MERIT RESEARCH JOURNALS
www.meritresearchjournals.org

Merit Research Journal of Microbiology and Biological Sciences (ISSN: 2408-7076) Vol. 9(3) pp. 021-031, May, 2021
Available online http://www.meritresearchjournals.org/mbs/index.htm

DOI: 10.5281/zenodo.5067964

Original Research Article

Effect of Raw and Toasted Soya Beans Diets on Growth of *Clarias gariepinus*

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Abstract

Comparing the effects of raw, toasted and amino acid enriched diets on the growth and nutrient utilization of Clarias gariepinus allocated in to eight different treatments with two replicates each with 10 Juveniles in 16 aquaria tanks. Eight different diets containing 40% crude protein each were compounded and fed to the fish at 5% body weight for 16 weeks. Diet T_1 was the control while diet T_2 was the conventional diet (coppens) purchased commercially. Diet T_5 which had a 50% toasted soybean inclusion and contained 50g yellow maize, 20g toasted .soybean. 10g fish meal, 13g Groundnut cake, 2.5g vegetable oil. 2.0g starch and 0.5g vegetable oil had the greatest growth rate which were significant higher ($P<0.05$) than those fish fed on other diets. Diet T_7 (100% raw soybean with methionine and lysine) containing 50g yellow maize 30g raw soybean. 13g groundnut cake. 2.5g vegetable oil. 2,0g starch and 0.5g vegetable oil followed diet T_5. Average weight gain, specific growth rate (SGR), Average daily weights gain, protein efficiency ratio (PER), feed conversion ratio (FCR) and Net Nitrogen retention were significantly higher ($P<0.05$) in fish fed diet T_5 and diet T_7 in the experiment. The results showed that fish fed toasted soybean based diet had the highest average weight gain (A.V/.G) of 432.55g, specific growth rate (SCR) of 3.38%/day and food conversion ration 'FCR} of 5.78. The juveniles fed raw soybean gave the least growth performance. It could be concluded in practice that toasted soybean based diet is optimal for growth of C. gariepinus juveniles, mortality rates recorded during the dietary trial ranged between 30% in fish fed diet T_s to 100% in fish fed diets $T_,$. 7_3. T_4, T_5 and T_6. The results were discussed in relation to fish feed production and its implication for fish culture intensification in Nigeria.

Keywords: Raw Toasted soya beans, growth, Clarias gariepinus, Feed ingredients

INTRODUCTION

Aquaculture like other agricultural sectors has potential to contribute significant!) to the national economy. It has been recognized in most developing countries as a major avenue for improving the diet of the people and generating employment opportunity for rural dwellers. The practice is still at the subsistence level by private individual with very few achievements at commercial level and at pilot scheme by some government agencies despite (he 40yeras old of pond culture in Nigeria (Okoye, 1986). Nigeria like other developing countries is having as challenge, acute protein shortage as the daily intake falls far short of the recommended minimum (Olayide *et* a/., *1972).*

Fish farming is increasing rapidly in Nigeria today and

if this development is sustained, then aquaculture will create a great impact on the economy and provide protein as food for its populace fish is noted for high quality protein and its protein content can be high as 60% on dry matter basis. Lack of good quality feed for economic production of fish in Nigeria, adversely affects growth rate, survival rate, and total harvest. The deficiency of protein in human diets in Nigeria has been responsible for incidence of kwashiorkor in infants, general weakness of the human body which predisposes man to diseases. This has been so critical that Nigeria is now ranked among the group of nations characterized by deficiency of animal protein in their diets.

Soya bean (Glycine Max) is a leguminous crop that produces seeds containing 1400 to 2000kg/hectare. It is cultivate in many areas of the world from the tropics to the temperate regions. Soya beans also contain high nutritional value compared to other oil seed species. Its crude protein level ranges between. 44-50%, Nitrogen free extract (N F E) is 40%, Lipid is 15-20%and it is equal higher in essential ammo acid, fatly acids, vitamins and mineral (Dabrowski and Kozak. 1989). Fish meal has been the most used protein source in the production of feeds but due to its high cost and demand it becomes necessary to device different method on how best soya beans seeds can be processed to ensure high yield and good harvest in fish production.

Optimum protein level in fish diet is dependent on many factors. These include protein quality, energy source, physiological factors and economics. Dietary protein requirement for fish has been investigated by many workers (Ogino and Chen, (1973) and Faturoti *el al,* (1986) reported that fish has a high dietary protein requirement. The catfish, *Clarias gariepinus* has a protein requirement of 30-36% estimated protein requirement of fingerlings of *C. gariepinus* as between 31-34%and of brood stock at 40% Ayinla, (1998). Protein requirement of fish tends to change with the size of fish, water temperature and the balance of individual nutrient components in a given ratio. It is higher during the initial feeding stage of fry and then decrease in the age of the fish. A major problem in the development of complete artificial diets for aquaculture is the higher protein requirement of many species of fish, since it contributes a higher proportion of feed cost. Principally, quality of protein is dependent on its amino acid composition. Deficiency in any of the amino acid could cause retarded growth and loss of appetite. For optimum growth and development, total essential amino acid content of the feed ingredient must be balance to allow for maximum amount of amino acid in the diet.

