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Full Length Research Paper

Nutritional evaluation of sunflower and sesame seed meal in *Clarias gariepinus*: An assessment by growth performance and nutrient utilization

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A 70-day feeding trial was conducted to assess the potential nutritive value of raw sunflower and sesame seed meal as dietary replacement of soybean meal in practical diets of *Clarias gariepinus*. All diets were prepared to be isonitrogenous, (40% c.p). Raw sunflower and sesame seed meal were used to replace soybean meal at a rate of 15, 30 and 45% respectively. The performance of the fish diets was compared to fish fed soybean meal based control diets containing 40% crude protein. Each treatment had three replicates using 15 catfish fingerling per tank with mean initial body weight of 3.28 ± 0.15 g. There was no significant difference (P > 0.05) in protein productive value, feed intake; specific growth rate, % weight gain and crude protein deposition between fish fed control diets and fish fed RSF_{15}, RSM_{15}, RSF_{30}, RSM_{30} diets. However, a significant difference (P < 0.05) was recorded between fish fed control diets and fish fed diets RSF_{45} and RSM_{45} using the above indices.

Key words: Sesame, sunflower, growth performance, nutrient utilization, *Clarias gariepinus.*

INTRODUCTION

Oilseed cake and legume seeds are considered suitable as alternative dietary protein sources for fish feed and are available in sub-Saharan Africa on a large scale (Fagbenro et al., 2003). Soybean meal (SBM) is one of the most nutritious of all plant protein sources (Lovell, 1988). Due of its high protein content, high digestibility and relatively well balanced amino acid profile, it is widely used as feed ingredient for many aquaculture species (Storebakken et al., 2000). It is currently the most commonly used plant protein source in fish feed (El-sayyed, 1999). Lim and Akiyama (1992) reported that soybean products have been used to replace a significant portion of fish meal in fish feed with nutritional, environmental and economic benefits. However, wider utilization and availability of this conventional source for fish feed is limited by increasing demand for human consumption and by other animal feed industries (Siddhuraju and Becker, 2001), hence the need to focus on using less expensive and readily available plant protein sources to replace soybean meal without reducing the nutritional quality of the feed becomes imperative (Barros et al., 2002).

Sunflower (*Helianthus annus* var. macrocarpus) and sesame seed (*Sesamum indicum*) are one of the important annual crops of the world grown for oil. They have nutritional quality comparable to other oilseed proteins including soybean and other conventional legumes (Robertson and Russel, 1972; Jackson et al., 1982; Hossain and Jauncey, 1989a, b; Sanz et al., 1994; Sintayehu et al., 1996) and their potential as dietary protein sources in animal feed is well recognized (Olvera-Novoa et al., 2002).

In fish feeding, sunflower had been tested with species such as *Oncorhynchus. mossambicus* (Jackson et al., 1982), *Oncorhynchus niloticus* (Sintayehu et al., 1996), *Oncorhynchus mykiss* (Tacon et al., 1984; Sanz et al., 1994; Stickney et al., 1996) *Clarias gariepinus*. (Akintayo et al., 2008); so also sesame seed cake had been tested with species such as *C. gariepinus* (Olukunle and Falaye, 1998), common carp (Hossain and Jauncey, 1989a, b; Hossain and Jauncey, 1990). Sesame seed is almost free of anti nutritional factors except high amount of

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Table 1. Proximate composition protein feed ingredients.

Ingredient	Fish meal	Soybean meal	Sunflower meal	Sesame meal	Corn meal
Moisture (%)	7.59	8.92	9.48	8.39	9.21
Crude protein (%)	69.76	42.81	40.01	42.21	8.89
Crude lipid (%)	8.82	18.56	20.28	15.92	1.49
Crude fibre (%)	-	5.63	12.80	5.48	29.78
Ash (%)	13.83	6.01	5.89	7.27	3.81
NFE (%)	-	18.07	11.54	20.73	46.82

Table 2. Gross composition (g/100 g dry matter) of experimental diets fed to *C. gariepinus* at varying replacement levels of raw samples of sunflower and sesame seed meal based diets.

