Growth Performance and Nutrient Utilization of African Catfish (*Clarias gariepinus*) fingerlings Fed Diets With Differently Fermented Sesame Seed (*Sesame indicus*)

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ABSTRACT

An experiment was conducted to assess the Growth Response (GR) and Nutrient Utilization (NU) of differently processed fermented sesame seed (Sesame inducum) in the diets of Clarias gariepinus fingerlings. Three categories of Sesame Seeds (SS) (undehulled, dehulled and prepressed) were fermented at room temperature. Their phytic acid and tannin content were determined pre and post fermentation. Four diets were then formulated at 40%, Crude Protein level; Diet 1 (control with 0% SS inclusion); Diet 2, Undehulled Fermented SS 25% inclusioin); Diet 3 Dehulled fermented SS 25% (Dehulled fermented SS 25% inclusion), and diet 4 (Prepressed fermented SS 25% inclusion). These diets were fed to the fish at 3% of their body weight, two times daily, for 8 weeks. Each treatment had three (3) replicates, with 10 individual fish average initial weight of 1.62g. At the end of the experiment, fish carcass (whole body) were analysed for proximate composition. Result showed that fish fed Diet 1 which is the control had the best growth performance and nutrient utilization values while fish fed Diet 2 had the poorest values for these parameters. Among the differently fermented sesame seeds diets, Diet 4 had the best Growth Performance (GP) and Nutrient Utilization (NU) indices. The Specific Growth rate and the Food Conversion Ratio of Diet 1 were better and significantly ($p < 0.05$) different from the fermented sesame seed based diets while the protein intake of all the diets were not significantly ($P < 0.05$) different from each other. The dehulled and prepressed based diets showed appreciable increase in GP and NU values when compared to other sesame seed fermented based diets. This observation was adjudged to be due to the reduction of tannin content from 0.066% (initial) to 0.056, 0.035 and 0.024% respectively and for phytic acid from 0.248% (initial) to 0.236, 0.216 and 0.187% in undehulled, dehulled and Prepressed Sesame Seed (PSS) based diets respectively. Fermented (PSS) based diet performed significantly ($P < 0.05$) best when compared with other fermented sesame seed based diets, due to the fact that prepressing of the seed further reduced the concentration of the antinutritional factor.

Keywords: Fermented *Sesame seeds, Clarias gariepinus*, nutrient utilization.

INTRODUCTION

Replacement of fish meal with plant proteins challenge, the quality and concentration of proteins from plant sources which are generally lesser in their amino acid composition and palatability. However, plant protein is cheaper and more available than fish meal. This cost advantage of plant proteins encourage the processing of crops to improve their nutritive value to finfish (Drew *et al*., 2007). In order to reduce the high cost of fish feed without adversely affecting its quality, some animal by product, bone meal and some plant proteins are good alternatives to use as ingredients in fish diets (Ofojukwu and Kigbu, 2002). Plant oilseeds and their by-products usually constitute a major source of dietary protein within aqua feeds for warm water omnivorous, and herbivorous fish species.

Some of the factors which limit incorporation of these plant ingredients at high levels in fish feeds are low protein content, amino acid imbalance and presence of anti-nutritional factors (Wee, 1991). The presence of anti-nutritional factors had always been some of the reasons for the observed retarded growth (Olukunle, 1996). The inclusion of plant proteins have also been noted to suppress growth in fish species like carp (Hossain and Jauncey, 1990), blue catfish (Carl *et al*., 1992), tilapia (Shiau *et al*., 1987) and *C. gariepinus* (Balogun and Ologhobo, 1989).