Among cultural fish in Nigeria freshwater are tilapia species, *Cyprinus carpio* (Common Carp], *Clarias* species, *Heterotis niloticus* and *Heterobrancus bidosariis* (Okoye, 1996) These species of fish are been produced on small scale.

Clarias gariepimta is of paramount importance to Nigeria as it is to other western world because of its rapid growth rate and high prolific-ness.

Objectives of the Study

The main aim of this study is to determine the effect of soyabean inclusion in practical diets on the growth performance and nutrient utilization of *Clarias gariepinus.* In order to achieve this, the following specific objectives arc determined:

i. To investigate the effect of diets totally substituted with variously processed soyabean on the growth of Juvenile C *gariepinus*

II. To investigate the effect of soyabean meal on the carcass composition of *Clarias gariepinus.*

iii. To determine the cost analysis of the experiment diet.

MATERIALS AND METHODS

Feed ingredients

Ingredients used for the diet formulations are yellow maize, groundnut cakes, soybean, fishmeal (produced from whole small *Alestes)* sourced from brigade market Kano; fishmeal was dried in an oven set at 60"C for 24 hours milled using a small grinder and stored in the freezer until required other ingredients include palm oil, vitamin premix which was brought from the Phed Agrovet stores in Kano town.

Processing of Soyabean

Raw soyabean was toasted at 100^0C for 10 minutes (Eyo, 1991) in an electronic oven; it was later grinded in a milling machine to a fine texture and sieve with 0.1mm mesh opening.

Processing of other Feed Ingredients

Groundnut cake was purchased from the local oil milling industry. Maize was prepared by grinding the maize into a fine powder with the hammer mill, while the vitamin mineral premix was purchased commercially from the shop in town.

Feed Formulation

The weighed ingredients were later mixed with starch of cassava origin and water as binder. Mixing of ingredients and premixes was-done with the hands in a

plastic bowl. The dough was pelleted using a screw type pelietizer to 2mm diameter sizes, the pelleted collected were air dried for 2 days and stored in plastic containers sample were taken for analysis.

Fingerling Procurement

C/arias gariepimts Juveniles were purchased from Baeauda fish farm located 60km Southeast of Kano town; they were transported in a 100 litre plastic can (cut at the top to provide aeration) which were later placed into two plastic tanks for 48 hours before stocking into experimental tanks.

The juveniles were acclimatized for forty-Eight hours (48 hours) before feeding commenced. They were fed twice daily at 5% (percent) of their body weight (Alatise, 2004) for sixteen weeks.

Feeding Regime

The experimental diets were offered to the fish in the experimental tanks twice daily at 8 am and 5 pm. feeding rate to be adopted was 5% body weight per day divided into two equal portions; usually, the fish ate almost all the feed offered to them. The left over feed was removed the next day before another feed was given.

The feeding trials will last for 120 days with the feeding trial commencing from 2nd January 2018 to 30th April 2018. The fish were fed on experimental diets compounded at 40% crude protein (Eyo, 1991) with varying levels of processed soybean. The diet with zero level soybean inclusion served as the control while other diets contained 50% and 100% dietary inclusion of soyabean,

The control diet was compounded with 30g of fishmeal, 50g of yellow maize, 13g of Groundnut cake, 2.0g of Vit. Premix 2.0g of starch, 0.5g salt x 2.5g of vegetable oil; the ingredients were poured into a large plastic and it was properly mixed, water is added before pelletizing.

Fish Holding Facility and Husbandry Protocol

Rectangular plastic aquarium tanks 30cm x 15cm were used during the experimental regime. They were filled with water sourced from the borehole at the Department of Biological Sciences; water was poured up to 75% of the capacity of the aquarium and left for 24 hours before socking with fish.

Daily water temperature, pH was measured, oxygen level was measured weekly, complete water change was effected daily to ensure good water quality for fish growth and dietary utilization.

The daily water temperature was measured using mercury in glass thermometer; it was inserted in the water and then the reading was taken to ascertain the water temperature. The pH was measured using a pH metre model 3150 the metre was standardized and then the was electrode was submerged inside the water samples and the reading was taken.

Clarias gariepinus of initial weight ranging from 7 - 8gm were stocked 10 per tank in duplicate. Fish were weighed out of the water in a Basket using the weight balance available at the department's aquarium; each experiment was conducted for 16 weeks.

