 5/6 of its volume (40m^3) with filtered and dechlorinated tap water, 20 fish were accommodated in each hapa. Each treatment was randomly allocated to three hapa, Photoperiod depends on the natural light, and water temperature was monitored daily. The water quality parameters in the system were monitored weekly, the temperature ranged between 25.5 ºC-30.3 ºC while the concentration of dissolved oxygen ranged between 5.94-7.82 mg/L and the pH values of the treatments ranged from 7.18-7.60. No critical values were detected for nitrite and nitrate. Two replicates of each treatment using 20 fish per hapa were reared on each of the four diets. The feed was manually administered and the fish were fed three times daily at 5% of body weight at 09:00 am, 12:00pm and 16:00pm. Feeding rate was subsequently adjusted according to their growth rates per hapa. The uneaten and faecal matters were siphoned out of the hapa every morning before feeding, and 45 minutes after the fish have been fed. The fish were denied feed 24 h prior to sampling. Five fish were randomly sampled on weekly basis, and weights were measured using a digital electronic weighing balance (*CITIZEN MP-300*) model.

Biochemical Analysis

About 10g initial sample and 15g of final samples from each hapa were pooled separately and then homogenized using laboratory mortar and pestle. The major ingredient used for the diet; the formulated diet and the fish body samples were subjected to chemical analysis. The proximate composition analysis was determined according to AOAC procedures (2000) [5]. Moisture content was determined by drying samples at 105±2 °C until a constant weight was obtained. Dried samples were used for determination of crude fat, protein and Ash contents. Crude fat was measured by solvent extraction method in a soxhlet system where n-hexane was used as solvent. Crude protein content was calculated by using nitrogen content obtained by Kjeldahl method. A conversion factor of 6.25 was used for calculation of protein content according to AOAC (2000) [5]. Anti-nutritional factors of the seeds; tannins and trypsin inhibitor activity (TIA) were analyzed by modifying the procedures of AOAC (1984) [4]. Phytic acid was determined by the method of Latta and Eskin (1980) [23].

Evaluation of Growth Parameters

Growth performance and diet nutrient were analysed in terms of Weight Gain (WG), Feed Efficiency (FE), Specific Growth Rate (SGR), Feed Intake (FI), Protein Efficiency Ratio (PER) and Protein Retention (PR). The following formulas were used:

Weight gain (%) = (final weight (g) – initial weight (g) × 100/ initial weight (g)

Feed efficiency (%) = (weight gained (g) / feed fed (g)) × 100

Specific growth rate (%) = (In final weight (g) – In initial weight (g) / feeding period (day) × 100

Feed intake (mg/fish/day) = dry feed (mg) given / number of fish / feeding period (day)

Protein efficiency ratio = wet body gain × 100/ protein intake (g)

Protein retention (%) = protein gain ×100/ protein fed.

Statistical analyses

Data were analysed using one-way analysis of variance (ANOVA) using Statistica 8.0 (Stat-Soft, Inc., Oklahoma, USA). Differences between treatments were compared by Tukey's test. Level of significance was tested at $P<0.05$.

Results

Over the 56 days feeding period, no significant differences were observed in the water-quality indices between the experimental treatments. The water temperature ranges from 25.5-30.3 °C, Dissolved oxygen from 6.4-7.6 mg/ *l*, pH from 6.4 -7.8 and ammonia from 0.22-0.28 mg/ *l*.

Table 1 showed the proximate composition of the major feed ingredients used in formulating the experimental diets. Fishmeal has the highest crude protein and lipid content (65.34% and 11.36%), followed by soybean meal (43.63% and 7.00%) while, the crude protein and lipid content of toasted *Senna obtusifolia* seed meal was 27.68% and 6.45% respectively. Table 2 showed the anti-nutritional factor composition of both the untreated raw *S. obtusifolia* (RSOM) and the treated toasted *S. obtusifolia* (TSOM). There was a significant reduction in all the anti-nutritive parameters measured in the treated TSOM ingredient as compared to RSOM. The proximate composition of the experimental diets is shown in Table 3, the crude protein of all the diets were similar and ranged between 38.14% and 38.88 %. Similarly, the lipid, ash and moisture content of the diets were not significantly different from each other and ranged between 9.15 and 9.94 %, 9.15 and 9.89 %, and 4.32 and 4.78% respectively.

