

Growth performance of fingerlings of *Clarias gariepinus* fed fermented seed of *Senna obtusifolia* (Linn)

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The effects of replacing soybean meal with graded levels of fermented *Senna obtusifolia* seed meals (SOSM) on the growth performance of *Clarias gariepinus* were investigated. Five isonitrogenous (42% crude protein) and isocaloric (25.7% NFE) diets were formulated in which fermented replaced soybean meal (SBM) at 0% (SOSM0), 25% (SOSM25), 50% (SOSM50), 75% (SOSM75) and 100% (SOSM100) inclusion levels and a commercial feed (CmF) as the second control. Three hundred and sixty (360) fingerlings of (*Clarias gariepinus*) mean weight (2.85 ± 0.01 g) were stocked at (20) fish per tank volume in triplicate groups per treatment and fed 3% body weight twice a day of the experimental diets for 180 days. The feeding rate was adjusted after weighing. The water qualities were within range recommended for *Clarias gariepinus*. There were no significant differences ($p > 0.05$) in growth performance and nutrient utilization between the control groups and those fed the fermented SOSM diets at 25%. The commercial, 0% and 25% groups had the highest mean weight gain (279 to 280 g), significantly ($P < 0.05$) superior to the groups that received the, 50%, 75% while the group that received 100% SOSM diet had the poorest mean weight gain (132.72g). Feed conversion ratios (FCR) of all treatments ranged from (1.75 to 2.18). These values increased slightly by increasing levels of fermented SOSM from 50 to 100%. The best FCR, 1.75 ± 0.02 , recorded for fish fed 25% fermented SOSM indicated a superior level of utilization of the SOSM diet by the fish. There was no significant difference ($P > 0.05$) in the protein intake among the group of fish fed 0 and 25%, but significant difference ($P < 0.05$) occur in fish fed 50, 75 and 100% fermented SOSM respectively. Protein efficiency ratio (PER) exhibited significant differences ($P < 0.05$) in all treatments except in the control diets that were not statistically different ($P > 0.05$) from the fish fed the 25% fermented SOSM. The PER values increased among the experimental fish with respect to the quantity of total feed intake. There were no significant differences ($P > 0.05$) in apparent net protein utilization (ANPU) among treatments CmF, 0% and 25%. The ANPU was highest in fish fed 0% fermented SOSM (91.6 ± 0.04) while fish fed 75 and 100 % fermented SOSM in diets were 71.4 ± 0.02 and 73.4 ± 0.03 were the least. There was a significant ($P < 0.05$) difference in the effect of the inclusion levels of fermented (SOSM) on final body carcass composition among treatments. This study showed that soybean meal can be substituted with fermented *Senna obtusifolia* seed meal up to 25% level in *Clarias gariepinus* diets without any negative effects on the growth and feed efficiency.

Keywords: Growth; fermented *Senna obtusifolia* (Linn); *Clarias gariepinus* fingerlings

Introduction

Profitable fish culture requires unflinching supply of formulated fish feed of low cost using the cheapest sources of proteins. To maintain the profitability of raising *Clarias gariepinus*, cutting down the production

costs is necessary, mainly through feeding, which has been acknowledged generally as the major cost incurred during the production cycle (Eyo, 2003; Jamu and Ayinla, 2003; Akinrotimi *et al.*, 2007). Gabriel *et al.* (2007) reported that feed