Sesame Seed (SS) contains anti-nutritional factor such as phytic acid which either forms complex protein or binds with metal ions such as calcium and magnesium inhibiting the absorption of these important minerals (Gobi, 1981). Phytic acid in SS is the main anti-nutritional factor which has a great influence on mineral availability in teleost fish (Mukhopadhyay and Ray, 1999). However, reduction in toxicity of such feedstuffs may be reduced through processing (e.g. water extraction, heat treatment) which inactivate enzyme, (Hossain and Jauncey, 1989) significantly ($P < 0.05$) decrease in phytate content was observed when soybean was soaked in water for 24 hours at room temperature (Cheryan, 1980). Niha *et al*., (2009) summarized the advantages of fermenting feeds as reduction in the level of anti-nutrients within feed, improved bio-availability of minerals (e.g. P. Ca, Mg, & Cu), increase in protein content of lysine, histidine and methionine), and the breakdown of indigestible carbohydrates.

The fermentation resulted in complete elimination of phytic acid in sesame seed (Mukhopadhyay, 2001). It would therefore be economical and beneficial to fish farmer if fermented sesame seed meal is incorporated into the fish feeds without compromising growth and conversion efficiencies.

MATERIALS AND METHODS

Experimental diets preparation

Feed ingredients were purchased from a reputable feed mill Adom (Nig) Enterprises, Orogun, Ojo Road, Ibadan. The sesame seed (*Sesamum indicum*) which is the test ingredient of interest were purchased from Bodija market, Bodija, Ibadan.

Preparation of Dehulled Sesame Seed (DSS)

One kilogram of raw sesame seeds was washed, soaked and de-bittered in hot water for 7 mins (Olukunle, 1996). The soaked seeds were dehulled by pounding in a mortar. The hull was separated from the dehulled seeds through floatation.

Preparation of the Pre-pressed Sesame Seed Cake (PSS)

Four kilogram of the raw sesame seed was thoroughly cleaned before dehulling manually by pounding in mortal. The dehulled seed was dried to 4% moisture, and cooked with steam at 95^0C in a litre of water in an aluminium pot for 1 hour. The seed were allowed to cool and was milled in a grinding mill. The ground mash was steamed for another 30 mins to a temperature of – 98^0C and loaded into the screw press while hot and pre-processed through a central cage lined with cloth for 30 mins as described by Olukunle (1996).

Fermentation of the sesame seeds

Three categories of seeds were fermented at room temperature using the method described by Soetan and Oyewole (2009). The first category is the dehulled sesame seed, the second is the Prepressed sesame seed, while the third is the raw undehulled sesame seed. 500g of each category were placed in different containers and soaked with water for 3 days.

Fermentation diets

Four diets were fermented. All the diets were formulated to contain 40% crude protein as appropriate for fingerlings of *Clarias gariepinus* (Faturoti *et al*., 1986). Diet 1 as Control with no Sesame seed inclusion, while diets 2, 3 and 4 contained 25% inclusion level of Fermented Undehulled (FUSS), Fermented Dehulled SS (FDSS), and Fermented Prepressed SS (FPSS) respectively. Table 1 shows the ingredients composition of the experiment diets containing 40% crude protein.

Experimental procedures

Each treatment had three replicates, 10 fish per replicate, with a mean initial weight of 1.60g. The experiment was conducted for 8 weeks. Fish were acclimatized to the experimental system for 2 week before the start of the experiment. Fish were fed 3% of their body weight. At the start of the experiment fish were bulk weighed to the nearest 0.01g. For intermediate weighing, fish were bulk weighed every 7 days. The quantity of feed fed were adjusted after each weekly weighing and fed for the subsequent week.

Table 1: Ingredient composition of the experiment diets containing 40% crude protein

Ingredient	Diet 1	Diet 2	Diet 3	Diet 4
Fishmeal	15.28	16.06	16.11	16.14
Groundnut Cake Meal	30.56	32.11	32.20	32.30
Soyabean Meal	30.56	24.08	24.15	24.22
FUSS	-	8.03	-	-
FDSS	-	-	8.03	-
FPSS	-	-	-	8.03
Maize	15.08	12.17	11.99	11.82
Wheat Offal	5.02	4.05	4.00	3.94
Vitamin premix	1.00	1.00	1.00	1.00
Mineral premix	1.00	1.00	1.00	1.00
Palm Oil	1.00	1.00	1.00	1.00
Salt	0.5	0.5	0.5	0.5
Total	**100.00**	**100.00**	**99.98**	**99.95**

Note: FUSS = Fermented Undehulled Sesame Seed, FDSS = Fermented Dehulled Sessame Seed, FPSS = Fermented Prepressed Sesame Seed.