Diet	CTR	RSF_{15}	RSF_{30}	RSF_{45}	RSM_{15}	RSM_{30}	RSM_{45}
Fish meal	27.24	27.24	27.24	27.24	27.24	27.24	27.24
Soybean meal	46.71	39.71	32.70	25.70	39.71	32.70	25.70
Raw samples	-	7.48	14.96	22.44	7.08	14.16	21.25
Corn meal	11.25	11.25	11.25	11.25	11.25	11.25	11.25
Fish oil	5.09	5.09	5.09	5.09	5.09	5.09	5.09
Vita/Min premix	5.00	5.00	5.00	5.00	5.00	5.00	5.00
Starch	4.76	4.22	3.76	3.28	4.63	4.26	4.17
Total	100	100	100	100	100	100	100

oxalate and phytic acid it contains (Narasinga, 1985; Johnson et al., 1979) which reduces the physiological value of calcium from the seed. Dehulling reduces the oxalic acid contents of the seed. The presence of trypsin inhibitor has been observed in sunflower seeds (Agrien and Lieden, 1968), however, the activity of the inhibitors is extremely low (Roy and Bhat, 1974). Their seeds are used for edible oil production and are presently available in Nigeria with their cost much below that of soybean meal: This therefore justifies investigating their use in fish feeding. This study evaluates the nutritive potential of mechanically extracted sunflower and sesame meal as alternative plant protein feed stuff to soybean meal (SBM) in dry practical diets formulated for the African Catfish, *C. gariepinus* fingerlings.

MATERIALS AND METHODS

Fish meal, SBM and other feedstuffs obtained from commercial sources in Nigeria were separately milled, screened to fine particle size (< 250 µm) and triplicate samples were analysed for proximate composition. Sunflower and sesame seedmeal were obtained from a farm in Kebbi State and ground in a hammer mill and the oil was removed from the seed meal using the pressure generated from locally made screw press. The cake thereafter was analysed for its proximate composition. Prior to formulation, the proximate composition of other protein feedstuff were analysed (AOAC, 1990). Based on the nutrient composition of the protein feedstuff (Table 1), a control diet and six test diets (40% crude protein, 12% crude lipid and 18.45 Mj/g gross energy) were formulated. The control diet (CTR) contained soybean meal, providing 50% of total protein. Three tests diets contained SFM protein at replacement levels of 15, 30 and 45% for the SBM to serve as RSF_{15}, RSF_{30} and RSF_{45} respectively. The other three contained sesame meal protein at the same replacement levels as above for the soybean meal to serve as test diets $RS\&M_{15}$, RSM_{30} and RSM_{45} respectively (Table 2). The feedstuffs were blended, moistened, steam pelleted and oven dried for 24 h.

C. gariepinus fingerlings were acclimated to experimental condition for 7 days prior to the feeding trial. Groups of 15 catfish fingerlings (3.38 ± 0.015 g) were stocked into aquaria comprising 60 litre-capacity rectangular plastic tanks. Each diet was fed to the catfish in triplicate tanks twice daily (09.00 h, 16.00 h) at 5% body weight for 70 days. Fish mortality was monitored daily, total fish weight in each tank was determined at two weeks intervals and the amount of diet was adjusted according to the new weight. Growth response and feed utilization indices were estimated. Water temperature and dissolved oxygen were measured using a combined digital YSI dissolved oxygen meter (YSI Model 57, Yellow Spring Ohio); pH was monitored weekly using pH meter (Mettler Toledo – 320, Jenway UK). Eight catfish and 6 catfish per treatment were respectively sacrificed at the beginning and end of the feeding trial respectively and analysed for their carcass composition (AOAC, 1990)

All data were subjected to one-way analysis of variance (ANOVA) test using SPSS 13.0 version. Where ANOVA revealed significant difference (PC 0.05), Duncan multiple – range test (Zar, 1996) was applied to characterize and quantity the differences between treatments.

RESULTS

Feed quality

Proximate composition of SBM sunflower, sesame, corn

Table 3. Proximate composition (g/100 g dry matter) of experimental diets fed to *C. gariepinus* at varying replacement levels of raw samples of sunflower and sesame seed meal based diets.

