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Original Article

Growth response and feed utilization of *Clarias gariepinus* (Burchell, 1822) juveniles fed graded levels of boiled *Senna obtusifolia* l. seed meal as a replacement for soybean meal

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ABSTRACT

Objective: The aim of this study was to evaluate the growth response and feed utilization of *Clarias gariepinus* juveniles fed graded levels of boiled *Senna obtusifolia* seed meal as replacement for soybean meal.
Materials and methods: Five isocaloric and isonitrogenous diets were formulated. The diest were- control diet (with 0% inclusion level boiled *S. obtusifolia* seed meal *i.e.*, 100% soybean meal), 25%, 50%, 75% and 100% inclusion level (total replacement of soya bean meal). The feeds were fed to *C. gariepinus* juveniles at 5% of their body weight for 84 days in an indoor partial flow through system. Weight and standard length of *C. gariepinus* juveniles were taken every fortnight and water quality parameters were monitored weekly.
Results: Experimental fish fed diets with 0 and 25% inclusion level of boiled *S. obtusifolia* seed meal gave the best results in terms of Mean Weight Gain (MWG) (20.22 and 19.79 g, respectively), Specific Growth Rate (1.82 and 1.83 respectively), Protein Efficiency Ratio (2.75 and 2.00, respectively) and the Lowest Feed Conversion Ratio (1.29 and 1.39 respectively). The lowest growth and feed utilization were observed in fish fed 100% inclusion level. The weight gain of fish decreased with increase in replacement level above 25%. There was no significant difference between control diet 0 and 25% inclusion level ($P \geq 0.05$).
Conclusion: Boiled *S. obtusifolia* seed meal is a nutritive source of plant protein and a good replacement for soybean meal at 25% inclusion level of boiled *S. obtusifolia* seed meal in formulating catfish feed for *C. gariepinus* juveniles without any deleterious effect.

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KEYWORDS

Catfish juveniles, *Clarias gariepinus*, *Senna obtusifolia*, *Senna* seed

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INTRODUCTION

The key to abundant fish production is availability of cheap and balanced feed. Aquaculture technology has evolved the push toward higher yield and fast growth has involved the enhancement or replacement of natural foods with prepared diets. Feed cost is known to account for over two third of the variable cost of an intensive aquaculture system (Aderolu and Sogbesan, 2010). Therefore, knowledge on nutrition and practical feeding of fish is essential to successful aquaculture. Aquaculture nutrition to a great extent relies on pond water productivity and the use of various feed supplements.

As at now nutritional data are available to allow the nutritionist to formulate catfish feed on a least cost basis. The primary constraint limiting the use of least cost programmes for formulating catfish feeds is that relatively few feed stuffs are available that are suitable for use in catfish feed (Robinson et al., 2001). Aquaculture can play a complimentary role to terrestrial animal production in ensuring food security to the teeming Nigerian population (Ochang, 2008). The demand for fish is very high, and in Nigeria, fish culture is getting popular both in homestead and commercial farms. Some species of fish cultured include catfish, highly relished in Nigeria because of its fast growth and high taste value (Oladosun et al., 1994).

To mitigate the effect of higher feed cost in fish culture, aqua culturists have always sought to replace fish meal and fresh oil components of the diet. Fish meal, known to be the most expensive component of the diet, is usually replaced at least partially with other cheaper animal protein source. Other plant protein sources which have not been traditionally used in feeds are being assessed for the suitability in fish feed formulation. When suitable ingredients are found that have little value as nutrient sources for food, their cost will be less and this will enhance the profitability of the aquaculture enterprises (Ochang, 2008).

The cost of fish feeds can be significantly reduced if locally available ingredients are incorporated in feed formulation. *Cassia fistuala,* Mucuna beans and Castor seeds were used to substitute soy bean meal (Adebayo et al., 2004; Bekibele, 2005; Auta et al., 2007) respectively. Soaring food prices have triggered an increase in hunger worldwide, the competition between human and livestock for the consumption of soybean and the increasing role of soybean in the world as a biodiesel (Cotula et al., 2008), One of such legumes that can be evaluated as alternative and replacement for soybean could be *Senna obtusifolia* (sickle pod seed).