RESULTS

The result of the proximate analysis of the raw and the differently fermented processed sesame seed is presented in Table 2. The lowest crude protein was observed in FPSS while highest was recorded in the raw seeds. The values of fat range from 48.96% FUSS to 43.77% in FPSS. Crude fibre ranged from 11.10% RAW to 7.0% in FDSS, while Moisture content ranged from 9.62 in FPSS to 5.33% in FUSS. Table 3 shows the details of the proximate composition of the experimental diets. The ether extracts varied from 5.67% to 5.42% with the highest in diet 4 and the lowest in diet 1. The values of the crude protein ranged from 44.62% in diet 3 to 43.89% in diet 2. Crude fibre ranged between 3.40% and 3.17% in diets 2 and 3 respectively. Ash varied between 13.5% and 14%. The result of the proximate composition of the fish before and after the experiment was presented in Table 4. Crude protein content of the fish before the experiment was 42.08%. At the end of the trials, fish samples fed diet 1 (0% sesame inclusion), has the highest crude protein content of 62.73% and lowest in diet 2 (FUSS inclusion) of 49.82%. A comparison of the proximate composition of experimental fish at the beginning and at the end of the experiment showed an increase in crude protein, fat content, crude fiber, and ash content. However, there was a decrease in nitrogen free extractives of all the treatments. Table 5 shows the parameters observed and recorded in the growth performance and nutrients utilization of *Clarias gariepinus* fingerlings fed with differently fermented sesame seeds based diets and the control. The weekly changes were observed and recorded. Treatment 1 (0% Sesame inclusion) with initial weight of 1.63g and final weight of 6.43g with the highest mean weight gain of 6.43g had the highest mean weight gain of 0.66. This was closely followed by treatment 4 (0.4%), treatment 3 (0.3%) in that order. The highest specific growth rate was obtained in fish fed diet 1 (0% Sesame inclusion) with the value of 2.57 and lowest in treatment 2 (1.65). There were significant differences in the treatments (P > 0.05). The Feed Conversion Ratio (FCR) recorded for fish fed diet 3 (2.67) was higher than those of diet 2 (2.50), 4 (1.78), and 1 (1.19). This high FCR may be due to the fact that catfish being an omnivore was able to utilize the FUSS at inclusion level of 25%. The Gross Feed Conversion Efficiency was highest in treatment 1 (30.51) followed by treatment 4 (18.89) then 3 (15.31) and 2 (13.89). The reason for this observation may be attributed to the inability of *Clarias gariepinus* to efficiently utilize the plant protein contained in sesame based diets. The Protein Efficiency Ratio recorded for fish fed diet 1 (0.69) was highest and closely followed by diet 4 (0.43), then diet 3 (0.35) and diet 2 (0.32). The disparity in the level of PER recorded could be attributed to the quality of protein in the diets because of the differently processed sesame seed inclusion. Gross Food Conversion Efficiency (GCFE) ranges from 30.51 in the treatment 1 to 13.89 in treatment 2. Protein intake was highest in treatment 3 (8.90) and lowest in treatment 4 (7.91). There was no significance difference from the means (P > 0.05) between treatments 1, 2, 3, and 4. The protein efficiency ratio (PER) ranged from 0.69 in diet 1 to 0.32 in diets 2. However, there was no significant deviation from the means (P < 0.05) in treatment 4 and treatments 2 and 3, however treatment 1 was significantly (P 0.05) from the other sesame seed based diets.

Table 2: Proximate composition of the raw and differently fermented Sesame seeds

Parameters (%)	RAW	FUSS	FDSS	FPSS
Crude Protein	23.92	23.72	22.84	21.77
Fat	48.25	48.96	46.93	43.77
Crude fibre	11.10	10.30	7.0	8.70
Ash	6.20	5.70	4.4	4.95
Moisture	6.69	5.33	5.71	9.62
NFE	3.84	5.99	13.12	11.98
Tannin	0.066	0.056	0.035	0.024
Phytic acid	0.248	0.236	0.216	0.187 .