The growth performances and nutrient utilization of *Clarias gariepinus* fingerlings in terms of FW, WG, SGR, FE, FI, PR and PER obtained in this experiment are summarized in Table 4 and Fig 1. Among all the experimental diets, *Clarias gariepinus* fingerlings fed D3 had the highest FW, WG, SGR and FI, and was significantly different from other fishes fed other experimental diets; while D5 was significantly lower than the other experimental diets ($P<0.05$). Table 4 also showed that, there was no significant ($P>0.05$) difference between fishes fed D1, and D2, however they were significantly higher than D4. Except for D3 with a higher significant value of FE and PER, fish fed D1, D2 and D4 were not significantly different from each other but were significantly higher than fish fed D5 ($P<0.05$). Furthermore, Fish mortality were found to be random and different inclusion levels did not have any effect on survival of the fish fed the experimental diets except for D5 hence, there was no significant difference in the survival rate among the fish fed TSOM experimental diets ($P>0.05$).

Table 5 revealed the whole body composition of fish before and after the feeding trial, except for moisture other proximate composition parameters measured were higher in the fish fed the experimental diets than the initials. There was significant difference ($P<0.05$) in the crude protein, lipid and moisture among all the fish fed the experimental diets. The carcass protein of fish fed D3 was the highest and was significantly different from fish fed other experimental diets ($P<0.05$), while fish fed D4 had the lowest value although not significantly different from fish fed D5 ($P>0.05$), furthermore there was no significant difference between fish fed D1 and D2 ($P>0.05$), but they were higher than fish fed D4 and D5 ($P<0.05$). Fish fed D4 had the highest carcass lipid and was followed by those fed D3, and although fish fed D1 had the lowest value there was no significant difference between them and those fed D2 and D5 ($P>0.05$). Fish fed D1 had the highest significant moisture content ($P<0.05$), while fish fed D4 had the lowest significant lipid content ($P<0.05$). Fish fed D2 and D5 were not significantly different from each other ($P>0.05$), however they were lower than fish fed D3 ($P<0.05$). There was no significant difference in the ash content among all the fish fed the experimental diets ($P>0.05$).

Discussion

This study envisages the possibility of toasting *Senna obtusifolia* meal inclusion in the diet of *C. gariepinus* fingerlings. During the period of experiment, the water temperature ranged between 26±0.5 ºC - 28±0.4 ºC and the dissolved oxygen 5.8-8.2mg/L. These physico-chemical parameters of the water used for this experiment were within the acceptable and optimum range for the normal physiological functioning of *Clarias gariepinus* fingerlings and catfish culture (Wedemoyer, 1977; Piper, *et al.* 1982 Lazo and Davies, 2000) [38, 33, 24].

The proximate composition of toasted *Senna obtusifolia* meal in the present study revealed that the crude protein content was 31.56% (Table 1). This value was higher than the value reported earlier by Dasuki *et al*, (2014) [10] however it was lower than the fermented meal reported by Bake *et al.* 2015 [9]. The differences might be attributed to differences in environmental conditions such as soil types, harvesting period and the processing condition. From Table 2 it was evident that the toasting processing method used to process SOM was very effective Fagbenro (1999) [11], Francis *et al.* (2001) [15], Sotolu *et al.* (2009) [35] and Akande and Fabiyi (2010) [2] have reported that heat treatment substantially reduces and inactivates levels of secondary compounds in the seeds meals, the results of this research tend to agree with their assertion as most of the secondary compounds were drastically reduced by the application of heat in the TSOM. Table 3 shows the formulation and proximate composition of the experimental diets, the results of the proximate composition of the experimental diets showed that the diets were iso-nitrogenous and iso-lipidic and all the diets met the nutrient requirements of *clarias gariepinus* fingerlings as reported by NRC (1997) [26]. Some authors have reported either depressed growth or reduction in feed intake in the fish as a result of antinutritional factors present in the plant protein hence similar growth may not be obtained Fagbenro and Davies 2003 [12] and Bake *et al.* 2015 [9]. All the fish in this study showed normal growth and the inclusion of toasted *Senna obtusifolia* did not have any adverse effect on their morphology and did not compromise their growth, survival, feed intake, and nutrient utilization except fish fed unprocessed raw *Senna obtusifolia* seed meal (D5) which showed lower growth and survival. All the fish fed with the experimental diet have an increase in their final weight compared to their initial weight, although their growth performances differs. A reduction in all the growth and nutrient utilization parameters measured was observed in the fish fed raw *Senna obtusifolia* diet (D5), this may be attributed to the presence of some antinutritional factors. This was consistence with our previous work on fermented *S.obtusifolia* (Bake *et al* 2015) [9]. Akande *et al* 2010 [3] have reported that most antinutrients or antinutritional factors inactivate some major nutrients, by the diminution of the digestive process or metabolic utilization of feed which exerts effect contrary to optimum nutrition. The result of this study agrees with the above statement, this is because all the five experimental diets evaluated, the growth performance showed progressive increase; implying that the growth performance of the fish fed the experimental diets was influenced by both the processing method used and the level of inclusion of toasted *Senna obtusifolia* meal. Growth parameters serve as indicators of fish's ability to utilize and retain nutrients in a given diet. This was evident in their WG, SGR, FE, FI and nutrient utilization. Survival rate of the fish fed experimental diet for 56 days in this study was between 95.2-96.36%. The high survival rate could be attributed to good handling, good water quality management and proper processing as well as the suitability of toasted *Senna obtusifolia* meal and non-toxicity of TSOM in the current study. Toasting method employed in processing the *Senna obtusifolia* seed in this study proved very effective according to the result obtained as shown in Table 4. This may be due to improved digestibility of Protein, polysaccharides and metabolizable energy in addition to inactivation of anti-nutritive factors, Fagbenro and Davis, (2003) [12]. The inactivation of anti- nutritive factors would certainly have increase protein digestion and palatability. Ogunji (2004) [28] and Bake *et al.*, (2009; 2013; 2015) [6, 7, 9] have suggested that the texture and palatability or taste of an experimental diet is related to the incorporated levels of plant material, hence can affect the acceptability of the feed and may consequently hinder growth. Decreased palatability or attractiveness of test diets with higher TSOM protein inclusion level was observed above 20% inclusion level in this study, in agreement to other reports about plant protein utilization in fish nutrition (Gatlin *et al.*, 2007; Thiessen, *et al.*, 2003; Ogunji & Wirth 2001) [18, 37, 29].