S. obtusifolia is a legume belonging to the family Fabaceae, subfamily Caesalpinoideae, commonly called sickle pod plant. Okezie and Agyakwa (1998) and Queensland Government (2006) gave a description of the plant as an erect, branched bushy annual or perennial up to 90cm high, that reproduces from seed. Ingweye et al. (2010a) evaluated the Proximate composition of the seed and reported (92.50%), (29.54%), (10.18%) for dry matter, crude protein and crude fibre respectively.

This study is therefore aimed at evaluating the growth response and feed utilization of *Clarias gariepinus* fed boiled *S. obtusifolia* seed meal as a replacement for soybean meal. The scope for improving the aquaculture nutritional practices in Nigeria is very wide with new developments of integrated cultures arising and paving way for better aquaculture nutritional practices with a resulting increase in production for food security and income generation for fish farmers.

MATERIALS AND METHODS

Ethical statement: The experimental protocol and sampling were done in accordance with the Ahmadu Bello University Committee on Animal Use and Care (ABUCAUC) protocol.

Feedstuff analyses: *S. obtusifolia* seeds were manually threshed from its pods. The seeds were then washed thoroughly to remove all impurities after which the seeds were air-dried, seeds were boiled at 100°C seeds for 40 min. Air-dried and boiled seeds were weighed and oven dried at 80°C in a paper bag for 24 h followed by cooling in a desiccator for dry matter to be taken, the dry seeds were pulverized using a laboratory blender and sieved using a 0.5 mm mesh sieve (Ingweye et al., 2010b). The flour was stored in screwed-capped bottles at room temperature for further analyses.

The seeds, experimental diets and fish carcass samples were used for the analyses of crude protein (CP), crude fibre (CF), Ether extract (EE), nitrogen free extract (NFE), ash and moisture content according to the standard method of AOAC (1999).

Air-dried and boiled *S. obtusifolia* seeds antinutritional factors such as hydrocyanic acid, oxalate, phytate, saponin and tannin were determined according to the standard method of AOAC (1999). The amino acid profile of experimental diets were determined using methods described by Benitez (1989) and AOAC (2006). The samples were dried to constant weight, defatted, hydrolyzed, evaporated in a rotary evaporator and loaded into the Technicon sequential Multi-Sample Amino Acid

Analyzer ((TSM-1 Technicon Instrument Basingstoke, UK).

Feed Formulation: Five diets with varying replacement level were; 0% inclusion level (control), 25%, 50%, 75%, and 100% inclusion level of boiled *S. obtusifolia* seed meal. These were formulated using the excel feed formulator worksheet (**Table 1**).

Experimental fish: One hundred and fifty *C. gariepinus* juveniles with an average weight of (5.74±0.02 g) were obtained from Bangiwa Farm in Funtua, Katsina state. The fish were transported to the Fisheries Laboratory of the Department of Biological Sciences, Ahmadu Bello University Zaria. Fish were left in the water bath (150x50x40 cm) for two weeks for acclimatization.

Experimental setup: Fifteen (15) plastic aquaria with dimension of 50×45×35 cm was used (three aquaria/ experimental diet), each containing dechlorinated water provided suitable environment for the fish. Ten (10) juveniles of *C. gariepinus* were stocked randomly in each aquarium. The set up was wire-meshed to avoid fish from jumping out. Water replacement was done every three (3) days using the flow through system. This eliminated fecal matter and unutilized feed by the fish. Feed was administered twice daily using 5% of their body weight (Marinmuthu et al., 2010).

Data collection: The weights of fish were determined every fortnight using an electric Mettler Zurich (Swiss made) top-loading balance model CP8201 for period of twelve weeks. The standard length of fish was measured using a measuring board calibrated in centimetre (cm). Water quality parameters were taken bi-weekly using the Hanna pH/EC/TDS/Temp H19830 instrument. Dissolved Oxygen was determined using DO meter (Hanna model D1946).

Growth and feed utilization determination: Mean weight gain (MWG)=mean final weight (MFW) – mean initial weight (MIW), mean standard length gain (MSLG)=mean final standard length (MFSL) – mean initial standard length (MISL), feed conversion efficiency (FCE), protein efficiency ratio (PER) were computed according to the method of Falayi (2009) method. FCR=F/(Wt–Wo), where F=the amount of given feed (g), Wt=final weight and Wo=initial weight were taken as reported by Tutas et al. (2013). The specific growth rate (SGR) was evaluated as reported by Morais et al. (2001), SGR (% per day)=(Ln Wt–Ln Wo)/t_2-t_1x100%, where t=experiment duration time (days). Nitrogen Metabolism (Nm)=(0.54) (b-a) h/2 Where: a=initial weight of fish (g), b=final weight of fish (g), h=experimental period in days (Dabrowski, 1977). Condition Factor (K)=(100xW)/L^3 (Pauley, 1984) Where: K=condition factor, L=length (cm) and W=body weight of fish (g) and percentage survival rate (PSR)=number of survived fish/ total number of fish stocked expressed in percentages.