N/B: FUSS = Fermented Undehulled Sesame Seed, FDSS = Fermented Dehulled Sessame Seed, FPSS = Fermented Prepressed Sesame Seed.

Table 3: Proximate Composition of experimental diets (% Dry Weight)

Parameters (%)	1	2	3	4
Crude Protein	44.32	43.89	44.62	44.04
Fat	5.42	5.56	5.48	5.67
Crude fibre	3.25	3.17	3.40	3.33
Ash	15.00	15.16	14.86	15.24
Moisture	5.79	5.47	5.22	5.54
NFE	26.22	26.75	26.42	26.18

Table 4: Carcass Composition of experimental Fish before and after the feeding trials

Parameters (%)	Initial	1	2	3	4
Crude Protein	42.06	63.48	49.82	61.93	62.73
Fat	4.71	8.94	6.31	9.80	8.73
Crude fibre	1.00	1.10	1.27	1.16	1.12
Ash	9.14	13.28	11.1	13.07	12.97
Moisture	3.82	2.89	3.78	3.44	3.33
NFE	39.27	10.31	27.65	10.60	11.12

Table 5: Growth Performance and Nutrients Utilization of *Clarias gariepinus* fed with differently fermented sesame seed (*Sesame indicum*)

PARAMETER	1	2	3	4	Mean	SE±
Experiment periods (days)	56	56	56	56		
Number of fish stocked 10	10	10	10			
Mortality (%)	7	23	20	10		
Survive rate (%)	93	77	80	90		
Initial weight (g)	1.63^{a}	1.64^{a}	1.62	1.63^{a}	1.63	0.01
Final weight (g)	6.43^{c}	3.80^{b}	4.35^{a}	4.83^{a}	4.85	0.92
Mean weight gain	0.66^{c}	0.31^{a}	0.39^{a}	0.48^{b}	0.46	0.11
Mean weight gain per Day (g/day)	0.09^{c}	0.04^{b}	0.06^{ab}	0.07^{ac}	0.07	0.02
Total % weight gain (g)	333.94^{a}	153.54^{b}	189.06^{c}	232.87^{d}	224.86	56.8
Specific Growth rate	2.57^{d}	1.65^{b}	1.81^{c}	2.14^{a}	2.04	0.31
Feed Intake	2.61^{c}	1.52^{b}	1.87^{b}	2.09^{b}	2.02	0.11
Food Conversion Ratio	1.19^{a}	2.50^{b}	2.67^{c}	1.78^{d}	2.04	0.21
Gross Food Conversion Efficiency	30.51^{b}	13.89^{a}	15.31^{a}	18.89^{a}	19.65	4.35
Protein Intake	7.91^{a}	8.04^{a}	8.90^{a}	8.83^{a}	8.42	0.53
Protein Efficiency Ratio	0.69^{a}	0.32^{b}	0.35^{b}	0.43^{c}	0.45	0.14

Note: Values in the same row showing the same superscript are not significantly (P > 0.05) different.