The fishes fed the experimental diets effectively utilized the diets as evident in their final body composition (Table 5). The body composition of all the fishes fed the experimental diet were higher than the initial body composition in all the parameters measured except for the moisture. The moisture of the fishes fed the experimental diets decrease with an increase in the inclusion level of toasted *Senna obtusifolia* meal while the lipid increased with an increase in the inclusion level of toasted *Senna obtusifolia* meal. The inverse relationship between fillet lipid and moisture content is well established and so a decrease in fillet moisture is expected among fish depositing lipid in their fillet tissue. Moisture content of fingerlings were not only relatively high but statistically significant in all treatments. This observation agrees with that report of Olorunfemi *et al.*, (2001) [31] Olele *et al.*, (2003) [30] they stated that such moisture content enables fish become more susceptible to deterioration if kept unpreserved for long after harvest. The fish fed D3 gave the highest carcass crude protein while D5 have the lowest, although there is no significant difference ($P< 0.05$) between D1 and D2. Likewise, the ash content was not significantly different ($P> 0.05$) in all the diets.

Table 1: Proximate composition of the major ingredients used in the formulation of the experimental diet for *C. gariepinus* fingerlings.

Ingredients	Fishmeal	Soybean meal	Maize meal	Millet meal	RSOM	TSOM
Proximate composition						
Moisture (%)	5.79	3.09	4.66	3.22	3.19	4.28
Crude protien (% d.b.*1)	65.34	43.63	9.32	12.9	22.15	27.68
Crude lipid (% d.b.*1)	11.36	7.00	4.20	4.36	3.98	5.89
Ash (% d.b.*1)	14.34	8.15	3.22	2.33	12.35	9.34
Crude fibre (% d.b.*1)	0.06	5.00	3.40	2.60	9.82	7.28

***1 d.b** = dry basis

Table 2: Effect of fermentation treatment on anti-nutritional factors in *Senna obtusifolia* seed meal.

Anti-nutritive factors	RSOM	TSOM	(%) decrease of anti-nutritive factors after Toasting
Phytate (mg/100g)	260.07	121.24	53.38
Hydrocyanic acid (mg/kg DM)	9.45	4.03	57.35
Saponin (mg/100g)	175.92	80.34	54.33
Tannin (g/100g)	358.54	154.22	56.99
Oxalate	74.46	11.25	84.89
Alkaloid	240.74	137.42	42.92
Phytohaemagglutinin (Hu/g)	1240.65	510.25	58.87

Table 3: Formulation of the experimental diet and proximate composition of the experimental diet for *C. gariepinus* fingerlings (g/kg).

