



ORIGINAL RESEARCH ARTICLE

Evaluation of the Growth Performance of Afrcian Catfish (*Clarias gariepinus*) Fed Graded Levels of Raw Sickle Pod (*Senna obtusifolia*) Seed Meal

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ABSTRACT

This study investigated the replacement of soybean meal with raw *Senna obtusifolia* seed meal on the growth of *Clarias gariepinus* fingerlings. Four isonitrogenous (40% crude protein) diets were formulated in which raw *Senna obtusifolia* seed meal RSOSM in graded levels replaced soybean meal (SBM) at 0% RSOSM, 10% RSOSM, 20% RSOSM and 30% RSOSM. Two hundred and forty (240) fingerlings of *Clarias gariepinus* with mean initial weight (2.85 ± 0.01 g) were stocked at twenty (20) fish per pond in three replicates per treatment and fed the experimental diets at 5% body weight twice a day for 180 days. Feeding quantity was adjusted after every weighing fortnightly. Water pH and temperature were 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. The water quality parameters monitored were within the range recommended for *Clarias gariepinus*. The 0% RSOSM had the highest mean weight gain (279.02g) significantly ($P < 0.05$) higher than the diets in the other treatments, while the diets that received 30% RSOSM had the poorest mean weight gain (210.60g). Feed conversion ratios (FCR) ranged from (1.78 to 2.09). The best FCR (1.78) was recorded for fish fed 20% RSOSM. Protein efficiency ratio (PER) exhibited no significant differences ($P < 0.05$) in all treatments except in the control and fish fed the 30% RSOSM. Apparent net protein utilization (NPU) among treatments 10% and 20% was not affected ($P > 0.05$). The NPU was highest in fish fed 0% RSOSM (91.64) while fish fed 30% RSOSM had the least (76.60). There was no significant difference among the mean feed intake except for the 30% RSOSM which has (71.60g) and is the lowest. Soybean meal can be substituted with RSOSM up to 20% in the diets of *Clarias gariepinus* without any negative effects on the growth and feed utilization. The inclusion of RSOSM in the diet of *C. gariepinus* should not exceed 30% level of substitution with soya bean.

Introduction

Aquaculture is a fast growing sector in Nigeria, to sustain such sector a matching increase in fish feed sources is imperative. Faced with the food supply problem for

cultured fish, nutritionist have done more work evaluating for alternative feed ingredients in order to attain more economically sustainable environmentally-friendly and viable production. Recently the

research interest has been directed at the evaluation and use of unconventional protein sources for fish. The significance of legumes in the diets of animals and man in the developing countries is well documented (Serra *et al.*, 2024). They are rich in nutrients such as digestible proteins with good array of amino acids and minerals (Aremu *et al.*, 2010 and Augustine *et al.*, 2020).

The percentage crude proteins of most legumes ranged from 20 to 50g/100g dry weight (Mugwanya *et al.*, 2023) and have been judged to be a good source of minerals Augustine *et al.*, (2017). Leguminous seeds are reported to be a good source of energy Aremu *et al.*, (2010) in animal and human diets. This explains why a lot of research is been directed towards harnessing the potential of the seed in animal and human diets. Sickie pod (*Senna obtusifolia*) belongs to the *Fabaceae* (*Leguminosae*) or bean (pea) family, and sub-family *Ceasalpinioideae*. It is annual weed or herb taxonomically known as *Senna obtusifolia*.

Though native to India, this weed is also found in Myanmar, China, and Central America and in Nigeria. This weed is a member of the family *Leguminosae* or *Fabaceae*. This is a small fetid herb growing up to an average height from 30 to 90 cm (Paster *et al.*, (2007). The stem is light green cylindrical or grooved and profusely branched. The leaves are paripinnate; leaflets are in 3- pairs and obviate-oblong. Leaves are arranged on a rachis which is grooved and up to 10 cm in length. Conical glands are found between each two lowest pairs of leaflets. The leaflets are usually in three pairs, opposite, obviate and oblong with oblique base. Flowers are found in pairs in axils of leaves. The flowers bloom in August to September. Corolla consists of five petals in yellow or pale colour. The pods are long and slender, 4 sided sharp and pointed. Each pod has 20-30 seeds that are rhombohedra in shape. The plant *Senna obtusifolia* is extensively used in traditional

