



A Study of Growth Performance of African Catfish (*Clarias gariepinus*) Fingerlings Fed with Groundnut and Soybean Blend Meals

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ABSTRACT

Study of growth performance of African catfish fingerlings fed with groundnut and soybean meal blends as alternative protein source was carried out for ninety (90) days. Five isonitrogenous diets that contained (0% : 100%), (25% : 75%), (50% : 50%), (75% : 25%) and (100% : 0%) inclusions levels of blended groundnut meal (GNM) and soybean meal (SBM) were formulated and designated as D1, D2, D3, D4 and D5. Coppens and fishmeal (100% protein) served as positive and negative controls. The nutritional compositions of these diets were compared with both controls. Diet D2 with highest standard and total lengths of fishes among diets differ significantly ($p < 0.05$) with Coppens but not with fishmeal. The result indicates that the best diet as alternate protein source was D2 which gave the best BWG (86.11 ± 5.80 g), SGR (0.63 ± 0.13), Protein Efficiency Ratio PER (3.12 ± 0.40), lowest FCR (0.88 ± 0.22) when compared with D1 (100% : 0%) and diet D3 (50% : 50%), D4 (25% : 75%) and D5 (0% : 100%). The lowest growth and feed utilization parameters were observed in D3 (50% : 50%), respectively. There were high survival rates among diets with diet D2 being highest differ significantly ($p < 0.05$) with diets D3, diet D5, Coppens and fishmeal. The monitored water quality parameters fell within the acceptable range of standard values for successful fish production. It is therefore recommended that D2 (25% : 75%) inclusion level of groundnut and soybean blends should be used as alternative diet of *C. gariepinus* fish feeds for optimal production.

Keywords: Aquatic environment, African catfish, substitute of soybean and groundnut meal

INTRODUCTION

Fish is an important and major source of animal protein, which is an essential food item in the diet of many Nigerians. Fish is a good source of thiamine, calcium, riboflavin, vitamins A and D, phosphorus and iron. It is also very high in polyunsaturated fatty acids, which are important in lowering blood cholesterol level. It is therefore, suitable for complementing high carbohydrate diets that is common with low income group in Nigeria (Areola, 2008).

The potential of Aquaculture to meet the challenges of food security, employment generation and foreign exchange has been clearly demonstrated over the years by the rapid expansion of the sector. This sector accounts for increase fish supply and have played a considerable role in meeting increased demand for fish in some countries (Troé *et al.*, 2014). It is well known that fish supplies from inland water bodies are unlikely to increase substantially and that the projected shortfalls in fish supply will probably be met mainly from expansion within the aquaculture sector (FAO,

2010). In Nigeria, the consumption of fish as source protein is on the increase especially as the cost from other sources kept on increasing. Aquaculture practice has expanded in the country for increased fish production in order to compensate those from capture fisheries in meeting the demand of the country.

A major contributor to fish farming is the use of manufactured feeds, which usually formulated to meet the nutritional requirement of the targeted fish species (FAO, 2009). This has accounted for 40-60% of the total recurrent cost of production (Sogbesan *et al.*, 2005). In fish feed formulation, groundnut and soybean seeds have been used over the years to replace fishmeal. groundnut is rich in protein, but also easily digestible with high biological value and rich in B-complex vitamins (Musa *et al.*, 2010).

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Soybean is a rich source of protein and lipid, and as such a good source of energy, vitamins and minerals. It has protein content that ranges from 38-45% as well as high oil content of approximately 20% and widely grown in Nigeria (Tashikalma *et al.*, 2010).

METHODOLOGY

Experimental Site

This research work was conducted at the Department of Biology Laboratory, Faculty of Natural Sciences, Ibrahim Badamasi Babangida University main campus, Lapai, Niger State.

Collection and Transportation of Experimental Fish

Three hundred (300) healthy fingerlings of *C. gariepinus* were purchased at about four (4) weeks of age from Chikuba Farm, Bwari Area Council Abuja. The fish were transported in a fifty (50) litres half-filled plastic Jerican with water very early in the morning between 7.00am- 8.00am to the Biology Departmental laboratory at Ibrahim Badamasi Babangida University main campus, Lapai, Niger State where the research was conducted, this was done to take advantage of the early morning low temperature and were immediately transferred into two large water baths with dimension of 150x50x40cm for a period of two weeks (acclimatization period). No mortality was recorded on the course of transportation.

Acclimatization of Experimental Fish

Fish collected were acclimatized to the laboratory conditions for two (2) weeks before the commencement of the feeding trials. During this period fish were fed with 2mm foreign feed Coppens (Alltech) in the morning and evening. Once the water was noticed to be dirty due to feed accumulation and faecal materials, the half volume was changed immediately.