Ingredients	D1	D2	D3	D4	D5
FM	529.30	486.90	444.60	402.20	495.40
SBM	100.00	100.00	100.00	100.00	100.00
TSOM	0.00	100.00	200.00	300.00	0.00
RSOM	0.00	0.00	0.00	0.00	100.00
MM	50.00	50.00	50.00	50.00	50.00
Millet	50.00	50.00	50.00	50.00	50.00
starch	50.00	50.00	50.00	50.00	50.00
Vitamin premix	12.50	12.50	12.50	12.50	12.50
SBO	24.30	22.60	20.90	19.30	24.20
Cellulose	171.40	115.50	59.50	3.50	105.40
Mineral	12.50	12.50	12.50	12.50	12.50
Total	1000.00	1000.00	1000.00	1000.00	1000.00
Moisture (%)	4.78	4.32	4.66	4.54	4.38
Crude protien (% d.b.*1)	38.14	38.88	38.55	38.33	38.32
Crude lipid (% d.b.*1)	9.15	9.65	9.79	9.94	9.57
Ash (% d.b.*1)	9.15	9.21	9.46	9.89	9.35
Crude fibre (% d.b.*1)	6.14	6.25	6.66	6.93	6.36

*1 **d.b** = dry basis
F.M = Fish meal: **SBM** = Soybean meal: **TSOM** = Toasted *Senna obtusifolia* seed meal
RSOM = Raw *Senna obtusifolia* seed meal: **MM** = Yellow Maize: **SBO** = Soybean oil

Table 4: Growth performances and nutrient utilization of *C. gariepinus* fingerlings fed experimental diets for 56 days.

Diet code	Body weight (g)		Weight gain (%)	Survival rate (%)	Specific growth rate (%)	Total feed intake (g)	Feed efficiency	Protein efficiency ratio	Protein retention (%)
	Initial	Final							
D1	1.46±0.04	11.60±0.31[b]	690.02±17.67[b]	98.50±2.14[a]	3.70±0.51[b]	13.58±0.52[b]	0.74±0.41[b]	1.96±0.57[b]	35.65±0.27[b]
D2	1.46±0.07	11.62±0.52[b]	695.89±15.48[b]	98.52±2.12[a]	3.70±0.24[b]	13.52±0.46[b]	0.75±0.62[b]	1.93±0.45[b]	35.44±0.76[bc]
D3	1.45±0.06	13.57±0.22[a]	836.09±26.51[a]	98.66±2.21[a]	3.99±0.36[a]	14.85±0.36[a]	0.82±0.28[a]	2.12±0.24[a]	39.12±0.42[a]
D4	1.47±0.02	9.92±0.64[c]	574.82±32.55[c]	98.42±2.15[a]	3.40±0.48[c]	11.40±0.64[c]	0.74±0.39[b]	1.93±0.26[b]	35.05±0.26[c]
D5	1.47±0.04	8.78±0.64[d]	497.27±24.33[d]	85.22±2.37[b]	3.19±0.48[d]	10.39±0.64[d]	0.70±0.39[c]	1.83±0.26[c]	33.45±0.26[d]

Values in the same column with different superscript letters are significantly different ($p<0.05$) from each other

Table 5: Proximate composition analyses of whole body C. *gariepinus* (dry basis) fed experimental diets for 56 days

Component (%)	Initial	Final*1				
		D1	D2	D3	D4	D5
Moisture	77.42	75.55±1.2[a]	74.68±0.8[b]	73.12±1.4[c]	72.67±1.5[d]	74.65±0.4[b]
Protein	13.64	17.63±1.5[b]	17.76±1.3[b]	17.92±1.1[a]	17.46±1.2[c]	17.41±1.5[c]
Lipid	4.11	4.35±0.5[c]	4.55±0.4[c]	5.75±0.6[b]	6.32±0.4[a]	4.65±0.4[c]
Ash	8.00	8.87±0.2[a]	8.57±0.3[a]	8.65±0.1[a]	8.75±0.3[a]	8.57±0.3[a]

*1 Values in the same row with different superscript letters are significantly different (p<0.05) from each other (n=3).

Conclusion

From the result obtained in this study, it is concluded that toasting processing technique is very effective in processing *Senna obtusifolia* and it can relatively reduce anti nutritional factors in the seed. When processed, catfish fingerlings (*Clarias gariepinus)* can make use of toasted *Senna obtusifolia* seed meal at an inclusion level up to 20 % in their diets to give an excellent performance in growth, nutrient utilization and body composition without any adverse effect on their body. However, an increase above this percentage would lead to depression in their growth response.