Composition	CTR	RSF_{15}	RSF_{30}	RSF_{45}	RSM_{15}	RSM_{30}	RSM_{45}
Moisture	9.17 ± 0.15^{b}	9.67 ± 0.72^{a}	9.36 ± 0.46^{ab}	9.57 ± 0.09^{ab}	9.39 ± 0.19^{ab}	9.43 ± 0.26^{ab}	$9.37 \pm 0 .15^{ab}$
Crude protein	40.60 ± 0.72	40.47 ± 0.46	40.28 ± 0.87	$40.18 \pm 0 .28$	40.48 ± 0.61	40.42 ± 0.36	$40.24 \pm 0 .38$
Crude lipid	11.74 ± 0.04^{c}	12.18 ± 0.12^{ab}	12.28 ± 0.05^{a}	12.32 ± 0.05^{a}	11.93 ± 0.12^{bc}	12.33 ± 0.06^{a}	12.46 ± 0.35^{a}
Crude fibre	5.84 ± 0.10^{b}	5.84 ± 0.08^{b}	6.44 ± 0.29^{a}	6.44 ± 0.28^{a}	$5.53 \pm .28^{b}$	5.90 ± 0.04^{b}	$5.87 \pm .22^{b}$
Ash	9.35 ± 0.10^{a}	8.71 ± 0.24^{bc}	8.80 ± 0.11^{bc}	9.04 ± 0.47^{ab}	8.91 ± 0.13^{abc}	8.81 ± 0.11^{bc}	8.51 ± 0.27^{c}
NFE	23.13 ± 0.74	23.42 ± 0.39	23.05 ± 0.75	$22.46 \pm 0 .13$	$23.76 \pm 0 .93$	22.92 ± 0.26	$23.55 \pm 0 .94$
Energy	4.31 ± 0.02^{d}	4.34 ± 0.01^{bc}	$4.34 \pm 0 .02$	4.32 ± 0.01^{cd}	4.35 ± 0.01^{ab}	4.35 ± 0.02^{b}	4.37 ± 0.01^{a}
AIA	0.62 ± 0.02	0.74 ± 0.02^{b}	0.74 ± 0.01^{b}	0.75 ± 0.03^{b}	$0.74 \pm 0 .03^{b}$	0.75 ± 0.03^{b}	0.74 ± 0.02^{b}

Figures in each row with different superscript are significantly different ($P < 0.05$) from each other.

meal and fish meal are presented in Table 1. Table 3 showed the proximate composition of the experimental diets fed to *C. gariepinus*, it revealed the diet to be isoproteic as there was no significant difference ($P > 0.05$) in the protein content of the diets.

Feed intake and general behaviours of clariid catfish

Fish in different dietary groups were actively fed on the experimental diets throughout the experiments. Highest mortality was recorded in tank fed diet RSF_{45} followed by RSM 45.

Growth performance and nutrient utilization

Table 4 presents growth performance and nutrient utilization of *C. gariepinus* fed with the experimental diets; % weight gain, specific growth rate protein production value and feed intake were not statistically different ($P < 0.05$) among the fish fed diets CTR, RSF_{15}, $RSF_{30,}$ RSM_{15} and $RSM_{30.}$ However, there was significant difference ($p < 0.05$) in the PER of control diets and other test diets. Fish fed diet RSF_{45} had the lowest value in each of these parameters followed by fish fed with RSM_{45}. The % WG, SGR, FCR, PER, PPV reduced with level of replacement of sunflower and sesame seed meal. Higher inclusion of sunflower and sesame and resulted in reduction of final body weight, SGR, FCR and PPV when compared to control diet, RSF_{15}, RSF_{30}, RSM_{15} and RSM_{30}. Fish fed diet RSF_{30} and RSF_{45} were not statistically different ($P > 0.05$) from each other using the same criteria as above. So also fish fed RSM_{30} and RSM_{45} were not significantly different ($P > 0.05$) from each other.

Whole body composition

Table 5 revealed the whole body composition of fish at the beginning and at the end of the experiment. There was significant difference ($P < 0.05$) between the initial and final body composition of fish used during the experiments with respect to moisture crude protein, crude lipid and ash content. For crude protein, the highest value was recorded for fish fed CTR followed by RSF_{15} and RSM_{15}; the lowest value was recorded for fish fed RSF_{45}. However, there was no significant difference ($P > 0.05$) in the protein content of the fish fed diet CTR and diets RSF_{15} and $RSM_{15.}$ A significant difference ($P < 0.05$) in the crude protein content occurred between the fish fed diet CTR and RSF_{15}, RSM_{30}, RSM_{45} and $RSF_{45.}$ However there was no significant difference ($P > 0.05$) in the protein contents of the fish fed RSM_{30}, RSM_{45} and $RSF_{45.}$ Fish fed diet RSF_{45} had no significant difference ($P > 0.05$) in the protein content when compared with initial body composition.

The highest crude lipid was recorded in the initial body composition of fish used for the experiment which was significantly different ($P < 0.05$) from that of the final body composition. There was no significant difference ($P > 0.05$) in lipid content of the fish fed diets RSM_{15}, RSF_{15}, RSM_{30} and RSF_{45}. However, there was significant difference (($P < 0.05$) in the lipid content of the fish fed these diets and diets RSM_{15} and RSM_{30}

The highest ash content was recorded in fish fed diet CTR, however, the lipid was not significant different ($P > 0.05$) from fish fed diet RSF_{45}. There was no significant difference between the fish fed diet RSF_{15}, RSF_{30}, RSM_{15}, RSM_{30} $RSM_{45.so}$; also no significant difference ($P > 0.05$) in ash content among the fish fed these diets and the initial ash content of the fish used.