Proximate composition Analysis

The following laboratory experiment were Carried out on the feeds

Content Estimation

Moisture content was determined by drying the samples in an oven. The samples were dried in the oven for twenty minutes to evaporate the moisture in the Petri-dish and place in the dessicator to cool. After cooling, weight of Petri-dishes were recorded, 5gm of the sample was placed in to the Petri-dishes. The weight of the dish together with the sample were dried for 6 hours at a temperature of 70^{0}C. The Petri-dishes removed, cooled in the dessicator and reweighed until a constant weigh was-obtain (AOAC, 1975).

Ash Content Estimation

The ash content was determined by burning each of the samples in the muffle furnace at a temperature of 550°C for three hours, the residue estimated as percentage ash content. Thus residue was then weighed and the ash content of the feed (g ash / kg feed Dm) is calculated from:

$$\text{Ash content of the feed} = \frac{\text{Weight of ash} \times 100}{\text{Weight of sample feed}}$$

(FAO, 2004)

Crude Fibre Estimation (C.F.E)

This-was determined by subjecting the residual feed from ether extraction (lipids) to successive treatments with boiling acid and alkali of defined concentration. 2g of the dried free sample was weighed into a 600ml beaker, 200 ml of hot sulphuric acid was, added and heated to boiling within 1 minute. After boiling for 30 minutes, the mixture

was filtered through porous crucible and wash with boiling water 1% hydrochloric acid and then again with boiling water. It was then washed twice with alcohol, dry overnight at 100°C cool and weigh. Ash at 500°C for 3 hours, cool and weighed. The weight of fibre was calculated by the difference in weights.

Crude fibre (% of fat - free Dm)

$$\frac{\text{(Weight of crucible + dried residue) - (weight crucible + ashed residue) X 100}}{\text{(weight of sample)}}$$

(FAO, 1987)

Lipid Content Analysis

Lipid extraction was by soyhlet extraction method, using petroleum ether on the dry sample gotten from the moisture free sample. The solvent was removed by evaporation and the residue of fat wag-weighed.

Dry residue from the determination of moisture was transferred into extraction thimbles. The thimbles were placed in the extraction and a weighed flask containing 100ml petroleum ether was connected. The extractor was connected to a reflux condenser, and was extracted under a reflux on a steam bath for 8 hours. The petroleum ether was evaporated up to the extent of drying. The dry flask containing the fat residue was put in an air oven for 40 minutes, cooled in a dessicator (AOAC, 1975).

Percentage lipid content was calculated as:

$$\text{Extracted fat \% - } \frac{W_3 - W_2}{W_1} \times \frac{100}{I}$$

W_1 = Weight (g) of sample before drying
W_2 = Weight (g) of flask without fat
W_3 = Weight (g) of flask with fat

Crude Protein Estimation

Protein content was determined using the microkjeldahl method (AOAC, 1975), sulphuric acid was used 10 digest the samples with copper used as a catalysts. This was done to convert organic nitrogen into ammonia ions. Sodium hydroxide was added and the liberated ammonia was distilled in the boric acid solution. Determination of ammonia absorbed in boric acid was done by titrating the distillate with hydrochonic acid 0.5gm of copper sulphate and 15gm of potassium were put in kjedahl flask, 2g of the sample was weighed using filter paper, this was also added into the acid in the kjeldahl flask, 25ml of concentrated sulphuric acid was added to the content of the flask and mixed gently.

Nitrogen Free Extract (NFE)

This was obtained as a difference between hundred and the sum of percentage Ash, lipid, crude protein, crude fibre and moisture.

Bacteriological Analysis

One gram (lg) of the feed sample was added to 25ml of buffered peptone water and the mixture was weighed aseptically into a sterile jar. The feed was blended and the food homogcnatc was mixed by shaking and 1.0ml was pippetted into a tube containing 9ml of buffered peptone water. This was mixed with a fresh pippete. This was repeated using a 3^{rd}, 4^{th}, 5^{th} tube.

One milliliter (1.0ml) of the food homogenate, of each dilution of the homogenate will be pipetted into each of the appropriately marked dishes. 10 - 15mi of plate count agar (kept at $45^0C \pm 1^0C$ in a water bath) was poured into each Fein-dish within 15mins of the time of original dilution.

The sample dilution and agar medium was mixed thoroughly and allowed to solidify. The prepare dishes was inverted and incubated at 30 ± 1^0C for 72 hours. After incubation, all the colonies on the dishes containing 30 - 300 colonies were counted and the result recorded per dilution (FAO, 1979).

Water Quality Parameters

The water temperature of the experimental tanks were taken by a mercury - in - glass thermometer and the mean temperature during the experimental period was. 25. 30^0C.