This study recommends that further work should be carry out on the amino acid profile of the seed to evaluate any deficiency in the amino acid profile of the seed. Other processing methods should be employed to allow increase in the inclusion level of *Senna obsitufolia* meal in aqua feed production.

References

1. Abdelghany AE. Replacement of herring fishmeal by soybean flour in practical diets for red tilapia, Oreochromis niloticus × O. mossambicus, grown in concrete tanks. J Appl Aquac. 2004; 14:69-87.
2. Akande KE, Fabiyi EF. Effect of Processing Methods on Some Anti-nutritional Factors in Legume Seeds for Poultry Feeding. Int. J of Poul Sci. 2010; 9(10):996-1001.
3. Akande KE, Doma UD, Agu HO, Adamu HM. Major Antinutrients Found in Plant Protein Sources: Their Effect on Nutrition. Pak. J of Nutr. 2010; 9(8):827-832.
4. AOAC. Official methods of analysis. Association of Official Analytical Chemist. 14th Edn. Washington, DC, 1984.
5. AOAC. Official methods of analysis. Association of Official Analytical Chemist. 17th Edn. Washington, DC, 2000.
6. Bake GG, Endo M, Akimoto A, Takeuchi T. Evaluation of recycled food waste as a partial replacement of fishmeal in the diets for first feeding Nile tilapia Oreochromis niloticus. Fish Sci 2009; 75:1275-1283.
7. Bake GG, Adejumo TM, Sadiku SOE. Growth performance and Nutrient utilization of Nile Tilapia (*Oreochromis niloticus*) Fed toasted Flamboyant seed meal (*Delonix regia*) Cont J of Agric Sci. 2013; 7(1):1-10.
8. Bake GG, Martins EI, Sadiku SOE. Nutritional Evaluation