DISCUSSION

The results showed that it is possible to replace soybean meal in *C. gariepinus* diet with raw sunflower and sesame seed meal with optimum growth response at a 30% replacement level. These results also show a reduction in growth and feeding conversion ratio as the raw plant protein increased beyond 30%. This growth reduction

Table 4. Growth performance and nutrients utilization of *C. gariepinus* fed raw sunflower and sesame meal based diets

Parameter	CTR	RSF_{15}	RSF_{30}	RSF_{45}	RSM_{15}	RSM_{30}	RSM_{45}
Initial weight(g)	30.4 ± 10.8^{a}	30.37 ± 0.05^{a}	30.09 ± 0.20^{c}	30.27 ± 0.09^{abc}	30.14 ± 00.04^{bc}	30.33 ± 0.05^{ab}	30.33 ± 0.10^{ab}
Final weight(g)	130.24 ± 10.31^{a}	100.64 ± 30.62^{ab}	80.81 ± 20.73^{bc}	50.40 ± 10.1^{c}	100.06 ± 0.98^{ab}	90.10 ± 0.83^{b}	70.13 ± 10.03^{bc}
Weight gain (g)	90.84 ±10.25 ^{a}	70.27 ± 30.59^{ab}	50.72 ± 20.92^{bc}	20.13 ± 10.04 ^{c}	60.92 ± 10.02^{ab}	50.76 ± 0.81^{bc}	30.79 ± 0.94^{bc}
% weight gain	2940.01±360.49^{a}	2150.31 ±1040.33^{ab}	1890.48 ±1090.95^{ab}	640.85 ±300.29^{c}	2200.90 ± 350.41^{ab}	1720.82 ± 230.58^{bc}	1130.62 ± 240.41^{bc}
Specific growth rate (%/day)	10.78 ± 0.40 ^{a}	10.46 ± 0.26^{ab}	10.46 ± 0.51^{ab}	0.71 ± 0.27^{c}	10.66 ± 0.16^{a}	10.43 ± 0.13^{ab}	10.08 ± 0.16^{bc}
Feed Intake (g)	120.32 ± 20.07^{ab}	140.00 ± 50.12^{a}	120.83 ± 40.25^{ab}	80.12 ± 10.09 ^{b}	130.09 ± 10.66^{ab}	120.80 ± 10.35^{ab}	100.42 ± 0.87^{ab}
Food conversion ratio	10.22 ± 0.09^{d}	10.31 ± 0.05^{cd}	10.45 ± 0.04^{bc}	10.52 ± 0.11^{a}	10.3 ± 0.06^{cd}	10.41 ± 0.14^{bc}	10.47 ±0.09^{ab}
Protein efficiency ratio	20.01 ± 0.14^{a}	10.26 ± 0.18^{b}	10.07 ± 0.18^{bc}	0.63 ± 0.22^{d}	10.32 ± 0.06^{b}	10.13 ± 0.16^{bc}	0.93 ± 0.15^{cd}
Protein productive value	520.51 ± 80.86^{a}	420.31 ± 130.09^{ab}	420.84 ± 120.21^{ab}	340.85 ± 40.34^{b}	430.25 ± 50.57^{ab}	420.32 ± 40.34^{ab}	480.95 ± 40.09^{ab}

Figures in each row with different superscript are significantly different ($P < 0.05$) from each other .

Table 5. Proximate composition (%) of carcass of *C. gariepinus* fed with varying replacement levels of raw samples of sunflower and sesame seed meal based diets

Composition	Initials	CTR	RSF_{15}	RSF_{30}	RSF_{45}	RSM_{15}	RSM_{30}	RSM_{45}
Moisture	76.57 ± 0.24^{a}	74.14 ± 0.52^{c}	75.46 ± 0.85^{b}	75.73 ± 0.12^{b}	75.71 ± 0 .40^{b}	75.55 ± 0.10b	76.09 ± 0.16^{ab}	76.39 ± 0.17^{a}
Crude protein	15.30 ± 0.21^{c}	17.85 ± 0.40^{a}	17.50 ± 0.11^{ab}	17.37 ± .08^{b}	16.43 ±0 .99^{c}	17.55 ± 0.42^{ab}	17.46 ± 0.01^{b}	17.34 ± 0.03^{b}
Crude lipid	5.21 ± 0.03^{a}	3.54 ± 0.26^{bc}	3.90. ± 0.06^{b}	3.61 ± 0.18^{bc}	3.71 ± 0..59^{bc}	3.55 ± 0.50^{bc}	3.25 ± 0.17^{c}	3.27 ± 0 .04^{c}
Ash	3.42 ± 0.50^{b}	4.47 ± 0.13^{b}	3.17 ± 0 .06^{b}	3.3 ± 0.23^{b}	3.66± 0.99^{ab}	3.33 ± 0.50^{b}	3.20 ± .03^{b}	3.10 ± 0.03^{b}

