J. Agric. Food. Tech., **5(3)7-13, 2015**
ISSN 2090 – 424X
Journal of Agriculture and Food Technology
www.textroad.com

Evaluation of Growth Performance and Body Composition of *Clarias Gariepinus* Fingerling Fed Graded Level of Bambara Nut Meal *(Vigna substrarreana)*

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Received: February 14, 2015
Accepted: May 3, 2015

ABSTRACT

A 56-day feeding trial was conducted to evaluate the use of Bambara nut Meal (BNM) *(vigna substrarreana)* a plant protein to replace Fish meal (FM) in the diet of *Clarias gariepinus*. Five diets containing 0%, 25%, 50%, 75% and 100% Bambara nut meal as fishmeal replacement was formulated. The effect of BNM was evaluated as fishmeal replacer on the growth performance of *Clarias gariepinus* fingerlings (0.95±0.07g). At the end of the study, there were significant differences ($P<0.05$) in the growth and body compositions parameters evaluated. The highest mean weight gain of 3.53g, specific growth rate of 2.30 and lowest feed conversion rate of 1.23 were recorded with fish fed diet 3 containing 50% BNM with no significant difference ($P>0.05$) to diet 4 with 75% inclusion level. The findings showed that Bambara nut meal was accepted and utilized by the experimental fish up to 75% bambara nut meal replacement level of fishmeal. Fish feed producers and fish farmers can therefore include it in the feedsuffs.
KEYWORDS: Fish meal, feed utilization, bambara nut meal, *Clarias gariepinus*

INTRODUCTION

In the world today, aquaculture accounts for an increase of 10 % in fish production (1). In other to maintain such demand constant increment in feed production is important (2). Feed production cost has been considered to be the highest cost in aquaculture practices today, which often ranges from 30 – 70% of total production cost (3). The cost effectiveness in feed production especially fish meal as well as its unavailability has brought to notice the need to search for various alternative protein sources in feed production (4). Research has also been placed on the use of other plants protein source, such as soybeans (5, 6), cottonseed (5, 7) and rapeseed meal (5). To reduce the production cost of a balanced diet in aquaculture, locally sourced feed ingredients such as agricultural by-products proteins source from plant are to be included in the diet. Alternative sources of protein from plant product to replace fish meal is cheaper and vital because of the unavailability and cost implication of fish meal (8). As world population rises, the demand for high fish protein from aquatic sources has risen considerably and increase in aquaculture production is required to meet world demand because wild fisheries is showing precipitous decline due to over exploitation, habitat degradation, pollution and unstable global climatic condition (9). The success of aquaculture production depends on adequacy of good nutrition. Bambara-nut is one of the well know plant in Africa, which is been favored in terms of nutritional value and tolerance to adverse environmental conditions. It is has been recorded as the third most important legumes plant after groundnut and cowpea respectively. It is a leguminous plant common to the groundnut which is usually grown for its underground seeds especially in the middle belt region and Enugu state of Nigeria (10, 11). The seeds are often eaten raw when immature while the hard mature seeds have to be roasted or boiled for consumption. The crude protein level of the seed ranges from 14-24% protein, about 60% carbohydrate, and it is higher in essential amino acids like isoleucine, leucine, lycine, phenylalanine, threonine, valine and methionine than most other grain legumes including groundnut (12, 13). It contains 6-12 % oil an amount that is lesser than that in peanuts.. Bambara groundnut has not been effectively cultivated or underutilized especially in hostile tropical environments (14). The utilization of Bambara nut is also limited by the presence of growth inhibitors such as trypsin and chymotrypsin inhibitors, phytates, nitrates and cyanogen's (15, 16). Traditional processing techniques such as soaking, pouting or cooking have limited effects on the improvement of protein quality of grain legumes (17, 18) and deficiencies in some essential amino acids (19). In view of challenges posed by fishmeal in feed industry, research into alternative protein source such as Bambara nut in the diet of *Clarias*

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gariepinus becomes imperative. The objective of this research therefore, is to evaluate the growth and body composition of *Clarias gariepinus* fingerlings fed graded level of Bambara nut (*Vigna subterranean)* meal.