medicine in tropical and warm sub-tropical countries. The leaves of *Senna obtusifolia*, as well as roots and seeds are used in folk medicine in Asia (Ambasta, 2015 and Augustine *et al.*, 2017). It is believed to possess a laxative effect. Seeds of *Senna obtusifolia* are roasted and boiled in water to produce tea as folk medicine. Seeds of this plant yield a commercially valuable gum which is used as a food additive and as a thickener and “named for the Chinese Senna’s former placement in the genus *Cassia* (Augustine *et al.*, 2016) reported that the seed contain dry matter (92.40%), crude protein (27.4%) and crude fibre (16.8%), ether extract (3.8%) and nitrogen free extract (36.8%) He reported the presence of alkaloid, saponin, tannins, oxalate and phytate in various concentrations. The hydrogen cyanide concentration is reported to be 6.98mg/100g. The essential amino acids (EAA) of *S obtusifolia* include phenylalanine, lysine, valine, leucine, isoleucine, threonine, methionine, cystine and tyrosine while the non-essential amino acids are aspartic acid serine, glutamic acid, proline, glycine and alanine.

Materials and Methods

The sickie pod (*Senna obtusifolia*) seeds used for this study were collected manually during the dry season from the bush around Abubakar Barde campus of Adamawa State University, Mubi. The matured pods were allowed to dry after which the pods were thrashed and the seeds were used in the diet formulation.

Experimental Design

Two hundred and Forty (240) fish were randomly allotted to the four treatment diets in a randomized complete design and each treatment group was replicated three times with twenty fish per replicate.

Experimental diets

There were 4 treatment diets designated as T1,

T2, T3 and T4. Diet 1 was the control containing 0% *Senna obtusifolia* seed meal. T2,

T3 and T4 contained 10% RSOSM, 20% RSOSM and 30% RSOSM respectively.

Table 1: Ingredients Composition in the experimental diet

Ingrédients	Level of soybean meal replaced with RSOSM (%)			
	T1 (0%)	T2 (10%)	T3 (20%)	T4 (30%)
Maize	20.00	20.00	20.00	20.00
Ground cake	23.68	23.68	23.68	23.68
Soybean	24.64	22.18	19.71	14.78
RSOSM	0.00	2.63	4.93	9.86
Fish meal	29.55	29.55	29.55	29.55
Oil	0.99	0.99	0.99	0.99
Bone meal	0.71	0.71	0.71	0.71
Vitamin premix	0.49	0.49	0.49	0.49
Lysine	0.049	0.049	0.049	0.049
Methionine	0.0099	0.0099	0.0099	0.0099
Vitamin C	0.030	0.030	0.030	0.030
Salt	0.15	0.15	0.15	0.15
Total	100	100	100	100

RSOSM= Raw *Senna obtusifolia* Seed Meal

Experimental Fish management

Two hundred and forty (240) fingerlings of *C. gariepinus* were used in 180 days feeding trial. On arrival of the fish to the research location, they were kept for a period of one week to acclimatize and were fed commercial feed before they were put into the research ponds at 20 fish per pond according to the designated treatments that is Treatment 1, 2, 3 and 4.

Before the fish were allocated to the various treatment ponds, their initial weight and length were taken and were fed two times daily at 8:00 am and 4:00 pm at 5% body weight. The feeding regime was adjusted as the fish grow. Water quality parameters were monitored every week throughout the period of the research. The parameters that were monitored include Temperature, dissolved Oxygen, pH, Ammonia and Turbidity. Their

weight and length were measured every two weeks until the end of the research. Data on feed intake, body weight gain, feed conversion ratio, specific growth rate, protein efficiency ratio, and survival of *C. gariepinus* fed raw *S. obtusifolia* seed meal was calculated as below.

Mean weight gain

The fish fresh Mean Weight Gain (MWG) was calculated as the difference between the final mean weight of the fish at the end of the experiment and initial mean weight in grams (Augustine *et al.*, 2016).