Formulation of Experimental Diets

The diets were formulated at 35% crude protein using Pearson method. Five is nitrogenous diets each containing different varying levels of blended groundnut meal (GNM) and soybean meal (SBM) were formulated. The diets contain (0% : 100%), (25% : 75%), (50% : 50%), (75% : 25%) and (100% : 0%) inclusions level designated as D1, D2, D3, D4 and D5 (Table 3.1) Coppens (standard feed) and fish meal, were used as positive and negative control respectively.

Table 1: Percentage (%) composition of ingredients used for diets formulation

Parameters	D1	D2	D3	D4	D5
Maize meal (%)	10	8	7	6	5
Soybean (%)	80	62	43	24	0
Fish meal(%)	6	6	6	6	6
Starch (%)	2	2	2	2	2
Primix (%)	2	2	2	2	2
Ground nut (%)	0	20	40	60	85
Total (%)s	100	100	100	100	100

Sources and Preparation of Experimental Ingredients

Groundnut and soybean were purchased at Lapai market and used for the formulation of the diets. Groundnut was processed locally by toasting on fire at the temperature (90°C). Soybean was toasted at 100°C for 30 minutes according to the method of Tiamiyu *et al.*, (2015). Toasting was carried out by continuous stirring to give fine texture on a hot plate. Other ingredients for the feed formulation (fish meal, maize and starch) were also purchased at Lapai market.

The ingredients were then grounded separately into equal and finest sizes with hammer mill and then weighed according to proportions needed for each diet. Sensitive weighting balance were used to measure the quantity of each ingredient. Starch was added to the feed to act as binder in holding the feed together after thorough and proper mixing of the ingredients. Hot water was also added to bring about the binding ability to dough - like paste for smooth pelleting using pelleting machine. The resulting pellets were oven dried to remove moisture and then packaged in air tight polythene for storage in a dry place.

Experimental Set - up and Feeding trials

Seventeen (17) transparent plastic tanks of dimension (60 x 30 x 30 cm) were set up for five (5) treatments with each made in triplicates and two (2) controls (Positive - Coppens; negative - Fishmeal). Fingerlings were randomly selected, length and weight taken and then transferred into each tank and fed twice daily at 3% body weight (8am in the morning and 6pm in the evening). Ten (10) fingerlings of *Clarias gariepinus* were introduced in each plastic tank.

Fish were starved for twenty four (24) hours before the commencement of feeding trials in order to empty their bowels. Feeding trials was done for a period of 90 days (3 months). The water in each tank was changed once there is

much accumulation of remnant feed and fecal materials.

Sampling of Fish

Fish sampling was done every two (2) weeks. Standard length, total lengths and weight were measured and taken respectively using measuring board and weighing balance. Mortality was also monitored and recorded once a dead fish is seen and then removed from the tank.

Measurement of Water Quality Parameters

Temperature ($^{\circ}\text{C}$), pH, electrical conductivity (EC), nitrate (NO_3), nitrite (NO_2) and biochemical oxygen demand (BOD) of water in each plastic tank were monitored throughout the period of experiment. Temperature were measured twice in a day using thermometer (Mercury - in - glass thermometer), pH with the aid of pH meter (Model - 0009 (III) Pen type) and electrical conductivity using conductivity meter once daily. Standard Analytical Procedures according to methods of APHA (1995) were employed to analyze nitrate, nitrite and biochemical oxygen demand of water from each plastic tank.

Proximate Analyses of Experimental Diets

The experimental diets - (D1, D2, D3, D4 and D5), Copen, groundnut meal blend, soybean meal blend, maize and fish meal were subjected to proximate analyses according to standard methods of AOAC (2006). Duplicate measurements were obtained for each feed sample analysed for moisture, ash, crude protein, crude fibre, crude fat, gross energy .

Statistical Analysis

Data collected were subjected to descriptive statistics to compute the means, standard deviations, minimum and maximum values. One - way Analysis of variance (ANOVA) was carried out to test for variation in diets at 5% level of significance. Post-hoc Duncan Multiple Regression Test (DMRT) was used to rank the differences in means. Microsoft Excel 2010 and Statistical Package for Social Sciences (SPSS) version 20 were used as statistic