Hydrogen Ion Concentration **(pH)**

The pH values were read off a pH meter (model 3150 Jenway) after standardizing the meter, the meter electrode was. Submerged inside the water samples and the reading taken.

Dissolved Oxygen

D.O and the water conductivity were- measured weekly using an oxygen metre of model HANNA HI 9146 OXYGEN BENCHMETER.

Evaluation of Growth Performance

Nutrient utilization of the fish was determined.

Weight Gain

This was calculated from the difference between the final weight of the test fish and the initial weight
Weight gain = Final Weight - Initial Weight.

Percentage Weight Gain

This was estimated from the relationship between the increment in weight (i.e. weight gain) and the protein consumed (Zeitoun *el al.,* 1973).

$$\frac{\text{Gain in Weight of Fish}}{\text{Protein consumed}}$$

Specific Growth Rate

Specific growth rate is the actual weight gain during the fish life or during the feeding trial. It has the following formular according to Brown (1957).

$$SGR = 100 \times \frac{(\ln V_f \ln M_1)}{t}$$

Where, W_f = Final average weight at the end of the experiment
W_1 = Initial average weight at the beginning of experiment
T = Culture period in days.

Feed Conversion Ratio

A feed conversion ratio is defined as measure of the degree of gross utilization of food for growth in fish.
Feed conversion ratio is the quantity of feed required to produce a given weight offish.

$$FCR = \frac{\text{Dry weight of diet (g)}}{\text{Total wet weight gain } by \text{ fish (g)}}$$

(FAO, 2004)

Protein Intake

This was calculated using the formular: protein intake = feed consumed x. % crude protein content of feed.

Feed Intake

This was estimated by subtracting weight of the feed remnants siphoned from each tank from the feed fed to the fishes.

Net Nitrogen Retention

This was expressed as percentage Net Nitrogen retention.

$$\frac{\text{Initial body protein}}{\text{Final body protein}} \times 100$$

Statistical Analysis

The Biological data arising from the treatment were subjected to descriptive analysis and differences in means were determined using the least significant correlation. All statistical analysis, the sum, the mean, standard deviation and the range (Minimum -- Maximum) were done using the software SPSS version 15.1.

RESULTS

Proximate Composition of the Experiment Diets

The proximate composition of the experimental diet is shown in Table 3.

Diets T_1 and T_2 have the highest crude proteins; they are the control and conventional feeds, followed by T_5 and T_7 which are 50% inclusion of toasted soybean and 100% inclusion of Raw soybean with methionine and lysine. Diet T_4, with 100% Raw soybean inclusion has the least crude protein.

The lipids content is highest in Diet T_2, while Diet T_5 has equal amount of lipid content with the control diet T_1,. Diets T_7 and T_8 have equal lipid contents.

Diet T_8 has the highest Ash percentage 24.78 while diets T_3 and T_4 have the lowest percentage Ash. The highest crude fibre content of 9.00 percent was obtained in diet T_3 and T_4 while the least 7.00 percent in T_4 and T_7.

The moisture content is highest in diet T_2 (9.99) while diets T_4 and T_8 have the lowest moisture content of 8.80 and 8.40 percent each.

Growth Performance of the Experimental Fish Fed with Different Levels of Soybean Inclusions

The growth response of *Glorias gariepinus* juveniles fed with the different diets is shown in table 4. The result showed that diet T_2 (conventional diet) had the highest Average weight gain - This was followed closely by diet T_5 (50% Toasted Soybean) and diet T_7 and T_6. There is no significant different ($P>0.05$) between diet T_2 and T_5 in weight gain while diet T_6 and T_7 are significantly different from diets T_2 and T_5. Based on the average weight gain

diet T_5 with 50% Toasted soybean performed better and diets T_7 and T_6 (100% Raw soybean and 100% toasted soybean) followed closely.

Percentage Weight Gain

Diet T_2 gave the highest percentage weight gain of 470.2% while diet T_5 with 432.55% ranked second. The poorest percentage weight gain was obtained in fish fed with diet T_3 Percentage weight gain of the groups of fish were also significantly different ($P<0.05$) from each other. Diet T_2 performed best followed closely by diet T_5 and both are not significantly different ($P>0.05$) from each other. Diet T_7 and T_6 which ranked third and fourth are significantly different from diet T_3 (with the lest value).

Specific Growth rate

The lowest specific growth rate of the experimental fish was obtained in fish fed with diet T^ with a value of 2.88 while the highest S.G.R value of 3.48 was obtained in diet T_2 which was followed by diet T, (50% toasted soybean) then diet T_l (which is the control).

Diets to and T_7 have a value of 3.08 while diet T_8 have a value of 3.02.