Specific Growth Rate

This is the mean percentage increase in body weight per day over a given time interval (Ojelade *et al.*, 2022).

$$SGR = \frac{\text{weight at time of observation} - \text{initial weight} \times 100}{\text{Duration of experiment in days}} \quad (1)$$

Feed Conversion ratio (FCR)

The efficiency of feed is normally measured by the amount necessary to produce a unit weight of fish. This is called the feed conversion ratio (FRC). The FCR is the unit weight of feed given, divided by the live weight of the animal produced (kanem *et al.*, 2024).

$$FCR = \frac{\text{Total dry feed fed (g)}}{\text{Total wet weight gain (g)}} \quad (2)$$

Protein Efficiency Ratio (PER)

This is the efficiency with which the fish utilizes dietary protein and is defined by the Equation (Umar *et al.*, 2024),

$$PER = \frac{\text{weight gain (g)}}{\text{Protein intake (g)}} \quad (3)$$

Where weight gain (g) = Final body weight

Weight = initial body weight

Net protein utilization

This the measure of the proportion of dietary protein that is retained in the body after digestion and metabolism. It indicates how efficiently an animal uses the protein consumed for growth and maintenance.

$$NPU = \frac{\text{Nitrogen retained}}{\text{Nitrogen intake} \times 100} \quad (4)$$

Where: Nitrogen retained = intake – Nitrogen losses (mainly in feces and urine)

Nitrogen intake = Total nitrogen consumed from the diet.

Nutrient Digestibility

This is the measure of the absorption efficiency of the digested food and was determined according the procedure of AOAC (2004). Nutrient digestibility coefficient was calculated thus:

$$NDC\% = \frac{(\text{Nutrient in diet} \times \text{feed intake}) - (\text{Nutrient in faeces} \times \text{faecal output}) \times 100}{\text{Nutrient in diet} \times \text{feed intake}} \quad (5)$$

Statistical analysis

Data were analyzed using one- way analysis of variance (ANOVA) using statistica 8.0 (Statsoft, Inc, Oklahoma, and USA). Differences between treatments were compared by Tukey's level of significance tested at $p < 0.05$.

Results

The growth performance and feed utilization of *C. gariepinus* fed Raw *Senna obtusifolia* seed meal (RSOSM) is shown in (Table 2). *C. gariepinus* fed the control diets gained 279.02g which was the highest and 210.60 for the 30% being the lowest. There was no significant difference ($p < 0.05$) between diet 10% RSOSM and diet 20% RSOSM. The specific growth rate (SGR) showed that *C. gariepinus* fed control diet had the highest value of 1.15%/day *C. gariepinus* fed 30% RSOSM had 1.06%/day. Feed conversion ratio (FCR) values was from

1.34-2.06. There was no significant variation ($p > 0.05$) among FCR in *C. gariepinus* fed control diet 0% ,10% and 20% RSOSM, but fishes fed diet containing 30% RSOSM was significantly different ($p < 0.05$).

The protein efficiency ratio (PER) of 1.38 was recorded in *C. gariepinus* fed the control 0% and 10% diets and the lowest value of 1.20 was recorded in *C. gariepinus* fed with 30% RSOSM. Highest mean feed intake was recorded in the control 0% RSOSM (486.82g) followed by 20% RSOSM (486.46g) respectively. The lowest was recorded in diet with 30% RSOSM inclusion. There was significant variation ($p > 0.05$ between the diet with 30% RSOSM from the other diets. The protein intake of 204.86, 203.50 and 203.12 were observed in *C. gariepinus* fed with the control diet 0% RSOSM, 10% RSOSM and 20%

RSOSM respectively. They are significantly different when compared with *C. gariepinus* fed with 30% RSOSM. Survival rate was higher in fish fed with the control diet 0%

RSOSM, 10% RSOSM, 20% RSOSM, while the lowest was recorded in the fish fed with 30% RSOSM.

Table 2: Growth Performance and Feed Utilization of *C. gariepinus* Fed Graded Levels of raw *S.obtusifolia* Seed meal.