RESULTS

Nutritional composition of ingredients used in feed formulation

Table 2: Nutritional Composition of Ingredient used in feed Formulation . there were no Significant different in the experiment diet, consequently, Moisture content had the Highest

value Maize meal (14.66 ± 0.21) followed by Fish meal (13.21 ± 1.09) and lowest was recorded in soybean meal (12.98 ± 0.02). Fish meal had height ash Content (18.98 ± 0.14) while the lowest was seen in maize (1.72 ± 0.17). Ground nut meal showed the height in Fat (35.25 ± 0.36) and the least was observed in maize meal (3.45 ± 0.11). crude protein was height in fish meal (51.67 ± 0.42) followed by soybean meal (42.06 ± 0.06) and lowest was recorded in (13.19 ± 0.93). Apparently crude fiber was height in soybean meal (4.92 ± 0.09) followed by ground nut meal (3.36 ± 0.45) and lowest recorded in Maize meal (1.39 ± 0.01). Carbohydrate was height in maize meal (67.11 ± 0.05) lowest was recorded in fish meal (1.31 ± 0.01) respectively.

Nutritional composition of Experimental Diets with copen as postive control.

Nutritional composition of Experimental Diets with copen as postive control. is presented in table 3. there significant differences ($p < 0.05$). moisture content was highest in Diet 4 (12.5 ± 0.51) lowest in Diet 3 (6.5 ± 0.05) Control had the highest crude protein (44.97 ± 0.57) followed by Diet 2 and Diet 1 (35.98 ± 0.13 and 34.86 ± 0.51) while the lowest was Diet 5 (31.42 ± 0.08). Control also had the highest fat (14.25 ± 0.03) followed by Diet 3 (10.24 ± 0.02) and lowest in Diet 5 (7.49 ± 0.01) respectively. Ash content was highest in Diet 1 (15.01 ± 0.01) and low in diet 5 (1.72 ± 0.06). Crude Fibre was highest in diet 4 (7.89 ± 0.01) and lowest was recorded in copen (6.79 ± 0.09). carbohydrate was highest in Diet 3 (34.89 ± 0.02) followed by Diet 5 (30.63 ± 0.51) and least was recorded in copen (30.63 ± 0.51) respectively.

Nutritional Composition of experimental Diet with Fish meal as Negative control

Nutritional Composition of experimental Diet with Fish meal as Negative control is presented in table 4 there were significant difference from the composition of the diets used during the study. moisture content was highest in D4 (11.5 ± 0.51) and lowest in D3 (6.5 ± 0.51) D2 had the highest q1 crude protein (35.98 ± 0.13) followed by D1 (34.86 ± 0.51) while the lowest crude protein was recorded in diet D5 (31.42 ± 0.08). D3 had the highest fat content (10.24 ± 0.02) followed by D1 (9.01 ± 0.49) while the lowest control was recorded in Diet2 (7.49 ± 0.01) Ash content was had the highest value in fish meal (20.5 ± 0.51) and lowest value was recorded in D5

(1.72±0.06). Crude fibre was had the highest value in D4 (7.89±0.01) and lowest was recorded in fish meal (6.63±0.05) respectively. carbohydrate was highest in D5(30.63±0.51) followed by fish meal (29.54±4.48) and lowest value was observed in D1 (24.69±0.42) respectively.

Growth response of *Clarias gariepinus* fingerlings fed experimental diets with coppers as control

Growth response of *Clarias gariepinus* fingerlings fed varying levels of soybean and groundnut blend meals with Coppers as positive control is shown in table 5. There were little variations in standard length, total length and initial weight of fish during the period of study. Control had highest standard length (18.60 ± 4.03^acm) and total length (20.00 ± 4.22cm) of fish with diet D3 being lowest in both standard (16.00 ± 3.65 cm) and total length (17.13 ± 3.76^c cm). Diet D2 had the highest initial weight (12.33 ± 0.87 g) followed by control (12.22 ± 1.09g) while the lowest was diet D3 (11.22 ± 0.97g). Control had the highest final weight (142.22 ± 19.10g) followed by D2 (124.11 ± 14.63 g) and D3 (71.90 ± 7.01g) as lowest. Body weight gain was highest in control (130.00 ± 19.80 g) followed by diet D2 (111.80 ± 14.31g) and the lowest was diet D3 (60.70 ± 7.48g).

There were significant differences (p<0.05) in standard and total lengths between control and other diets. There was no significant difference (p>0.05) in the initial weights across diets. There were significant differences (p<0.05) in both final weight and body weight gain between control and other diets.

Growth response of *Clarias gariepinus* fingerlings fed experimental diets with fish meal as control

Growth response of *Clarias gariepinus* fingerlings fed varying levels of soybean and groundnut blend meals with fish meal as negative control is shown in table 6. There were little variations in standard length, total length and initial weight of fish during the period of study.