Performance of fingerlings of Clarias gariepinus fed fermented seed of Senna obtusifolia (Linn)

alone in fish farming accounted for between 60-70% of the running expense in the operation of a fish farm enterprise. Reduction in feeding cost can be obtained by optimizing feeding strategies, nutrient levels in diets, and by using plant sources as substitutes for fish oil and fish meal (Martinez-Llorens *et al.*, 2009). Plant feedstuffs have received most attention in recent years; however, due to amino acid imbalances, presence of anti-nutritional compounds, low palatability and poor digestibility, a high level of replacement of fish meal with plant feedstuffs is generally not well accepted by fish (Belgin *et al.*, 2009). Some plant ingredients have been studied in the production of *Clarias gariepinus*, among which jack bean and soybean meal, are widely used because of their high protein (40-60%) content, low cost and relative availability. Soybean meal, being the most nutritive, has been used as the major protein source in many fish diets; partial or total replacement of dietary fish meal by soybean meal had been accomplished with *clarias* and other catfish species (Soltan *et al.*, 2001; Fagbenro and Davies, 2002; Wilson, *et al.*, 2004, Abdelhamid *et al.*, 2006; Magdy, 2006). *Senna obtusifolia* is an annual plant, a serious weed in many places and a competitive shrub that grows in the tropics (Ingweye *et al.*, 2010). The plant grows to a height of about 1.5-2.5m tall and 1m wide. The pod is 10-15cm long, 3-5mm wide, slender and sickle shaped. The plant prefers well drained fertile soil. The proximate composition of the seeds shows a high dry matter (95.50%), crude protein (29.54%), crude fibre (10.18%), while the leaves contains dry matter (92.40%), crude protein (27.4%), crude fibre (16.8%), ether extract (3.8%), nitrogen free extract (36.8%) with high concentrations of anti-nutrients which can be detoxified through processing

(Ingweye *et al.*, 2010 and Ayssiwede, *et al.*, 2011). There is dearth of information on the use of fermented *Senna obtusifolia* seed meal in fish and animal feed formulation; hence the aim of this study was to evaluate the effect of partial and complete replacement of soyabean meal with graded levels of fermented *Senna obtusifolia* seed meal on growth performance of *Clarias gariepinus*.

Materials and methods

Collection and processing of Senna obtusifolia seeds

The seeds of *Senna obtusifolia* were handpicked in Shika Zaria, Kaduna State. The seeds were soaked in water in a 1:6 (seeds: water) i.e.1kg/6lit ratio for 12h, drained and soaked seeds were allowed to ferment for four days (Udensi *et al.*, 2006). The fermented seeds were air dried for two days, and were ground into fine powder, and analyzed for proximate composition, amino acids, mineral elements and anti-nutritional compounds.

Experimental fish

Three hundred and sixty (360) fingerlings of *Clarias gariepinus* with mean initial weight (2.85 ± 0.01 g) were stocked at twenty fish per tank in three replicates per treatment after acclimatization.

Feed formulation and pellet preparation

The experimental diets contained fish meal (FM), soybean meal (SBM), yellow maize meal (YMM), groundnut cake meal (GNCM) and fermented *Senna obtusifolia* seed meal (SOSM). All ingredients were ground into a fine powder using a hammer mill and sieved to pass through a 0.25-mm sieve. FM, SBM, GNCM and YMM were obtained from commercial suppliers. Prior to feed formulation, proximate compositions of these ingredients were determined (Table 1). On the basis of the

proximate composition of the ingredients, five isonitrogenous diets (42%CP) and Isocaloric (gross energy 2777 kcal kg⁻¹) was prepared where the fermented *Senna obtusifolia* seed meal (SOSM) replaced soybean meal (SBM) at 0%, 25%, 50%,

75%, and 100%. While 0% (SBM0) and commercial pelleted feed served as the control diets (Table 2). Diet samples were subjected to proximate analysis as described (A.O.A.C.2000) and presented in Table 3.