Parameters	0%	10%	20%	30%	SEM
Mean initial weight (g)	2.86 ^a	2.84 ^a	2.88 ^a	2.87 ^a	0.02
Mean final weight (g)	282.88 ^a	281.08 ^a	278.40 ^b	200.50 ^c	13.94
Mean weight gain (g)	279.02 ^a	276.24 ^a	276.78 ^a	210.60 ^b	13.92
SGR %/day	1.15 ^a	1.12 ^a	1.13 ^a	1.06 ^b	0.03
FCR	1.82 ^a	1.78 ^a	1.81 ^a	2.09 ^a	0.05
PER	1.38 ^a	1.38 ^a	1.34 ^a	1.20 ^a	0.04
NPU	91.64 ^a	91.83 ^a	91.62 ^a	76.60 ^b	2.28
Survival rate %	98.60 ^a	97.30 ^a	95.33 ^a	86.30 ^b	1.74
Mean feed intake (g)	486.82 ^a	483.50 ^a	486.46 ^a	71.60 ^a	18.64
Protein intake	204.86 ^a	203.12 ^a	203.50 ^a	187.60 ^a	7.84

Means on the same row with the same superscripts are not significantly different (p>0.05)

Discussion

The fact that fish fed with experimental diets gained weight shows that protein was converted to muscles, which is an indication of growth. The fingerlings consumed all the diets but feed intake was higher in groups that received diets with lowest levels (10% and 20%) of raw *S. obtusifolia* seed meal (RSOSM), this could be due to the presence of low molecular weight metabolites such as free amino acids (FAA) which act as feed attractants in fish rations. Which agrees with the report of (Erbas *et al.*, 2005). The lower feed intake in the groups fed the 30% may be due to poor palatability resulting from presence of anti-nutritional compounds such as tannin, saponins, hydrogen cyanide and non-starch polysaccharides as reported to have adverse effect on the growth performance of young fish as also reported by (Leenhouwers *et al.*, 2009; Aroyhun *et al.*, 2021 Umar *et al.*, 2024).

At the end of the experiment, there were no significant differences in growth performance and nutrient utilization between the 10% and those fed diets containing 20% raw ROSM. The control group had the highest mean weight gain (279.02 g), which is significantly higher than the groups that received (10%, 20% and 30%). The group that received 30% RSOSM had the lowest weight gain (210.60 g). The better growth performance recorded in the group containing 20% RSOSM might be due to the synergistic effect of combining two biological compounds to have a single and superior effect than when applied individually. This observation is in agreement with suggestions that combination of protein sources is better than single protein source in the diet of fish (Sogbesan *et al.*, 2005, Ogunji *et al.*, 2021; Sogbesan and Onimisi *et al.*, 2017).The poor growth performance at the

higher 30% inclusion of RSOSM may be due to the inability of the fish to cope with the detrimental effects of the anti-nutrients. Hence lower level of inclusion of RSOSM did not affect the growth and nutrient utilization of the fish. The reduced growth performance of fish fed higher inclusion level of RSOSM may be attributed to some factors such as reduced bioavailability of minerals, impaired protein digestibility caused by growth inhibiting compounds and possibly formation of phytic acid-protein complexes (Francis *et al.*, 2001, Tibbetts *et al.*, 2006 and Augustine *et al.*, 2016). Also, the poor growth performance of *C. gariepinus* fed 30% RSOSM may be attributed to inadequate protein utilization due to concentration of other anti-nutrients such as alkaloids, phenols and saponins (Bressani, 2000; Francis *et al.*, 2001; Adeniji *et al.*, 2007 and Onimisi *et al.*, 2017). Similarly, anti-nutrients such as saponins have also been reported to reduce pancreatic lipase activity, thus, delaying intestinal absorption of dietary fat (Putsztai, 2010; Saba *et al.*, 2023).