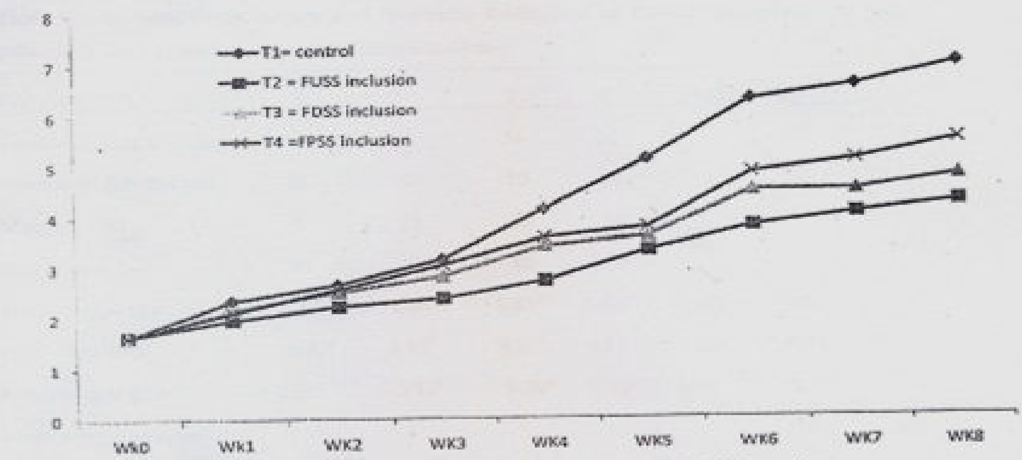

Figure 1: feed consumption of *Clarias gariepinus* fingerlings fed with different diets.

DISCUSSION

Removal of undesirable composition is essential for the enhancement and effective utilization of plant protein in animal feeds. Sesame seeds used for diet fermentation in this study were subjected to different types of processing methods to remove the detrimental components such as antinutritional factors. The anti-nutritional factor, tannin from sesame seeds was reduced in concentration from 0.006% to 0.056. 0.035, and 0.024% in FUSS, FDSS and FPSS respectively. Fermentation of the different processed raw sesame seeds included the Undehulled, Dehulled and Prepressed which resulted in the reduction of the phytic acid level from 0.248 (Raw) to 0.236, 0.216 and 0.187 respectively in the processed.

The carcass composition of experimental fish before and after the experiment showed generally, an increase in body protein, crude fat and ash content of fish at the end of the experiment. This study further revealed that experimental diets significantly influenced protein carcass composition. Fish fed diet 1 (0% sesame seed inclusion) had the highest protein content of 63.48% followed by those fed diet 4 (62.73%), diet 3 (61.93%) and diet 2 (49.82%). This is a reflection of the quality of protein in the diet in terms of amino acid composition and its availability to the fish as a result of the presence of the antinutritional factors.

Diet 1 with (0% sesame seed) had the optimum performance in terms of percentage weight gain, specific growth rate, food conversion and protein efficiency ratio, compared to FUSS, FDSS and FPSS diets when fed to *C. gariepinus* fingerlings. The inclusion of plant proteins has been noted to suppress growth in fish species like *C. gariepinus* (Balogun and Ologhobo, 1989 and Olukunle, 1996). Fish-fed diets containing FUSS exhibited low feed acceptance. The reason for low acceptance and consumption results from poor flavour and palatability of raw sesame seed meal (Olukunle, 1996). In addition, the poor performance of fish fed these diets was due to increasing level of anti-nutritional factor arising from the 25% inclusion level of the differently fermented sesame seeds. This is corroborated by the significant decrease and increase in fish SGR and FCR respectively observed in this experiment.

CONCLUSION AND RECOMMENDATION

The Growth Performance (GP) and Nutrient Unitilization (NU) of *C. gariepinus* fed with differently fermented sesame seeds were established in this study. Fermentation process using the local, traditional method was adopted to reduce the antinutritional factor present in the differently treated sesame seeds. The results of the fermentation process showed a significant decrease in tannin and phytic acid content in the treated seeds. It was evident at the end of 8 weeks feeding trial that inclusion of fermented undehulled sesame seeds (FUSS) caused poor GP and NU in the fish fed. However, the fermentation of further processed sesame seeds (Dehulled and Prepressed (FPSS) performed better when compared with other fermented seeds, due to the fact that pre-pressing of the seed further reduced the concentration of the anti-nutritional factors present in these diets.

This study also provides basis for further research into a better processing method of removing the antinutritional factors by fermentation. Besides, the digestibility of the differently fermented seeds by omnivore like *Clarias gariepinus* should also be investigated while histopathology, serum biochemistry and haematology analyses should be carried out to investigate the assimilation of the nutrients contained in the fermented sesame seed. And also more feeding trial needs to be carried out to determine the optimum inclusion level of the Fermented Prepressed Sesame seeds.

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