Data analyses: Data were analysed using one way analyses of variance (ANOVA) and Duncan's multiple range test (DMRT) was used to rank means where significant at (P<0.05) using SAS 9.1.3 software package.

RESULTS AND DISCUSSION

The proximate composition in percentages of raw and boiled *S. obtusifolia* seeds (**Table 2**) indicated that boiled seeds were higher in crude protein (22.87±0.01), moisture content (8.12±0.02) and ash content (4.66±0.01), crude fibre, ether extract, nitrogen free extract were higher in raw *S. obtusifolia* seeds with the value 16.20±0.00, 6.81±0.01 and 46.22±0.00, respectively. There was significant difference in all proximate contents (P<0.05) with the exception of ash content of raw and boiled *S. obtusifolia* seeds. The crude protein, ether extract of boiled and raw seeds in this study were lower than that of reported by Ingweye et al. (2010a, b). Balogun et al. (2016) reported similar results on *S. obtusifolia*, *S. siamea* and soaked *Bauhinia monandra* seed meals, respectively, FAO (2004) reported that soil type, climatic condition and geographical location could play a role in differences in phytochemical composition of plant, this could be the possible reason for these difference because Ingweye et al. (2010a, b) carried out their study in Cross river while this present study was carried out in Kaduna state Nigeria. However, *S. obtusifolia* seeds ash content in this present study was higher and NFE value was similar to that reported by Ingweye et al. (2010a) and Ingweye et al. (2010b). Robinson et al. (2001) reported that feed ingredients with crude protein greater than 20% are referred as protein source which makes *S. obtusifolia* seeds one.

The anti-nutrient of raw and boiled *S. obtusifolia* seed is presented in **Table 2**, hydrocyanic acid, oxalate, phytate, saponin and tannin range in raw and boiled seed in mg/100 g were 0.14-1.42, 0.26-2.64, 0.96-4.16, 0.44-0.96 and 0.20-2.44 respectively, the anti-nutrient recorded for raw seed was lower than that reported by Bake et al. (2016a) for *S. obtusifolia* seeds, anti-nutrient in the raw seeds were significantly reduced by boiling at 100^{0}C for 40mins (P<0.05), boiling effectively reduced the anti-nutrients in seeds which were lower than anti-nutrients in toasted *S. obtusifolia* seed reported by Bake et al. (2016a), a better percentage reduction in anti-nutrient was obtain in this study than toasting the results of Bake et al. (2016a).

Table 1: Composition of experimental diets used for feeding trial

Different meals	Inclusion Levels of Boiled *S. obtusifolia* Seed Meal, (%)				
	0	25	50	75	100
Senna Seed	0	6.16	12.32	18.48	24.64
Maize	3.55	3.55	3.55	3.55	3.55
G. corn	15.77	15.77	15.77	15.77	15.77
G. nut cake	23.68	23.68	23.68	23.68	23.68
Soybean meal	24.64	18.48	12.32	6.16	0
Benni Seed Meal	9.86	9.86	9.86	9.86	9.86
Fish Meal	19.71	19.71	19.71	19.71	19.71
Oil Sludge	0.99	0.99	0.99	0.99	0.99
Lime Stone	0.24	0.24	0.24	0.24	0.24
Bone Meal	0.49	0.49	0.49	0.49	0.49
Salt	0.15	0.15	0.15	0.15	0.15
Vitamin Premix*	0.49	0.49	0.49	0.49	0.49
Methionine	0.03	0.03	0.03	0.03	0.03
L-Lysine	0.049	0.049	0.049	0.049	0.049
Enzyme (Phytase)	0.0099	0.0099	0.0099	0.0099	0.0099
Vitamin C	0.03	0.03	0.03	0.03	0.03
Klino Feed Mycotoxin inhibitor	0.049	0.049	0.049	0.049	0.049
Pellet binder	0.3	0.3	0.3	0.3	0.3