Table 1: Proximate and Energy Composition of Ingredients used in the Experimental diets

Ingredients	Moist%	CP%	EE%	CF%	ASH%	NFE%	GE
Fish meal	9.78	72	7.92	-	11.03	4.89	2980
Soya meal	7.92	44	2.6	7.8	5.6	32	2400
Yellow corn	9.13	8.9	3.48	11.6	3.81	63.08	3447
GNC meal	9.09	43	5.2	6.0	5.8	30.91	2400
Fermented <i>Senna obtusifolia</i>	6.54	32.11	7.71	4.3	5.14	44.2	3226

CP: Crude protein, EE: Ether extract, CF: Crude fibre, ASH: Ash content, NFE: Nitrogen free extract, GE: Gross energy

Table 2: Gross Composition of the Experimental diets for *Clarias gariepinus* fingerling

Ingredients	0%	25%	50%	75%	100%
Maize	23	21.0	19.	16	13
Fermented <i>Senna obtusifolia</i>	-	8.75	17.5	26.25	35
Ground nut cake	15	17.5	20.5	23	27
Soya bean meal	35	26.25	17.5	8.75	-
Fish meal	24	24	24	24	24
Palm oil	2	2	1.5	1.5	2
Vitamins	0.25	0.25	0.25	0.25	0.25
Salt	0.2	0.2	0.2	0.2	0.2
Lysine	0.25	0.25	0.25	0.25	0.25
Methionine	0.25	0.25	0.25	0.25	0.25
Total	100	100	100	100	100

Table 3 proximate compositions of experimental diets *Clarias gariepinus* fingerling

Composition	CF	0%	25%	50%	75%	100%
Crude protein	42.34	42.35	42.28	42.23	42.22	42.24
Moisture	7.86	7.38	7.49	7.90	7.38	7.48
Crude lipid	14.69	11.47	11.46	11.69	11.84	11.79
Crude fibre	2.8	4.91	4.62	4.59	5.32	5.33
Ash	6.7	8.21	8.30	8.46	8.14	8.18
NFE	25.7	25.68	25.85	25.03	25.10	24.98
Dry matter	92.23	92.62	92.51	92.00	91.62	92.12

CF: Commercial feed, NFE: Nitrogen free extract

Experimental procedures

The experimental system consisted of 18 units cylindrical black plastic tanks of 380-L capacity, 50-cm diameter and 50-cm depth each in a complete randomized design. Water was supplied to each tank at a rate of 1-L min⁻¹ from a 2000-L header GP tank. Fish were fed the experimental diet at 3% body weight twice a day for 180 days.

Feeding quantity was adjusted after every weighing fortnightly for growth and survival records (mean body weight, mean standard length and mortality). Water pH and temperature was taken daily (8.00-9.00h) using combined pH and thermometer model pH-009(111), while the Dissolved oxygen (DO) was determined using the DO meter model DO-510.

Performance of fingerlings of Clarias gariepinus fed fermented seed of Senna obtusifolia (Linn)

Growth and feed utilization parameters

The data collected was analyzed for the following

Mean body weight gain (MWG)= $W_2 - W_1$

Where W_1 = initial body weight W_2 = Final body weight

Specific Growth Rate (SGR) = $100(\ln W_2 - \ln W_1) / T$ -----

(Kaushik, 1998)
Where W_1 = initial body weight W_2 = Final body weight \ln = Natural log

Feed conversion Ratio (FCR) = weight of feed fed/ weight gain by fish x 100-----

(Adikwu, 2003)
Protein Efficiency Ratio (PER) = weight gain/weight of protein fed

Apparent Net protein utilization (NPU) = fish protein gained (g) /protein consumed (g) X100 (Jackson *et al.*, 1982). Carcass proximate composition of fish before and after the feeding trial were determined as described by AOAC (2000)

Statistical analysis

Data collected were subjected to one way analysis of variance (ANOVA) using

General Linear Model (GLM) procedure of SAS (SAS, 2004). Duncan Multiple Range F-test (DMRT) was used to separate means. Value of $P < 0.05$ was considered significant.

Results

Growth performance and feed utilisation of clarias gariepinus

Figure 1 showed that there was a slow growth of fish in all treatments during the first two weeks of culture, particularly in the groups fed 50%, 75% and 100% after which, a significant growth was evident in the fish fed the commercial feeds (CF), treatments 0 and 25%.