of Varying levels of Cooked Flamboyant seed meal (*Delonix regia*) on the Growth Performance and Body Composition of Nile Tilapia (Oreochromis niloticus) fingerlings Agric., Forst and Fish 2014; 3(4):233-239.
9. Bake GG, Yusuf AA, Endo M, Haga Y, Satoh S, Sadiku SOE *et al.* Preliminary investigation on the inclusion of fermented Sickle pod *Senna obtusifolia* seed meal as an ingredient in the diet of *Clarias gariepinus* fingerlings. Int. J Curr Res Biosci Plant Biol. 2015; 2(8):70-80.
10. Dasuki A, Dauda AB, Oshoke JO. Preliminary Investigation of Nutritional Quality of *Senna Obtusifolia* for Potential Use in Fish Feed American-Eurasian J of Sust Agric. 2014; 8(5):94-98.
11. Fagbenro OA. Comparative evaluation of heat-processed Winged bean (*Psophocarpus tetragonolobus*) meals as partial replacement for fish meal in diets for the African catfish (Clarias gariepinus). Aquac 1999; 170:297-305.
12. Fagbenro OA, Davies SJ. Use of high percentages of soybean protein concentrates as fishmeal substitute in practical diets for African catfish, Clarias gariepinus (Burchell 1822): growth, feed utilization and digestibility. J of Appl. Aquac. 2003; 16(1):16-21.
13. Faghenro OA, Adeboyo OT. A review of the Animal and Aquafeed. Industries in Nigeria. FAO, Rome, 2005.
14. Fagbenro OA, Adeparusi EO, Jimoh WA. Nutrient quality of detoxified Jack bean (*Canavalia ensiformis* L. DC) seeds cooked in distilled water or trona solution and evaluation of the meal as a substitute for soybean in practical diets for Nile Tilapia, *Oreochromis niloticus*, fingerlings. In: New Dimensions on Farmed Tilapia, Proceedings of the 6th International Symposium on Tilapia in Aquaculture Philippine International Convention Center Roxas Boulevard, Manila, Philippine, 2004, 289-300.
15. Francis G, Makkar HPS, Becker K. Antinutritional factors present in plant derived alternate fish feed ingredients and their effects in fish Aquac 2001; 199:197-227.
16. Fapohunda OO. Evaluation of Processed Soybean Meal in the Feeding of Clarias gariepinus Fingerlings J Anim Sci Adv. 2012; 2(2):244-249.
17. Fasakin EA, Balogun AM, Fasuru BE. Use of duckweed Spirodela polyrrhiza L. Schleiden, as a protein feedstuff in practical diets for Tilapia, Oreochromis niloticus L Aquacult Res 1999; 30:313-318.
18. Gatlin DM, Barrows FT, Brown P. Expanding the utilization of sustainable plant products in aqua feeds: A review. Aquac Res 2007; 38:551-579.
19. Glencross BD, Booth M, Allan GL. A feed is only as good as its ingredients: A review of ingredient evaluation strategies for aquaculture feeds. Aquac Nutr 2007; 13:17-34.
20. Hashim R. Alternature ingredients for aqua-feed. The feasibility and economic aquation. Proceeding of the paper presened as Guest speaker at the National Fisheries Symposium, June 26-28th, Kuching, Sarawak, Malaysia, 2006, 1-12.
21. Ingweye JN, Kalio GA, Ubua JA, Umoren EP. Nutritional evaluation of wild sickle pod (Senna obtusifolia) seeds from Obanliku, South-Eastern Nigeria. Amer J of food Tech. 2010; 5(1):1-12.
22. Khan MN, Parveen M, Rab A, Afza M, Sahan L, Ali MR *et al*. Effect of replacement of fishmeal by soyabean and sunflower meal in the diet of Cyprinus capio fingerlings. Pak J Biol Sci. 2003; 6:601-604.
23. Latta M, Eskin M. Simple colorimetric method of phytate determination. J Agric and Food Chem. 1980; 28:1313-1315.
24. Lazo JP, Davies DA. Ingredients and feed evaluation in Encyclopedia of Aquaculture edited by R.R. Stickney. A Wiley Inter science Publication, John Wiley and Sons incorporation, USA, 2000, 1063.
25. Miles RD, Chapman FA. The benefits of fishmeal in aquaculture diets. University of Florida, IFAS Extension. Fish site, http.//www.thefishsite.com/articles/200/the-benefits-of-fishmeal-in- aquaculture-diet, 2006.
26. National Research Council. Nutrient requirements of fish (nutrient requirement of domestic animal) National council, National academy press Washington DC, 1993, 114.
27. New MB, Wijkstrom UN. Use of fishmeal and fish oil in aquafeeds: further thought on the fishmeal trap. FAO Fisheries circular No 975, Rome, 61.
28. Ogunji JO. Alternative protein sources in diets for farmed tilapia. Animalscience.com Reviews 2004 No 13; Nutrition Abstracts and Reviews 2004; 74(8):23-32.
29. Ogunji JO, Wirth M. Alternative protein sources as substitutes for fishmeal in the diet of young Tilapia Oreochromis niloticus (Linn.). Is. J of Aquac Bam. 2001; 53(1):34-43.
30. Olele NF. Comparative study on the use of natural and artificial based feeds for the culture of Clarias gariepinus fingerlings. Agric Biol Sci 2011; 6:9-13.
31. Olorunfemi TOS, Falaki FM, Aderibigbe SO, Adebayo O.T, Fasakin E.A. An overview of linear application to least-cost ration formulation in aquaculture. J Tech sci. 2001; 5:84-92.
32. Oresegun A, Oguntade OR, Ayinla OA. A review of catfish culture in Nigeria. Nig. J Fish. 2007; 4(1):27-52.
33. Piper RG, Mcelwain IB, Orme LE, Mccraren JP, Flower LG, Leonard JR. Fish Hatchery Management. U.S. Fish and Wildlife Service Washington D.C, 1982.
34. Sotolu AO. Growth performance of Clarias gariepinus (Burchell, 1822) fed varying inclusions of Leucaena luecocephala seed meal. Tropicultura 2010; 28(3):168-172.
35. Sotolu AO, Faturoti EO. Growth performance and haematology of Clarias gariepinus fed varying inclusions of Leucaena leucocephala leaf meal. Revista UDO Agricola 2009; 9(4):979 985.
36. Tacon AGJ, Metian M. Global overview on the use of fish meal and fish oil in industrially compounded aqua feeds: Trends and future prospects Aqua 2008; 285:146-158.
37. Thiessen DL, Campbell GL, Tyler RT. Utilization of thin distillers' solubles as a palatability enhancer in rainbow trout (Oncorhynchus mykiss) diets containing canola meal or air-classified pea protein Aqua Nutr 2003; 9:1-10.
38. Wedemeyer GA, Yasutake WT. Clinical methods for the assessment of the effects of environmental stress on fish health. United States Fish and Wildlife Service Technical papers, 1977, 89.