Diet D2 had highest standard length (17.53 ± 4.08cm) and total length (18.24 ± 3.82 cm) of fish with diet D3 being lowest in both standard (16.00 ± 3.65 cm) and total length (17.13 ± 3.76 cm). Diet D2 had the highest initial weight (12.33 ± 0.87 g) followed by diet D1 (12.11 ± 1.54g) while the lowest was diet D3 (11.22 ±

0.97 g). Control had the highest final weight (124.70 ± 10.50g) followed by diet D2 (124.11 ± 14.63 g) and D3 (71.90 ± 7.01 g) being the lowest. Body weight gain was highest in control (130.00 ± 19.80 g) followed by diet D2 (111.80 ± 14.31 g) and the lowest was diet D3 (60.70 ± 7.48 g).

There were significant differences (p<0.05) in standard, total lengths, final weight and body weight gain between control and other diets with the exception of diet D2. There was no significant difference (p>0.05) in the initial weights between control and other diets.

Feeding Utilization *Clarias gariepinus* fingerlings fed varying levels of experimental diets with coppers as control

the various feed utilization of *C.gariepinus* fingerlings fed varying levels of soybean and groundnut blend meals with Coppers as positive control. There were variations in specific growth rate, feed efficiency, protein efficiency ratio, feed conversion ratio and survival rates of fish during the period of study.

Specific growth rate was highest in control (0.78 ± 0.25) followed by diet D2 (0.63 ± 0.13) and diet D4 (0.29 ± 0.17) was the least. Feed efficiency was highest in diet D2 (1.07 ± 0.14) followed by diet D3 (1.03 ± 0.13) and the lowest was diet D1 (0.63 ± 0.04). Protein efficiency ratio was highest in diet D2 (3 ± 0.16) followed by control (2.93 ± 0.45) and the lowest being D3 (1.95 ± 0.24). Feed conversion ratio was highest in diet D4 (1.70 ± 0.31) followed by diet D5 (1.42 ± 0.46) and lowest being D2 (0.880.88 ± 0.22). There was high survival rate on the overall, control recorded highest survival rate (98.75 ± 2.48) followed by diets D1 and D2 each with 97.08 ± 2.14%, while the lowest was D5 (92.92 ± 3.30).

There were significant difference (p<0.05) between control and other diets with exception of diet D2 in both specific growth rate and protein efficiency ratio; diets D1 and D3 in feed conversion ratio. There were significant differences (p<0.05) between control and other diets in feed efficiency and survival rates.

Table 2: Nutritional Composition of Ingredient used in feed Formulation

Parameters	Moisture Content%	Ash content%	Fat content%	Crude protein%	Curde Fibre%	CH ₂ O% %
GNM	13.05±0.39 ^a	5.86±0.02 ^b	35.25±0.36 ^a	40.74±0.49 ^b	3.36±0.45 ^b	2.29±0.04 ^b
Soybean	12.98±0.02 ^a	6.29±0.06 ^b	29.91±0.79 ^b	42.06±0.06 ^b	4.92±0.09 ^a	3.33±0.03 ^b
Maize Meal	14.66±0.21 ^a	1.72±0.17 ^c	3.45±0.11 ^d	13.19±0.93 ^c	1.39±0.01 ^c	67.11±0.05 ^a
fish meal	13.21±1.09 ^a	18.98±0.14 ^a	11.76±0.65 ^c	51.67±0.42 ^a	1.88±0.03 ^c	1.31±0.01 ^c

Note: values in the same row with different superscript letter are significantly different p<0.05

Table 3: Nutritional composition of Experimental Diets with coppens as control

Parameters	Moisture Content%	Crude protein%	Fat content%	Ash content%	Crude Fibre%	CH ₂ O%
Coppens	10.03±0.03 ^b	44.97±0.57 ^a	14.25±0.03 ^a	6.5±0.05 ^c	6.79±0.09 ^b	19.05±0.49 ^d
Diet 1	8.01±0.01 ^c	34.86±0.51 ^b	9.01±0.49 ^b	15.01±0.01 ^a	7.86±0.01 ^a	24.69±0.41 ^c
Diet 2	8.28±0.06 ^d	35.98±0.13 ^b	7.49±0.01 ^c	12.23±0.23 ^c	7.28±0.06 ^a	28.78±0.01 ^b
Diet 3	6.5±0.05 ^d	31.63±0.48 ^b	10.24±0.02 ^b	10.5±0.01 ^c	7.75±0.01 ^a	34.89±0.02 ^a
Diet 4	12.5±0.51 ^b	33.27±0.51 ^b	8.35±0.02 ^c	12.35±0.01 ^b	7.89±0.01 ^a	27.29±0.59 ^b
Diet 5	11±0.01 ^a	31.42±0.08 ^b	7.93±0.02 ^c	1.72±0.06 ^d	7.86±0.02 ^a	30.63±0.51 ^a