There was a fairly uniform pattern of growth for fish fed diets CmF, 0% and 25% from the fourth week. Fish fed CmF increased in weight above the other treatments between weeks four to the end of the feeding period. Fish fed diet containing 50-100% SOSM lagged behind those of fish fed diets CmF, 0% and 25% after the fourth week.

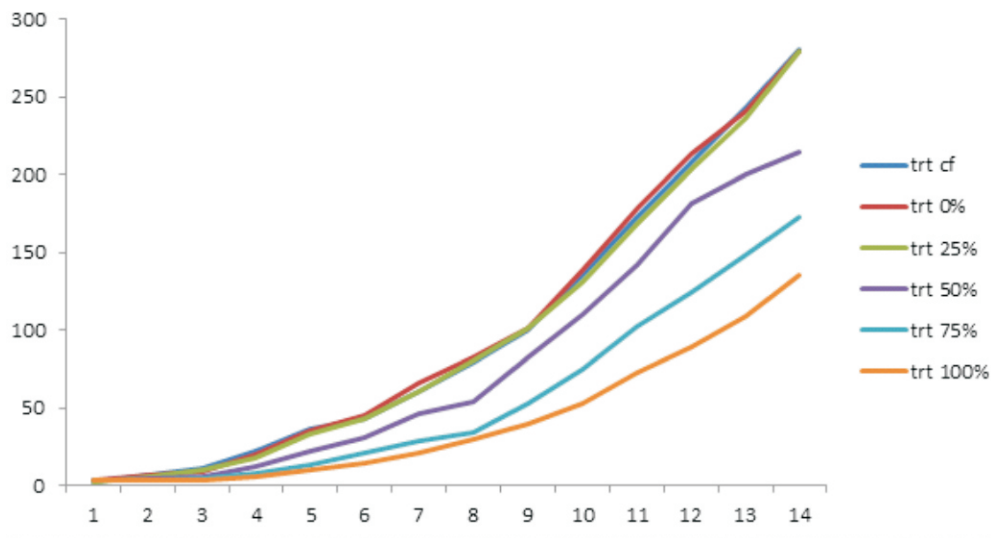


Fig.1: Biweekly growth pattern of Clarias gariepinus fed graded levels of fermented Senna obtusifolia seed meal

Table 5 showed that nutrient utilization was not affected ($p > 0.05$) in the control and that of the fish fed the 25% inclusion of FSOSM. The commercial, 0% and 25% FSOSM groups had the highest mean weight gain (279 and 280 g) significantly ($P < 0.05$) higher than the fish that received 50% and 75% FSOSM, while the fish that received 100% FSOSM inclusion had the poorest mean weight gain (132.72g). Feed conversion ratios (FCR) ranged from 1.79 to 2.18, these values increased as the inclusion of FSOSM increased from 50 to 100%. The best FCR (1.79 ± 0.02) was recorded for fish fed 25% FSOSM. Protein intake among the fish fed 0 and 25% FSOSM was not affected ($p > 0.05$), fish

fed 50, 75 and 100% FSOSM, however, had different ($p < 0.05$) protein intake levels. Protein efficiency ratio (PER) exhibited significant differences ($P < 0.05$) in all treatments except in the control and fish fed the 25% SOSM. Apparent net protein utilization (ANPU) among treatments CF, 0% and 25% was not affected ($p > 0.05$). The ANPU was highest in fish fed 0% fermented SOSM (91.6 ± 0.04) while fish fed 75 and 100% FSOSM had the least (71.4 ± 0.02 and 73.4 ± 0.03) respectively. Higher survival rates were found in the group of fish fed 0, 25, 50 and commercial feed, but lower survival occurred in fish fed 75 and 100% fermented SOSM (Table 5).