There are no significant difference ($P>0.05$) between diet T_2 diet T_5, Diet T_1 diet T_6 and diet T_7. Diet T_4 has a value of 2.98.

Percentage Survival

The highest percentage survival were those fish fed on diets, T_1, T_3, T_4, T_5, and T_6 with 100 percentage each. Diet T_2 ranked second with 95 percent, diet T_7 has the least percentage survival with a value of 30 percent survival rate.

Nutrient Utilization of *Clarias gariepinus* Juveniles Fed on the Different Diets

The nutrient utilization data are presented in Table 5 the protein efficiency ration (PER) was highest in fish fed with diet T_2 followed closely with diet T_5 with a value of 10.81, there is no significant difference in diet. T_2 and diet T_5. Diet T_7 has a PER of 7.86 which was followed by diet T_6 with a value of 7.62. This show that diet T_6 and T_7 are significantly different (PO.05) to diet 12 and T_5.

Diet T_1 (control diet) has a protein efficiency ratio of 7.2 and there is a significant difference (PO.05) in comparison to diets T_2, T_3, T_7. Diet T_3 has the least PER with value of 6.11 (Table 5).

The lowest feed conversion ratio (FCR) value of 5.32 was seen in diet T_2 while the highest FCR was obtained in diet T_8. While diet T_1, (control diet) is significantly different ($P<0.05$) from diet T_2, and diet T_5; The value obtained in diet T_3, T_4, T_6, T_7, and T_8. is not significantly different ($P<0.05$) from diet T_2 with the lowest FCR.

The net nitrogen retention value presented in table 4.3 showed that the fish fed on diet T_3 showed the highest net nitrogen retention value of 64.75 while the least valve was obtained from diet T_2 with value of 56.14.

The net nitrogen retention valve did not vary greatly between the treatments it ranged from 56.14% -64.75% and did not show any clear trend in the variation.

Carcass Analysis of the Flesh of *C. gariepinus* Juveniles Fed with Different Diets

The result of the proximate composition of the initial and final muscle tissues of *C. gariepinm* juveniles fed on the different diets is presented m Table 6: The highest protein value in the muscle was obtained from the fish fed on diet T_2 closely followed by fish fed on diet T_5 while the lowest muscle protein value was obtained from fish fed on diet T_3. Final carcass protein did not vary significantly ($P<0.05$) between treatments. Fish fed on diet T_2 showed the highest value of crude fat followed by fish fed on diet Ts while least crude fat value was recovered from fish fed on diet T_8.

The difference in carcass ash in the treatments was minimal (Table 6) while the least crude fibre was discovered in the carcass of the fish fed with diet T_5 the highest crude fibre was diet T_6.

Analysts of the Diets

The cost of production of one kilogramme of each diet is shown in table 7:

Diet T_l coasted N42.00 per kg and N42,000 per ton feed . Diet T_2 per kg feed is N350.00 and N350 000 per tone - Diet T_3 cost N28.5, diet T_4 N15, diet T_5 N28.50, diet T_6 Nl5.00 while diets T_7 and T_8 costN17.00,

Diets T_4 and diet T_6 are the cheapest in terms of cost of production while diet T_7 and T_8 are second in terms of feed cost, diet T_3 and T_5 cost N28,50k each:

Diets T_3 and T_5 could be termed cheapest in production cost when the relationship of weight gain and feed intake is calculated, especially when the protein efficiency ratio and its lowest feed conversion ratio is strictly considered.

Aerobic Mesophilic Bacterial Counts of the Feeds

Table 8 shows the bacterial load contained in the treat-

Table 1. Weekly Average Water Quality Parameters

Treatment								
Parameters	**T_1**	**T_2**	**T_3**	**T_4**	**T_5**	**T_6**	**T_7**	**T_8**
Temperature	25.5	25.0	25.0	25.5	25.0	25.0	25.5	25.0
pH	7.8	7.8	7.8	7.8	7.8	7.5	7.8	7.8
Dissolve 02 (mg/ht)	5.50	5.60	5.50	5.50	5.55	5.50	5.55	5.50
Conductivity	2.30	2.30	2.30	2.30	2.30	2.30	2.30	

Table 2. Gross Composition of Experimental Diets

100 Grammes:								
	T_1	**T_2**	**T_3**	**T_4**	**T_5**	**T_6**	**T_7**	**T_8**
a. Fish meal	30		10	-	0	-	-	-
b. Raw soyabean meal	0		20	30	-	-	-	-
c. Yellow maize	50		50	50	50	50	50	50
d. Groundnut cake	13		13	13	13	13	13	13
e. V.T Premix Vitamin Premix	2.0		2.0	2.0	2.0	2.0	2.0	2.0
f. Starch	2.0		2.0	2.0	2.0	2.0	2.0	2.0
g. Toasted soyabean	-		-	-	20	30	-	-
h. Raw soyabean meal with methionine (0.04g) and lysine (0.02g)	-		-	-	-	-	30	-
i. Toasted soyabean meal with methionine (0.04g) and lysine (0.02g)								30
j. Salt	0.5		0.5	0.5	0.5	0.5	0.5	0.5
k. Vegetable	2.5		2.5	2.5	2.5	2.5	2.5	2.5
l. Bone meal								