Note: values in the same row with different superscript letter are significantly different p<0.05

Table 4: Nutritional Composition of experimental Diet with Fish meal as Negative control

Parameters	Moisture Content%	Crude protein%	Fat content%	Ash content%	Crude Fibre%	CH ₂ O%
Fish meal	8.03±0.02 ^b	32.43±0.12 ^a	8.78±0.05 ^c	20.5±0.51 ^a	6.63±0.05 ^b	29.54±4.48 ^b
Diet 1	8.01±0.01 ^b	34.86±0.51 ^a	9.01±0.49 ^b	15.01±0.01 ^b	7.86±0.01 ^a	24.69±0.42 ^d
Deit 2	8.28±0.05 ^b	35.98±0.13 ^a	7.49±0.01 ^d	12.23±0.23 ^c	7.28±0.06 ^a	28.78±0.01 ^b
Diet 3	6.5±0.51 ^c	31.63±0.48 ^a	10.24±0.02 ^a	10.5±0.05 ^c	7.75±0.01 ^a	34.89±0.01 ^a
Diet 4	11.5±0.51 ^b	33.27±0.51 ^b	8.35±0.02 ^c	12.35±0.01 ^c	7.89±0.01 ^a	27.29±0.59 ^c
Deit 5	11±0.01 ^a	31.42±0.08 ^a	7.93±0.02 ^c	1.72±0.06 ^d	7.86±0.02 ^a	30.63±0.51 ^a

Note: values in the same row with different superscript letter are significantly different p<0.05

Table 5: Growth response of *Clarias gariepinusb* fingerlings fed experimental diets with coppens as control

Diet	Standard Length (cm)	Total Length (cm)	Initial Weight (g/fish)	Final Weight (g/fish)	Body Weight Gain (g/fish)
Coppens	18.60 ± 4.03 ^a	20.00 ± 4.22 ^a	12.22 ± 1.09 ^a	142.22 ± 19.10 ^a	130.00 ± 19.80 ^a
D1	17.20 ± 3.82 ^{bc}	18.24 ± 3.82 ^{bc}	12.11 ± 1.54 ^a	98.22 ± 5.95 ^c	86.11 ± 5.80 ^c
D2	17.53 ± 4.08 ^{ab}	18.72 ± 4.22 ^{ab}	12.33 ± 0.87 ^a	124.11 ± 14.63 ^b	111.80 ± 14.31 ^b
D3	16.00 ± 3.65 ^c	17.13 ± 3.76 ^c	11.22 ± 0.97 ^a	71.90 ± 7.01 ^d	60.70 ± 7.48 ^e
D4	16.88 ± 3.90 ^{bc}	17.90 ± 3.96 ^{bc}	11.80 ± 1.20 ^a	81.11 ± 4.57 ^d	69.33 ± 4.27 ^{de}
D5	17.13 ± 3.93 ^{bc}	18.19 ± 3.99 ^{bc}	11.78 ± 0.83 ^a	91.60 ± 6.29 ^c	79.80 ± 6.48 ^{cd}

Values in each column with different alphabets are significantly different (p<0.05)

Table 6: Growth response of *Clarias gariepinus* fingerlings fed experimental diets with fish meal as control

Diet	Standard Length (cm)	Total Length (cm)	Initial Weight (g/fish)	Final Weight (g/fish)	Body Weight Gain (g/fish)
Fishmeal	16.22 ± 5.90 ^a	17.40 ± 6.10 ^a	11.80 ± 1.09 ^a	124.70 ± 10.50 ^a	112.9 ± 10.00 ^a
D1	17.20 ± 3.82 ^{ab}	18.24 ± 3.82 ^{ab}	12.11 ± 1.54 ^a	98.22 ± 5.95 ^b	86.11 ± 5.80 ^b
D2	17.53 ± 4.08 ^a	18.72 ± 4.22 ^a	12.33 ± 0.87 ^a	124.11 ± 14.63 ^a	111.80 ± 14.31 ^a
D3	16.00 ± 3.65 ^b	17.13 ± 3.76 ^b	11.22 ± 0.97 ^a	71.90 ± 7.01 ^d	60.70 ± 7.48 ^d
D4	16.88 ± 3.90 ^{ab}	17.90 ± 3.96 ^{ab}	11.80 ± 1.20 ^a	81.11 ± 4.57 ^c	69.33 ± 4.27 ^c
D5	17.13 ± 3.93 ^{ab}	18.19 ± 3.99 ^{ab}	11.78 ± 0.83 ^a	91.60 ± 6.29 ^b	79.80 ± 6.48 ^b