Table 5: Growth performance and nutrient utilization of *Clarias gariepinus* fed graded levels of fermented SOSM

Indices	Levels of inclusion of fermented <i>Senna obtusifolia</i> seed meal (%)						SEM
	CmF	0%	25%	50%	75%	100%	
Mean initial weight	2.84 ^a	2.85 ^a	2.86 ^a	2.84 ^a	2.87 ^a	2.85 ^a	± 0.01
Mean final weight	280.86 ^a	280.08 ^a	279.62 ^a	218.47 ^b	173.48 ^c	135.81 ^d	± 13.91
Mean weight gain	278.02 ^a	277.23 ^a	276.76 ^a	215.6 ^b	170.60 ^c	135.81 ^d	± 13.91
Specific growth rate	1.14 ^a	1.12 ^a	1.13 ^a	1.06 ^b	0.97 ^c	0.92 ^d	± 0.02
FCR	1.81 ^b	1.79 ^b	1.81 ^b	2.09 ^a	2.18 ^a	2.11 ^a	± 0.04
PER	1.38 ^a	1.38 ^a	1.36 ^a	1.15 ^b	1.09 ^c	1.12 ^{bc}	± 0.03
ANPU	91.63 ^a	91.83 ^a	91.63 ^a	76.35 ^b	71.43 ^c	71.70 ^c	± 2.29
Survival rate	98.67 ^a	97.33 ^a	95.33 ^b	87.33 ^c	82.67 ^d	80.67 ^d	± 1.72
Mean feed intake	487.80 ^a	483.58 ^b	484.48 ^b	446.69 ^c	371.57 ^d	279.64 ^e	± 18.62
Protein Intake	204.88 ^a	203.10 ^b	203.48 ^b	187.61 ^c	156.07 ^c	117.45 ^e	± 7.82

Figures on the same row having the same superscript are not significantly different ($p > 0.05$)

FCR: Feed conversion ratio, PER: Protein efficiency ratio, ANPU: Apparent net protein efficiency utilisation

Table 6: Carcass compositions of *Clarias gariepinus* fed graded levels of Fermented *Senna obtusifolia* seed meal

Indices	Levels of inclusion of fermented <i>Senna obtusifolia</i> seed meal (%)							SEM
	Initial	CmF	0%	25%	50%	75%	100%	
Crude protein	63.27 ^e	67.71 ^a	67.41 ^{ab}	67.21 ^b	66.25 ^c	65.52 ^d	65.18 ^d	± 0.33
Lipids	5.25 ^e	7.81 ^a	7.81 ^a	7.68 ^b	6.46 ^c	5.98 ^d	5.84 ^d	± 0.22
Moisture	7.41 ^d	6.51 ^e	6.34 ^e	6.34 ^e	8.76 ^c	9.85 ^b	10.48 ^a	± 0.36
Ash	8.64 ^c	9.51 ^b	9.67 ^b	9.63 ^b	12.35 ^a	12.48 ^a	12.50 ^a	± 0.35
NFE	14.91 ^a	8.88 ^d	9.13 ^c	9.24 ^b	6.77 ^e	6.41 ^f	6.08 ^g	± 0.63

^{abcde} Figures on the same row having the same superscript are significantly different ($p < 0.05$)

NFE=Nitrogen free extract

Carcass composition

The proximate carcass composition of experimental fish fed graded levels of FSOSM was determined at the beginning and at the end of the experiment. The initial carcass compositions of fish were 7.41, 63.27, 5.25, 8.64, and 14.91% for moisture, protein, lipid, ash and NFE, respectively (Table 6). The FSOSM affected ($p < 0.05$) final body carcass composition among treatments.

Discussion

Water quality parameters such as temperature, pH and dissolved oxygen in this study are within the recommended limits for warm-water fishes (Boyd and Gross, 2000; Ajani, 2006). The fingerlings consumed all the diets but feed intake was higher in groups that received diets with lowest levels of fermented *Senna obtusifolia* seed meal (FSOSM). The lower feed intake in the groups fed the 50%, 75% and 100% diets could be due to poor quality resulting from residual anti-nutritional factors such as tannin and non-starch polysaccharide (NSP) (Alegbeleye *et al.*, 2011). Soluble NSP has been reported to be deleterious to the growth performance of young fish (Leenhouders *et al.*, 2009).