Figures in each row with different superscript are significantly different ($P < 0.05$) from each other.

observed at higher inclusion levels of SFM and SSM could be related not only to dietary amino acid profile but also the presence of anti-nutritional factors. Sesame seed is reported to contain high amount of oxalate and phytic acid (Narasinga, 1985; Johnson et al., 1979). Oxalic acid reduces the physiological availability of calcium from the seed. However dehulling reduces the oxalic acid contact of the seed (Salunkhe et al., 1991). The presence of trypsin inhibitor has been observed in sunflower seeds (Agren and Lieden, 1968). However, the activity of the inhibitor is extremely low. It was also reported that sunflower contain high amount of phytate (Smith, 1968). The bio availability of phosphorus for animal seems to depend on the level of phytate – splitting enzyme, phytase, in the intestinal tract. Monogastric animals have little or no phytate activity. Jackson et al. (1982) reported good growth in tilapia (*Sarotherodon mossambicus*) fed rations containing 35.2% sunflower meal replacing 50% of the fish meal protein Martinez (1984) reported that there was no loss in growth performance and diet utilization efficiency when rainbow trout (*Salmo gairdneri*) was fed diet containing 22 and 37.3% sunflower meal though he added L-methionine to that of 37.5% sunflower meal. Lower growth performance recorded for fish fed diet RSF_{45} might not unlikely be attributed to higher fiber content of sunflower cake. The result observed for fish fed diets CTR, RS_{15}, RSF_{30} RSM_{15} and RSM_{30} are similar to that of Stickney et al. (1996) who found that sunflower protein concentrate can replace 25% fish meal protein in rainbow trout diets. Sanz et al. (1994) observed better results when replacing 40% of the animal protein in rainbow trout with sunflower protein supplemented with EAA. Olukunle and Falaye 1998 also found out that 25% sesame seed cake incorporation supported weight gains in *C. gariepinus* similar to diets with 100% fish meal. Sesame seed meal was suggested by Tacon (1993) of its maximum level of inclusion in both omnivorous and herbivory fish species to be 35%. Hossain and Jauncey (1989) find that Bangladeshi variety of sesame oil seed meal can be included up to 25% in raw condition in the diet of *Cyprinus carpio* L. Hossain et al. (1992) substituted fish meal with sesame oilseed meal in the diets of catfish, *Heteropneustes fossilis* and reported promising result. Sesame usually contains anti-nutritional factor, phytic acid which either forms complex with protein or binds metal ions such as calcium and magnesium inhibiting the absorption of these important minerals (Gohl, 1981). However, it seems that at a lower level of inclusion, there is a physiological mechanism in fish that could compensate for the presence of these antinutrients 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-nutrient will be well pronounced. Francis et al. (2001) postulated that below the 5 mg/g level, most cultured fish are able to compensate the presence of trypsin inhibitors by increasing trypsin production. The lowered growth performance of fish fed high phytate containing sesame diets; can be attributed to various factors, namely reduced bioavailability of minerals, impaired protein digestibility caused by formation of phytic acid-protein complexes and depressed absorption of nutrients due to damage to pyloric cecal region of the intestine (Francis et al., 2001). Possible interactions between the various anti-nutrients could also remove their inhibitory action. Fish and Thompson (1991) reported that interaction between Tannins and Lectins removed the inhibitory action on amylase and interaction between Tannin and cyanogenic glycosides reduced the deleterious effects of the latter (Goldstein and Spencer, 1985). So also, Makkar et al. (1995) reported that complex formation between saponins and other antinutrients could lead to inactivation of the toxic effects of both the substance. Simultaneous consumption of saponin and tannin resulted in the loss of their individual toxicity to rat (Freeland et al., 1985). This is considered to be due to chemical reactions between them leading to formation of tannin-saponin complexes, inactivating the biological activity of both tannins and saponins. Tacon (1992, 1997) reported that sunflower contains protease inhibitors, arginase saponin, tannin and inhibitor, while sesame is reported to contain phytate. Hence lower level of inclusion of both sunflower and sesame meals did not affect the growth and nutrient utilization of fish. The performance of fish fed these meals was comparable to that of control. Comparable performance in growth, nutrient utilization and carcass crude protein deposition in *C. gariepinus* fed diets with SSM and SFM showed that these meals could be viable means of improving the cost of fish feeding.

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