Bio-organics Vitamin/ Mineral Premix per Kg; Vitamin A: 10,000,000IU, Vitamin D3: 2,000,000IU, Vitamin K3: 2,000mg, Vitamin E: 23,000mg, Vitamin B1: 1,800mg, Vitamin B2: 5,500mg, Vitamin B6: 3,000mg, Vitamin B12: 15mg, Niacin: 27,500mg, Pantothenic: 7,500mg, Folic acid: 7,500mg, Biotin H2: 60mg, choline chloride: 300,000mg, Cobalt: 200mg, Copper: 3,000mg, Iodine: 1,000mg, Manganese: 40,000mg, Iron: 20,000mg, Selenium: 200mg, Zinc: 30,000mg, antioxidant: 1,250mg and Calcium Sulphate Guar gum (pellet binder). Note: (c) = control diet*

Table 2. Proximate and anti-nutrient composition of raw and boiled *S. obtusifolia* seed

Proximate content	**Seed (%)**		
	Raw	**Boiled**	
Moisture content	5.89±0.02[b]	8.12±0.02[a]	
Dry matter	94.11±0.00[a]	91.88±0.02[b]	
Crude protein	20.36±0.00[b]	22.87±0.01[a]	
Crude fibre	16.20±0.00[a]	15.04±0.01[b]	
Ether extract	6.81±0.01[a]	6.03±0.02[b]	
Ash content	4.52±0.00[a]	4.66±0.01[a]	
Nitrogen free extract	46.22±0.00[a]	43.28±0.00[b]	
Anti-nutritional content (mg/100g)			**% Reduction**
Hydrocyanic acid	1.42[a]	0.14[b]	90.14
Oxalate	2.64[a]	0.26[b]	90.15
Phytate	4.16[a]	0.96[b]	76.92
Saponin	0.96[a]	0.44[b]	54.17
Tannin	2.44[a]	0.20[b]	91.83

Means with different superscript along row are significantly different (P<0.05)

Tannin recorded the highest percentage reduction (91.83%), this can be attributed to the presence of tannin in seed coats of plants, saponin recorded the lowest percentage reduction (54.17%).

The proximate and amino acid composition of experimental diets (**Table 3**), indicated percentage dry matter, crude protein, crude fibre, ether extract, ash, moisture and nitrogen free extract range were 94.90-96.73, 35.32-35.99, 8.11-12.46, 4.75-7.20, 3.28-5.10 and 30.46-32.22%, respectively. The overall amino acid composition of experimental diets shows that glutamic acid had highest concentration (9.00 g/100 g) in diet with 50% inclusion level of boiled *S. obtusifolia* seed meal, while the lowest was methionine (0.71 g/100 g) in diet with 100% inclusion level of boiled *S. obtusifolia* seed meal. The percentage crude protein of diets were within the CP requirement of African catfish juveniles, as reported by Bolorunduro (2002). Amino acid composition of diets were higher than amino acid requirement for channel catfish, as reported by Robinson et al. (2001). Campbell (2009) reported that histidine helped in the removal of heavy metal from the body, isoleusine helped to increase endurance and helped to heal and repair muscle tissue, leucine increased the production of growth hormone, Lysine is needed for hormone production, methionine helps the body process and eliminate fat and phenylalanine is needed for normal functioning of the central nervous system.

The growth response and feed utilization of experimental fish fed different level of boiled *S. obtusifolia* seed meal (**Table 4**) shows that the highest MWG was observed in 0% and 25% inclusion levels of boiled *S. obtusifolia* seed meal while the lowest MWG was recorded in experimental fish fed 100% level of boiled *S. obtusifolia* seed meal, although no weight loss was recorded in this present study when compared to the weight at initial observation before feeding trial. Growth and nutrient utilization parameters (MWG, SGR, PER, FCE and Nm) significantly reduced as inclusion level of boiled *S. obtusifolia* seed meal increased in formulated diet. Dienye and Olumuji (2014), Bake et al. (2016a), Bake et al. (2016b), and Balogun et al. (2016) reported similar findings using moringa leaf meal, toasted *S. obtusifolia* seed meal, toasted *Delonix regia* seed meal and soaked *B. monandra* seed meal respectively fed to *C. gariepinus*,