Table 3: Proximate composition of the formulation diets used in the experiments

Nutrient contents	**T_1**	**T_2**	**T_3**	**T_4**	**T_5**	**T_6**	**T_7**	**T_8**
Crude protein %	45.40^{b}	44.97^{b}	39.24^{b}	39.20^{d}	42.00^{d}	40.10^{d}	42.10^{b}	41.20^{d}
Crude fat %	2.50^{b}	2.65^{b}	2.30^{c}	2.25^{c}	2.50^{b}	2.45^{b}	2.40^{b}	2.40^{b}
Crude ash %	21.59^{a}	20.81^{a}	19.00^{b}	19.50^{b}	21.59^{a}	20.49^{b}	23.80^{c}	24.78^{c}
Crude fibre %	8.00^{b}	8.97^{d}	9.00^{d}	7.00^{a}	8.00^{b}	9.00^{d}	7.00^{a}	8.40^{c}
Moisture %	9.81^{d}	9.99^{d}	8.90^{c}	8.80^{c}	9.40^{d}	9.63^{d}	9.13^{d}	8.40^{d}
Nitrogen free	15.53^{a}	19.34^{b}	21.60^{c}	21.63^{c}	15.20^{a}	15.28^{a}	20.64^{c}	20.50^{c}
Extract % (NFE)								

Figure bearing the same superscripts in the same row are not significantly different (P<0.005)

Table 4. Growth Performance of *Clarias gariepinus* Juveniles Fed on the Different Diets

Growth Parameters	T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8
Average initial Wt (g)	7.0^{d}	7.3^{d}	7.7^{d}	7.3^{d}	7.7^{d}	7.8^{d}	8.0^{d}	7.8^{d}
Average final Wt (g)	285.9^{b}	477.5^{d}	245.25^{a}	262.5^{a}	440.25^{d}	313.5^{c}	322.5^{c}	290.00^{b}
Average Wt gain (g)	288.0^{a}	470.2^{d}	224.55^{c}	255.2^{c}	432.55^{d}	304.7^{b}	314.5^{b}	282.2_{b}
Average daily Wt gain (g)	0.024	0.039	0.019	0.021	0.036	0.025	0.026	0.024
Average % Wt	41.14	64.11	29.16	34.9	56.17	39.06	39.31	36.17
Average-specific growth rate	3.12	3.48	2.88	2.98	3.38	3.08	3.08	3.02
Percentage survival	100	95	100	100	100	100	75	30
Initial body length	6.77	6.70	6.79	6.50	6.72	6.70	6.72	6.79
(cm) Average								
Final body length (cm)	25.50	28.70	21.70	22.75	27.80	26.80	16.50	17.40
Average length gain (cm)	18.73	22.00	14.991	16.25	21.08	20.10	9.78	10.61
Average length gain (cm)	18.73	22.00	14.91	16.25	21.08	20.10	9.78	10.61

Figures being the same superscript in the same row are not significantly different (P<0.05)

Table 5. Nutrient Utilization of Clarias gariepinus Juveniles Fed on the Different Diets

Growth Parameters	T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8
Average daily gain (g)	0.024	0.039	0.019	0.021	0.036	0.025	0.026	0.024
Average protein efficiency ratio (PER) (g)	7.2d	11.80c	6.11a	6.40a	10.81c	7.62d	7.86d	7.10d
Average feed conversion ratio (FCR) (g)	8.68	5.23	10.22	9.80	5.78	8.20	7.95	8.86
Net Nitrogen retention	57.42	56.14	64.75	63.48	56.24	61.37	58.93	58.44

Figures being the same superscript in the same row are not significantly different (P<0.05)

Table 6. Proximate Composition of the Fish Carcasses (% Dry weight) Fed on the Different Diets