Table 7: Feeding Utilization *Clarias gariepinus* fingerlings fed varying levels of experimental diets with coppers as control

Diet	SGR	FE	PER	FCR	SR
Coppers	0.78 ± 0.25 ^a	0.95 ± 0.14 ^b	2.93 ± 0.45 ^a	1.10 ± 0.16 ^{bc}	98.75 ± 2.48 ^a
D1	0.44 ± 0.22 ^b	0.63 ± 0.04 ^d	2.43 ± 0.16 ^b	1.17 ± 0.36 ^{bc}	97.08 ± 2.14 ^{ab}
D2	0.63 ± 0.13 ^a	1.07 ± 0.14 ^a	3.12 ± 0.40 ^a	0.88 ± 0.22 ^c	97.08 ± 2.78 ^{ab}
D3	0.25 ± 0.21 ^b	1.03 ± 0.13 ^{ab}	1.95 ± 0.24 ^c	1.14 ± 0.70 ^{bc}	93.33 ± 8.00 ^b
D4	0.29 ± 0.17 ^b	0.75 ± 0.05 ^c	2.12 ± 0.13 ^c	1.70 ± 0.31 ^a	96.70 ± 4.71 ^{ab}
D5	0.41 ± 0.15 ^b	0.68 ± 0.06 ^{cd}	2.53 ± 0.21 ^b	1.42 ± 0.46 ^{ab}	92.92 ± 3.30 ^b

Values in each column with different alphabets are significantly different (p<0.05)

Table 8: Feeding Utilization *Clarias gariepinus* fingerlings fed varying levels of experimental diets with fish meal as control

Diet	SGR	FE	PER	FCR	SR
Fishmeal	0.72 ± 0.16 ^a	1.12 ± 0.10 ^a	3.50 ± 0.31 ^a	0.89 ± 0.10 ^c	98.75 ± 2.48 ^a
D1	0.44 ± 0.22 ^b	0.63 ± 0.04 ^d	2.43 ± 0.16 ^c	1.17 ± 0.36 ^{bc}	97.08 ± 2.14 ^{ab}
D2	0.63 ± 0.13 ^a	1.07 ± 0.14 ^{ab}	3.12 ± 0.40 ^b	0.88 ± 0.22 ^c	97.08 ± 2.78 ^{ab}
D3	0.25 ± 0.21 ^c	1.03 ± 0.13 ^b	1.95 ± 0.24 ^d	1.14 ± 0.70 ^{bc}	93.33 ± 8.00 ^b
D4	0.29 ± 0.17 ^{bc}	0.75 ± 0.05 ^c	2.12 ± 0.13 ^d	1.70 ± 0.31 ^a	96.70 ± 4.71 ^{ab}
D5	0.41 ± 0.15 ^{bc}	0.68 ± 0.06 ^{cd}	2.53 ± 0.21 ^c	1.42 ± 0.46 ^{ab}	92.92 ± 3.30 ^b

Values in each column with different alphabets are significantly different (p<0.05)

DISCUSSION

The nutritional value of ingredients used for feed formulation is very vital because quality feed contribute to growth and development as well as health of fish. The nutritional composition of such ingredients revealed higher crude protein content (42.06 ± 0.06) in soybean than groundnut (40.74 ± 0.49) although both were lower than fish meal (51.67 ± 0.42). The value for soybean in this study is greater than 37.08% earlier reported by Alfred *et al.* (2020) but less in crude fibre (4.82%) compared with 5.12% reported by Alfred *et al.*, (2020). This could be due to the methods of processing, variety of soybean and geographical location - where the plant was cultivated. This implies that soybean and groundnut could be used as good protein source in feed formulation.

Crude protein is known to be the most crucial component of food in the life of fish and other living organisms. The higher crude protein values were recorded in diets D2 (35.98 ± 0.13) and D1 (34.86 ± 0.51) inclusion level crude protein were in conformity with value recommended by Ayinla (1988), Robinson (1991), Bolorunduro (2002), Bekibele (2005), and Gatlin (2010) as crude protein requirement for *C. gariepinus* juvenile. And can be compared favourably with coppens, which is an indication that they could give better growth performance than the rest diets. Crude fibre of diets D2 (7.28 ± 0.06) and D3 (7.75 ± 0.01), can be compared with coppens though less in percentage composition (6.88%).

Crude protein in the formulated diets can be compared favourably with negative control (fish meal) and even better in diets D1, D2 and D4. This implies that the diets could give good growth performance of *C. gariepinus* fingerlings. The higher amounts of crude fibre and carbohydrate in the formulated diets (D2 - D4) compared with control emanated from plant as source of ingredient.