Table 3: Proximate and amino acid composition of experimental diets

Nutrition Contents	Inclusion Levels of Boiled S. obtusifolia Seed Meal, (%)				
Proximate Composition	0	25	50	75	100
Dry Matter	96.73	96.40	96.09	95.06	94.90
Crude Protein	35.99	35.95	35.62	35.32	35.52
Crude Fibre	8.11	8.46	10.03	12.18	12.46
Crude lipid	7.20	6.62	4.75	4.71	4.66
Ash Content	14.96	14.18	12.82	10.76	10.04
Moisture	3.28	3.60	4.92	4.94	5.10
NFE	30.46	31.19	31.86	32.09	32.22
Amino Acid Composition					
*Lysine	3.19	3.17	3.03	2.97	2.78
*Histidine	2.22	2.16	2.02	1.95	1.91
*Arginine	3.77	3.75	4.01	4.11	4.10
Asp Acid	7.54	8.23	8.53	8.57	8.63
*Threonine	3.57	3.65	3.31	3.23	3.21
Serine	2.11	2.13	2.09	2.05	2.06
Glut Acid	8.94	9.16	9.00	8.89	8.85
Proline	2.23	2.21	2.13	2.21	2.22
*Methionine	1.02	1.09	0.81	0.76	0.71
*1soleucine	3.27	3.57	3.11	3.07	3.03
Tyrosine	2.25	2.25	2.26	2.21	2.17
*Phenylalanine	1.61	2.01	2.12	2.08	2.09
Glysine	2.50	2.31	2.17	2.13	2.11
Alanine	4.02	3.71	2.34	2.29	2.99
Cysteine	1.53	1.46	1.01	1.09	0.94
*Valine	3.66	3.69	3.45	3.15	3.12
*Leucine	2.22	2.12	1.78	1.74	1.79
*Tryptophan	Nd	Nd	Nd	Nd	Nd

**= Essential amino acid Nd= Not Determined*

however, FCR increased with increase in inclusion of plant material but there was no significant difference ($P \geq 0.05$) between 0 and 25% inclusion level. Despite the isocaloric and isonitrogenous nature of diets, differences in the growth performance experimental fish may be linked to superiority of protein quality of soybean meal as inclusion level of boiled *S. obtusifolia* seed meal increased, similar finding was reported by Aderolu and Sogbesan (2010) and Tiamiyu et al. (2015) using cocoa yam peels and water melon respectively. Crude fibre in diets, high level of soybean used with corresponding low fishmeal composition in experimental diets formulated (**Table 1**), processing method of *S. obtusifolia* seeds and anti-nutrients in seed could also have resulted in differences recorded in the growth and nutrient utilization of experimental fish at different inclusion level (Tiamiyu et al., 2015).

Carcass composition of *C. gariepinus* juveniles fed different inclusion levels of boiled *S. obtusifolia* seed (**Table 5**) showed that fish fed diet with 0% inclusion level had the highest percentage carcass crude protein (68.63) while the lowest percentage carcass crude protein (55.44) was recorded in fish fed 100% inclusion level.

The crude protein, crude lipid, ash and moisture content of fish before and after feeding trial period were

Table 4: Growth response and feed utilization of *C. gariepinus* juveniles fed different inclusion levels of boiled *S. obtusifolia* seed meal

Parameter	Inclusion Levels of Boiled *S. obtusifolia* Seed Meal, (%)					
	0.00	25.00	50.00	75.00	100.00	S.EM
MIW	5.68^a	5.55^a	5.86^a	5.69^a	5.93^a	±0.10
MFW	25.90^a	25.34^a	17.37^b	13.22^c	11.77^d	±0.11
MWG	20.22^a	19.79^a	11.51^b	7.53^c	6.12^c	±3.51
MISL	8.18^a	8.36^a	8.52^a	8.55^a	8.44^a	±0.50
MFSL	13.16^a	12.98^a	12.43^{ab}	12.45^{ab}	11.92^b	±0.50
MSLG	4.98^a	4.62^a	3.91^b	3.90^b	3.48^b	±0.50
Conditon factor (k)	1.14^a	1.16^a	0.90^a	0.69^b	0.69^b	±0.01
SGR	1.82^a	1.83^a	1.30^b	1.01^c	0.69^d	±0.02
PER	2.75a	2.00b	1.39c	1.22cd	1.10d	±0.01
FCR	1.29^c	1.39^c	2.02^b	2.32^a	2.55^a	±0.10
FCE	0.76^a	0.72^a	0.50^b	0.43^c	0.39^c	±0.11
Nm	4585.90^a	4488.37^a	2610.47^b	1707.80^c	1388.02^c	±120.50
PSR	96.66^a	96.66^a	86.67^b	86.67^b	86.67^b	±0.50