The enhanced growth performance observed in the fish with lower inclusion of FSOSM could be as a result of the synergetic effect of combining two biological compounds having a single and superior effect than when applied individually. This observation is in agreement with suggestions by previous authors that combined protein source is better than single protein source for fish diets (Ugwumba *et al.*, 2001; Sogbesan *et al.*, 2005; Sogbesan and Ugwumba, 2006a). (Fagbenro *et al.*, 2010) assert that there could be a physiological mechanism in fish that could compensate for the presence of

lower inclusion level of anti-nutrients hence their negative effect may not be felt, but at higher level of inclusion, when the limit might have been exceeded, then the negative effect of these anti-nutrients will be pronounced as clearly depicted in this study. The lowered growth performance of fish fed higher level of FSOSM may be attributed to reduced bioavailability of minerals, impaired protein digestibility caused by formation of phytic acid-protein complexes and depressed absorption of nutrients (Francis *et al.*, 2001). The inability of *Clarias gariepinus* to effectively utilize high dietary inclusion level of FSOSM beyond 25% could be associated with low concentration of the enzyme cellulase which is absent in most piscivores such as *Malapterurus electricus*, *Gymnarchus niloticus*, *Parachanna obscura* but available in Tilapia species (Fagbenro *et al.*, 2005). In *Clarias gariepinus* which is an omnivore but with a higher tendency towards being a canivore, the enzyme cellulase is anticipated in the gastro intestinal tract in appreciable quantity to effect digestion. But opposite appears to be the case in this study. The utilization of 25% inclusion of FSOSM in the diets by *Clarias gariepinus* is in agreement with finding of Olukunle and Agboola (2005); and Aminsah *et al.* (2009). The best feed conversion ratio (FCR), 1.75 ± 0.02 , recorded for fish at 25% inclusion of FSOSM indicated a superior level of utilization of the FSOSM diet by the fish and this obviously accounted for better growth performance of *C. gariepinus* fed 25% inclusion of FSOSM diet among other diets. Adikwu (2003) reported that the lower the FCR the better the feed utilization by the fish. The higher PER value obtained in the control and 25% inclusion of FSOSM treatments points to high utilization of inherent nutrients in the diet at this level in

comparison to higher inclusion levels (> 25% and above). This agrees with the observation by Adejumo (2005) who reported high PER value at 20% inclusion level when maize was replaced with fermented millet. The improved ANPU in fish fed 25% inclusion of FSOSM compared to other treatments in this study, might be due to the fact that, protein deposition is significantly influenced by the ratio of FSOSM and soya bean meal in the diets. The carcass composition of the experimental fishes showed that all the fishes fed the experimental diets had higher carcass protein, lipid and ash contents but lower nitrogen free extract than the initial fish sample. This may be implied that there was protein synthesis and increased tissue production in *C. gariepinus* and that fish growth was not due to the increase in weight alone (Koven *et al.*, 2001; Fountolaki *et al.*, 2003). The moderately high level of carcass fat in fish fed the control and diets with 25% inclusion of FSOSM indicated an enhanced production of lipids in the fish (Udo *et al.*, 2012). Increase in lipids has been associated with increase efficiency of metabolism. Similar result was also observed in gilthead bream fingerlings (Fountolaki *et al.*, 2003). Fish fed diets higher inclusion of FSOSM had higher body moisture content and low lipid. The decrease in lipid content is probably due to poor feed intake which resulted in starvation and in turn led to mobilization of body lipid reserves to meet energy requirements for vital body functions. Similar results have been reported in *Clarias lazera* (Hogendoorn, 1983) and rainbow trout (Reinitz, 1983).

Conclusion

The study showed that soybean meal can be substituted with fermented *Senna obtusifolia* seed meal up to 25% level in *Clarias gariepinus* diets without any negative effects on the growth and feed

efficiency.

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Performance of fingerlings of Clarias gariepinus fed fermented seed of Senna obtusifolia (Linn)

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