The inability of *C. gariepinus* to efficiently utilize high dietary inclusion level of RSOSM beyond 20% could be due to 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 (Onimisi *et al.*, 2017). *C. gariepinus* which is an omnivore but with higher tendency towards being a carnivore, the enzyme cellulase is expected in the gastro-intestine in enough quantity to effect digestion, but this is not the case in this study. In this study, the lowest feed conversion ratio FCR (1.78) value indicated better feed utilization by the fish, which may have accounted for better growth performance of *C. gariepinus* fed 10% RSOSM amongst other diets. August *et al.*, (2016), reported that the lower the FCR the better the feed utilization by the animal. This result obtained here supports the observation made by Shabbir *et al.* (2003),

Jabeen *et al.* (2004) and Adeyeye *et al.*, (2010) in related studies.

The protein efficiency ratio PER values in this study shows no significant differences in the treatments except the (30%) RSOSM. The higher PER value were obtained at the control and 0% and 10% RSOSM treatments indicating maximum utilization of nutrients in the diets in comparison with higher inclusion levels of RSOSM. (De silva and Anderson 1995 and Ojelade *et al.*, 2022), reported that protein efficiency ratio is a measure of how well the protein sources in a diet could provide the essential amino acids requirement of the fish fed. Protein efficiency ratio (PER) is also known to be regulated by the non-protein energy input of the diet and is a good measure of the protein-sparing effect of lipid and/or carbohydrate Onimisi *et al.*; (2020) and Babakiri *et al.*, 2020). When the RSOSM in diets inclusion level increases there is reduction in the NPU which suggest poor protein utilization, which may result from poor amino acid balance or the presence of anti-nutritional factors or low digestibility.

Digestibility was directly related to inclusion level of raw *Senna obtusifolia* seed meal. Crude protein digestibility of RSOSM at 10% inclusion in the diets was high (91.83%) in *C. gariepinus*, showing that RSOSM might be a good protein source for this species. Higher apparent digestibility coefficient for protein of RSOSM at 10% inclusion than other inclusions in the diets suggests that a greater amount of protein was available to the fish from the RSOSM at 10% inclusion. The minimum average weight gain (210.50g) and maximum average weight gain (279.02g) for all the treatments at the end of the six (6) months study are observed to be lower than 386g mean body weight of *C. gariepinus* reared in a flow through system in a (6) months culture period (Ingweye *et al.*, 2010).

Observation from this study showed that some fast growing in control (0%) inclusion level and other inclusion of *S. obtusifolia* seed meal had up to 650g, while the majority of the population weighed less than 300g. Those that were bigger will obviously dominate the smaller ones. This heterogeneity of growth and social dominance based on size has also been reported in other fish species such as *Heterobranchus longifilis* (Ewa-Oboho and Enyenihi, 2000) and *Clarias batrachus* (Onimisi *et al.*, 2017 and Dunham 2023). Similarly, lower mean weight gain of the cultured fish may also be due to inadequate acquisition of food by the smaller sized fish, as a result of variation in growth and social dominance of the larger sized fish and or inherent differences in feeding behaviour of the fish (Valente *et al.*, 2001; Martins *et al.*, 2006 and Onimisi *et al.*, 2021). Lower mean weights in this study, may also be related to possible effect of inbreeding brought about by repeated use of parent stock of fish of the same lineage (Dunham, *et al.*, 2011).

Conclusion

The findings from the evaluation of growth performance of African catfish (*Clarias gariepinus*) fed diets containing raw *Senna obtusifolia* seed meal has a potential as an alternative protein source in fish diets when properly processed. Raw *S. obtusifolia* seed meal generally results in reduced growth performance, poorer feed utilization, and lower protein efficiency due to the presence of anti-nutritional factors such as tannins, phytates, oxalates, saponins, and trypsin inhibitors. However, appropriate processing methods, including boiling, toasting, soaking and fermentation substantially reduce these anti-nutritional compounds, improve nutrient availability, and enhance feed intake and digestibility. If the raw *S. obtusifolia* seed meal is to be used, then the inclusion level of the raw seed meal should not exceed 20% as a replacement for soya bean meal in the diet of African catfish (*Clarias gariepinus*). Further

Studies should investigate higher inclusion levels, long term feeding and reproductive performance of fish fed processed *S. obtusifolia* seed meal.

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