Growth response of fish in any culture system is a reflection of the ability of fish to respond to feed, hence increase in size. The standard and total lengths of fish in this study differs significantly ($p < 0.05$) between positive control and experimental diets even though diets D1, D4 and D5 did not show any differences. The mean initial weights did not show significant differences ($p > 0.05$) with positive control; diets D2 (12.33 ± 0.87 g) and D3 (11.22

± 0.97 g) being highest and lowest respectively. Similar trends were observed with negative control (fish meal) in standard and total lengths as well as initial weight. This implies that fish had similar weight, belonging to same stock or age group even though they are not of the same length. This is a common observation with fish at different stages of development.

Positive control (Coppens), which recorded the highest mean final weight (142.22 ± 19.10 g) differs significantly ($p < 0.05$) with the diets even with diet D2 (124.11 ± 14.63 g). This could be due to the inability of the blend meals to have provided all the necessary nutrients needed for fish growth. However, final weight did not differ significantly ($p > 0.05$) between fish meal with (124.70 ± 10.50) g and diet D2 (124.11 ± 14.63 g), which is an indication of being alternative blends for better growth. Body weight gain differ significantly ($p < 0.05$) between coppens and diets whereas fishmeal did differ with other diets with the exception of diet D2(25% : 75%) The mean weight obtained here were similar to the mean weight obtained by Kenan *et al.*, (2008) for 105 days old European catfish. A similar trend was also reported by Isicheli (2008). Fafioye *et al.*, (2005) also observed higher percentage increase in body weight of fish fed heat treated soybean over fish fed raw soybean. The blends could be a good alternative for fish meal at D2(25% : 75%) inclusion. So the growth difference from diet (D1 - D5) These differences in mean weight gained can be attributed to differences in crude protein, crude fibre and carbohydrate of experimental diets because crude protein is known to be very important in optimal growth, crude fibre can affect digestibility and carbohydrate is known to have protein sparing effect. Faromi (2002) in an experiment with African catfish noted that the growth of the group of fish fed complete plant protein as main protein source were less than those fed complete fish meal because fish meal contains some amino acids not present in tissues from terrestrial plant; but when lysine and methionine were added to the diets there was improvement in all the diets. There was also a sudden decrease in body weight gain and drop in survival as blend levels reach D3(50% : 50%) inclusion, The possible reasons for the reduced growth in D3(50% : 50%) may be due to high fat content in supplemented diets D3 that might have reduced feed consumption or diet

digestibility. High fat content in the diet D3 inhibits the intake of nutrients required for growth (Ali & Jauncey, 2004) and could reduce digestibility (Watanabe, 1982). Similarly, Fasakin *et al.* (2003) reported a significant reduction in growth of African catfish fed full-fat maggot (*Musca domestica*) meal compared to fishmeal control diet. Fasakin *et al.*, (2003) attributed to the growth reduction to palatability, digestibility and amino acid content Diet D2 (25% : 75%) inclusion of blend meals that performed best among the diets could be due to high feed acceptability. According to Bake *et al.*, (2009), the suitability of alternative feed ingredient inclusion in fish diet in terms of growth response varies highly among fish species and experimental conditions Bake *et al.*, (2009). This could also be reasons for such observation. The acceptable growth of the African catfish fed Diet D2 (25% : 75%) inclusion in this study indicated that the amino acid profile of the test diets had met the dietary requirements of the fish. Several researchers have demonstrated that soybean meals have an ideal amino acid profile that is comparable to conventional protein (coppens) and fishmeal (Akpodiete *et al.*, 1997; Newton *et al.*, 2005). There are important parameters measured in feed trials that will help to determine its utilization by fish in culture system. These parameters include specific growth rate, feed efficiency, protein efficiency and feed conversion ratio amongst others.

The specific growth rate designated as SGR is a term used in aquaculture to estimate the production of fish after a certain period of time. The value, which was highest in positive control (0.78 ± 0.25) differ significantly ($p < 0.05$) with other diets with the exception of diet D2 (0.63 ± 0.13) and diet D1 (0.44 ± 0.22) differ significantly ($p < 0.05$) with D2. Likewise with fishmeal which did not differ with diet D2 but with other diets. This implies that diet D2 with (25% : 75%) inclusion of groundnut and soybean meals blend can be compared favourably with control due to its performance. The SGR obtained for the experimental fish in this study is low when compare to what (Enyidi, 2014). and (Fagbenro, 2000). who recorded significantly higher SGR in their studies. The SGR in the study decreased with increasing inclusion level of SBM in the experimental fish diet, an indication that the utilization of nutrient for growth is related to

SBM inclusion. The lowest SGR recorded in diets D3 that differ significantly ($p < 0.05$) with other diets indicated retarded or slow growth, which could influence the rate of production.