Nutrients	Initial	T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8
Crude protein	32.90^a	57.30^d	58.60^d	50.81^c	51.83^c	58.50^d	53.61^b	54.48^b	53.97^b
Crude fat	15.10^b	16.30^a	18.0^d	15.62^b	14.13^c	17.05^a	17.01^a	16.02^a	15.08^a
Crude Ash	15.20^c	14.10^a	15.30^c	16.20^d	16.10^d	15.08^c	14.34^a	6.20^d	16.40^d
Crude Fibre	4.60^a	4.40^a	3.45^b	4.10^a	2.49^c	2.80c	4.95^a	3.90^d	2.85^c
Moisture	2.40^b	4.71^a	3.50^a	2.74^b	2.70^b	3.23c	3.41^a	3.10^c	3.10^c
NFE	2.34^d	4.97^a	4.82^a	2.57^d	2.84d	3.98^c	4.10^c	2.95^d	3.05^d

Figures bearing the same superscripts in the same row are not significant different (P<0.05)

Table 7. Cost Analysis (100 grammes feed) of the Experimental Diets Inclusion Cost (₦)

Ingredients		T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8
a.	Yellow maize	0.30							
b.	Groundnut cate	0.60	(a-f)	75% (a-e)	50% (a-d)	75% (a-e)	50% (a-d)	50% (a-d)	50% (a-d)
c.	Starch binder	0.10							
d.	Premix	0.20							
e.	Fish meal	3.00							
f.	Soyabean meal	-		25%	25%	50%	50%	50%	50%
g.	Methionine and lysine	4.20	35.00	2.85	1.50	2.85	1.50	1.70	1.70
	Feed cost per kg	42.00	350.00	28.50	15.00	28.50	15.00	17.00	17.00
	Feed cost per ton	42.000	35.000	28.500	15.000	28.500	15.00	17.00	17.00

Diet	T_1	-	control zero percent level of soyabean
Diet	T_2	-	Conventional feed
Diet	T_3	-	50% raw S.B Inclusion
Diet	T_4	-	100% raw S.B Inclusion
Diet	T_5	-	50% toasted S.B Inclusion
Diet	T_6	-	100% toasted S.B Inclusion
Diet	T_7	-	100 raw S.B Inclusion
Diet	T_7	-	100% S.B Inclusion

Table 8. Aerobic mesophilic bacterial counts of the different feed

Treatments	(APC cfu/g)
1.	1.40 x 102
2.	6.80 x 102
3.	< 30
4.	< 30
5.	< 30
6.	< 30
7.	< 30
8.	< 30

ments the colonies formed in each of the treatment shows that they are less than thirty (<30) - there is no significant difference (P>0.05) in the different feeds in respect to the bacterial load; therefore the values obtained are within the acceptable values according to FAO, 1979; this shows that the feeds were not contaminated and is within the acceptable level for the fish consumption.

Water Quality Records

Dissolved oxygen contents of water in the various treatments were relatively similar and never got below 5.60mg/L. water temperature ranged between 25°C to 25.5°C while pH was between 7.5 and 7.8 (Table 1) these records were within the limits of good water quality for aquaculture as recommend by Boyd and Lichtkoppler (1985).

- T2 contains fish soluble, wheat fish oil, fish meal, soya, and premix. It also has an Ash content of 7.4%, phosphorous 1%, Vit A, D_3, E, and $CUso_4$ $5H_20$.
- Vitamin premix was composed (g/kg) diet: Vit. A5, 500 I.V., Vit. D100 I.V., Vit/E. 50 IV; 10mg, choline 550mg, Niacine 1000mg, Riboflavin 20mg, pyrodoxin 20mg, thiamine 20mg, u – calcion pantonenate 50mg, Biotin 0.1mg, floacin 5mg, Vit B_{12}.0.02mg, Ascobic acid 50mg, inocitol 0.1mg (Hayloy, 1992)

DISCUSSION

The relatively chapter cost of soybean in comparison to animal protein sources could lead to the rapid promotion of fish culture intensification in Nigeria and other developing countries. Results of the present research have shown that use of soybean in fish feed (Partial inclusion or fully substituted) in feed for catfish *C. gariepinus* gave good growth rate, good food conversion ratio and good protein utilization compared to the control diet (Table 4 and 5).

Viola, *et al* (1982) reported that partial replacement) 40% of fishmeal) by soybean meal in pond trails of carp required only supplement of methionine at 50% level in order to attain the same growth, protein and energy utilization as that with the control ration that had fish meal as the main protein supplement. When most of the fish meal was replaced by soybean meal, supplement of methionine and 0.4 - 0.5% lysine were necessary to achieve gains, protein efficiency ratio retention equal to those of the control fish meal ration. In this stud}', total replacement of fishmeal with soybean did not appear to significantly affect FCR and PER (Table 5)

Lovell (1997) stressed that soybean protein has one of the best amino acids profile of all protein rich plan; feeding stuffs to meet essential amino acid requirements of fish. There was no significant difference (PO.05) in weights of the fish in all the groups (Tables 4 and 5) this indicates that the different diets produce similar effect on growth of fishes.