Means with different superscript along row are significantly different (P<0.05)

Table 5: Carcass proximate composition of *C. gariepinus* juveniles fed fed different inclusion levels of boiled *S. obtusifolia* seed meal

Parameter	Initial	Inclusion Levels of Boiled *S. obtusifolia* Seed Meal, (%)					SEM
		0	25	50	75	100	
Crude protein	51.16^d	68.63^a	67.56^a	62.82^b	55.98^c	55.44^c	±1.42
Ether extract	13.99^a	10.33^b	9.33^c	8.44^d	9.92^c	9.70^c	±0.42
Ash content	15.37^a	7.74^d	8.11^d	10.63^c	11.52^b	12.21^b	±0.56
Moisture content	10.23^a	8.76^c	8.38^c	8.66^c	9.46^b	9.95^b	±0.20
NFE	9.25^b	4.54^d	6.62^c	9.45^b	13.12^a	12.70^a	±1.05

Means with different superscript along row are significantly different (P<0.05

Table 6: Physicochemical parameter of water used during feeding trial

Tank/inclusion level	pH	Temp (^{0}C)	Electrical conductivity (µs /cm)	TDS (ppt)	DO (mg/l)
Tank (0%)	6.77±0.02	25.76±0.02	0.20±0.01	0.10±0.01	6.99±0.10
Tank (25%)	6.84±0.01	25.73±0.02	0.20±0.00	0.10±0.00	7.00±0.10
Tank (50%)	6.80±0.03	25.66±0.01	0.20±0.00	0.10±0.00	6.98±0.10
Tank (75%)	6.81±0.01	25.65±0.02	0.20±0.00	0.10±0.00	7.02±0.20
Tank (100%)	6.79±0.02	25.71±0.02	0.20±0.01	0.10±0.00	6.98±0.10
FEPA range	5.00-9.00	20.00-35.00	20.00-1500.0	10-750ppm	>1.00

significantly different (P<0.05). The experimental fish carcass protein for all dietary treatments were higher than the initial carcass protein, indicating that there was synthesis and increased tissue protein production as reported by Fuller (1969), Auta et al. (2007) and Tiamiyu et al. (2015). The fish carcass ether extract decreased for all experimental fish and NFE only decreased in fish fed 0 and 25% inclusion level, indicating possible utilization of energy source and subsequently sparing of protein for tissue synthesis, carbohydrate level in diets were within Pantazis (2005) carbohydrate requirement for African catfish (25-32%). The carcass crude protein of fish fed different dietary levels in this study were higher than that reported by Bake et al. (2016a) for *C. gariepinus* fed different dietary levels of toasted *S. obtusifolia* seed meal; this confirmed that boiled *S. obtusifolia* seed yielded better growth performance of *C. gariepinus* juvenile than toasted seed fed to *C. gariepinus* fingerlings used in Bake et al. (2016a) study because of anti-nutrient presence in seed and feed utilization of fish at fingerling stage.

Physicochemical parameters of water determined as presented in **Table 6** shows that the hydrogen concentration ion pH ranged between 6.77-6.87 for all plastic aquaria. The temperature range was 25.65-25.76°C, electrical conductivity of water was the same (0.20 µs/cm) which shows that the total dissolve solid (TDS) was relatively the same (0.10 ppt). The dissolved oxygen ranged between 6.98-7.02 mg/L. The water quality parameters recorded in this study were within the range recommended for the culture of *C. gariepinus* defined for warm fish species. Boyd and Lichoppler (1981) reported temperature range of 22–27°C, pH range from 6.5–9.0 and dissolved oxygen of 6.3 mg/L and 9.6 mg/L gives the best growth in cultured tropical fishes. Mazid et al. (1972) and Devi (2013) also reported a similar value for fish culture, an average temperature of 28°C, dissolved oxygen of 6.9 mg/L and pH 7.3 are optimal for normal growth Auta (1993) reported temperature between 25°C and 30°C and pH (6.7 and 9.0) which were adequate for fresh water fish culture. The physiochemical parameters of water were within the range of FEPA acceptable range for culturing fresh water fish.

CONCLUSION

Boiled *Senna obtusifolia* seed meal is a nutritive source of plant protein and a good replacement for soybean meal at 25% inclusion level of boiled *S. obtusifolia* seed meal in formulating catfish feed for *C. gariepinus* juveniles without any deleterious effect.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

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