Feed efficiency (FE) measures the level or extent fish utilized feed by converting it into muscle or flesh. FE of coppens and fishmeal differs significantly ($p < 0.05$) with the diets, even though FE of diet D2 (1.07 ± 0.14) can be compared with both controls; coppens (0.95 ± 0.14) and fish meal (1.12 ± 0.10). This could be due to slow break down of the diets, non-palatability of the diets and absorption of nutrients from the feed by the fish and water quality amongst others.

Protein efficiency ratio (PER) refers to the weight gain as it relates to protein intake. This implies that the protein absorbed could be fully utilized for growth or weight gain. PER of coppens differ significantly ($p < 0.05$) with other diets with the exception of diets D2 that gave the best weight. This implies that the protein absorbed by the fish was better utilized or converted to flesh. However, the fish meal differ significantly ($p < 0.05$) with the diets, even though PER of D2 (3.12 ± 0.40) can be compared with fishmeal (3.50 ± 0.31). This implies that the protein absorbed by fish could have been used for other processes in addition to weight gain. Proteins derived from vegetable sources according to Karemah and Esquire (2014) may be deficient in several amino acids, such as lysine, methionine and tryptophan needed by fish for growth. This could also be a contributory reason for such observation.

Feed conversion ratio abbreviated as FCR is the amount (g or kg) of feed needed to produce 1kg of fish; the lower the FCR the less quantity of feed an animal use to produce a unit of product, which is good for the farmer. A low FCR also indicates a good quality feed. Diet D2 with lowest FCR (0.88 ± 0.22), which differ significantly ($p < 0.05$) from coppens (1.10 ± 0.16) and other diets, but did not differ ($p > 0.05$) with fish meal (0.89 ± 0.10), indicated the efficiency of converting this diet into product (Ugwumba and Ugwumba, 2007). This could be the reason for high body weight gain recorded during the study. In order words the diet was well utilized at (25% : 75%) inclusion level of groundnut and soybean meal blends. The highest FCR value recorded in diet D4 in

this study could be attributed to the unpalatability of the diet.

Survival rate (SR) is an important parameter measured in growth response studies. It helps to determine the success of any production. Determination of such parameter in feeding trials is also crucial because it helps to reveal the safe inclusion level of ingredient in formulation of feed as well as guide in water quality. Survival rates in the different treatments with Coppens (control) and fish meal (control) although both recorded highest percentages and differ significantly ($p < 0.05$) can be compared favourably with other diets. Also diet D1 for both controls did not differ significantly ($p > 0.05$) with diet D2. All the treatment recorded over 90% survival, which is quite high, hence it can be said that there was low mortality observed during the period of study. This could be due to good water quality, low faecal accumulation and safety of the ingredients used in feed formulation.

Conclusion

This study has evaluated the growth response of *Clarias gariepinus* fingerlings fed different levels of groundnut and soybean meals blend as alternate protein source for 90 days (3 months). It revealed the various constituents of nutrients found in the diets and controls. Diets D2 (25% : 75%) and D1 (0% : 100%) could be compared favourably with Coppens (control).

The standard and total lengths of fish in the diets show significant difference ($p < 0.05$) even though the weights can be compared with both controls. Although mean final weight of diets differ significantly ($p < 0.05$) with Coppens, no significant difference was observed with negative control (fish meal) and diet D2 (25% : 75%) in body weight gain.

Diets D2 (25% : 75%) performed best among the diets and can be compared with controls.

Feed utilization determined revealed that specific growth rate, protein efficiency ratio and feed conversion ratio of diet Diets D2 (25% : 75%) and D1 (0% : 100%) gave best performance and could be compared with controls. Feed efficiency although differ significantly ($p < 0.05$) with controls could also be compared in performance.

High survival rate of fish on the overall was recorded throughout the period of study.

The quality of the water measured in the culture system throughout the study supports fish survival and production.

Recommendations

- i. Diets D2 (25% : 75%) inclusion of groundnut and soybean meals blend is recommended for fish meal replacement in the diet of *C. gariepinus*
- ii. Since body weight gain of fish translate to income for fish farmers, Diets D2 (25% : 75%) inclusion is profitable for fish production at present
- iii. This type of research work need to be carried out for other culturable fish species, such as catfish *Heterobranchus* species, *Oreochromis niloticus* and Carp.
- iv. There is need to carry out the cost effectiveness of production of these diets

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