In this study, the best growth rate was obtained in fish fed on diet T_3 and diet T_5 followed by diet T_7. The diets are relatively higher in quality and quantity of the ingredients used in the formulation of the diets (Table 4, 5, 6, and 7). The finding of this study agrees with the work of Smith *el al* (2000) who claimed success in feeding rainbow trout a diet based almost entirely on raw materials of vegetable origin containing 80% roasted soybean.

Pantha (2007) observed no significant difference in growth performance and diet utilization in *O. niiiticus* fed a diet where all the protein was supplied *by* herring meal and 75% of the herring meal was replaced by full fat soybean cake supplemented by methionine. Jackson *et al,* (1992) also found no significant difference in growth performance and diet utilization in tilapia, *Sarotherodon mossambicus* fed a diet where 25% of a control diet was replaced by soybean meal, although complete replacement resulted in 27-33% growth depression. Other parameters such as specific growth rate (SGR), protein efficiency ratio (PER), food conversion ratio followed the same pattern as that of weight gain values (Tables 4 and 5). Feed ingredients of plant origin have shown to contain various anti-nutritional factors, for instance, soybean contains haemaglutinin (Jackson *e! al,* 1992), groundnut has aflatoxin (Rayfeltwell and Sydfox, 1998), wheat offal has high fibre and low amino acid content (Gohl, 2005). However, some of these defects in these plants product can be ameliorated by heat and chemical treatment. Heat is known to improve digestibility of polysaccharidcs and metabolization energy in addition to inactivation of trypsin inhibitors (Smith, 1997; Dabrowsky *et al.* 1989) the inactivation of trypsin inhibitors would certainly lead to increased protein digestion. Treatment 5 (T_5) with 50% inclusion of toasted soybean gave a very good performance than the control diet, also T_6 (100% inclusion of toasted soybean) gave a very good performance in comparison to the control; this is as earlier reported by Kyo (1999) who confirmed that toasted soybean gave the best growth performance to *Clarias anguillaris* fingerlings compared to raw soybean. Although the performance of the fish fed with the totally substituted fishmeal gave a good result it can be said that it produced to the nearest optimum: for the best result a partially substituted feed in fish some level of the fishmeal is substituted with the fishmeal will yield to a very satisfying yield as in diets T_5.

In these experiments when catfish *Clarias gariepinus* juveniles were fed 40% protein from differently processed soybean FCR of 5.32-10.22 was obtained (Table 5). In this study, no depression in growth was observed between treatment group on the experimental diets. Fish

fed on diets T_1. T_3, T_4, $T_?$, and T_6 recorded the highest percentage of survival each. This could be attributed to acceptability of the diets and a high level of nutrient utility in the fish. The low percentage survival offish in diet T_8 may be an indication of their non - acceptability of the artificial diet (Madu *e1 al,* 2001) also the low percentage survival offish in diet T_8 could as a result pollution of the water (when water was left for 4 days before replacement) foul smell (pollution) resulted. It is certain that too much nutrients in culture medium results in pollution and Joss of fish if adequate precautions are not taken (Adeniji, 1996).

The inferior growth rate observed for *C. gariepinus* juveniles in diet T_1 with zero percent inclusion of soybean could be a manifestation of the high crude fibre content and low protein content of the diet shown by proximate analysis (Table 6).

The physico-chemical parameters value are shown in table 1, these parameters arc within those recommended by Boyd (1985) and vivean *et al* (1985) for fish culture. The cost analysis of the diets was calculated base on the cost per kilogramme of feed stuffs at the period of the experiment. The analysis showed the feed with least cost was revealed in diet T_4 and T_6 soybean is relatively cheaper in comparison to animal source protein.

CONCLUSION

The results from this study showed that 50% inclusion of toasted soybean - performed better than the zero percent inclusion of soybean (control). This was closely followed by diet T_7 which is 100% raw soybean with methionine and lysine (included). The cost rate of diet T_5 and diet T_7 is minimal compared to diet T_1 and diet T_2 which is the conventional feed (coppens). The cost rate is cut down up to 50 - 80% per kilogramme feed.

RECOMMENDATIONS

Base on the growth performance, nutrient utilization parameters and cost effectiveness of the eight diets at varying inclusions of soybean in the practical diet for *C. gariepinus* in this study, and the superiority of 50% and 100% inclusion of toasted soybean (in addition to methioninc and lysine) the following recommendations are suggested:

(a) That toasted soybean should be embraced by fish farmers as the most preferred treatment for soybean used in fish feed.

(b) That in order to maximize profit animal protein can be substituted partially or fully with soybean provided the essential amino acid (methionine and lysine) are added to improve feed.

(c) That in the toasting of soybean, it should be done in a sufficient way so as to reduce the effect of inhibitors and also provides a flavour to the feed.

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