MATERIALS AND METHODS

The experiment was carried out in the laboratory of Water Resources, Aquaculture and Fisheries Technology department of the Federal University of Technology Minna-Nigeria, Gidan – Kwano campus. Catfish fingerlings of an average weight 0.95±0.07g were purchased from T.J.Farm Ilorin, Kwara state, Nigeria and were transported in a 50 litre jerry can to the laboratory and acclimatized in a plastic tank for one week. The feed stuffs used included maize, Bambara nut, fish meal, vegetable oil, and vitamin mineral premix were purchased at Minna markets. The feed ingredients were milled separately and analyzed for their proximate compositions (crude protein, crude lipid, ash, nitrogen free extract and moisture content according to AOAC (20). Persons square method of feed formulation was used to formulate the 5 diets. 20 fishes were randomly stocked in replicate of 15 tanks of dimension 30 x 60 x 30cm of 20 litres capacity. The formulated diets contained varying inclusion levels of Bambara nut meal (BNM) in replacement for fishmeal and designated as diet 1 (0% BNM , 100 FM); diet 2 (25% BNM, 75% FM); diet 3 (50:50 BNM/FM); diet 4 (75% BNM, 25%FM) and diet 5 (100% BNM, 0% FM). These were fed to the experimental fishes at 3% body weight per day which was adjusted fortnightly. Water exchange was done on a daily bases with the siphoning of feacal matter and uneaten feed. The water quality parameters were also monitored on weekly bases for temperature using clinical thermometer, dissolved oxygen according to the method of winker's (21, 22), hydrogen iron concentration (pH) was measured using EIL 7045/46 pH meter in the laboratory at room temperature while conductivity was monitored using conductivity meter (Table 1).

Table 1: Water Quality Parameters

Parameters	Diet 1	Diet 2	Diet 3	Diet 4	Diet 5
Temperature ^{o}C)	25.50	25.17	24.71	24.25	25.46
pH	7.23	6.90	6.95	7.23	7.24
Dissolved oxygen (mg/l)	0.33	0.34	0.43	0.33	0.33
Conductivity (µm/S)	171.30	169.04	202.22	204.21	202.04

Chemical Analysis

The diets and carcass compositions before and after the feeding trials were analysed according to the method of Association of Official Analytical Chemists-AOAC (20) for crude protein, crude fibre, fat, ash and dry matter contents.

Table 2: Formulated Diets And the Proximate Composition

Feedstuff	Diet1 (0% BNM)	Diet 2 (25% BNM)	Diet 3 (50% BNM)	Diet 4 (75% BNM)	Diet 5 (100% BNM)
Fishmeal (FM)	68.85	55.60	41.70	27.80	0
Maize meal (MM)	26.15	11.60	11.60	11.60	37.70
Bambara nut meal (BNM)	0	27.80	41.70	55.60	57.30
Vegetable oil	2	2	2	2	2
Vitamin-mineral premix	3	3	3	3	3
Total	100	100	100	100	100
Proximate compositions (%)					
Crude protein	49.00	47.25	49.00	47.25	50.75
Crude fat	16.00	14.12	12.00	14.12	16.08
Fibre	5.00	3.10	5.70	3.10	5.40
Ash	4.50	6.20	7.80	6.20	5.10
Moisture	8.00	9.11	9.01	9.11	9.10

Experimental analyses and Biological evaluation

Final values for each treatment represent the arithmetic mean of the triplicates. Feed intake was monitored to establish average feed intake and their effects on growth. The growth and nutrient utilization parameters measured included weight gain, specific growth rate (SGR), feed conversion ratio (FCR), the parameters were computed according to the methods of (23); and (24); protein efficiency ratio (PER), Apparent Net Protein Utilization (ANPU) and Apparent Digestibility Co-efficient (ADC %) were also evaluated using the formula of (25); (23)

Mean weight gain = Mean final weigh – mean initial weight

Specific Growth Rate (SGR)= $\frac{(Log_e W_2 - Log_e W_1)}{T_2 - T_1}$ X 100

Where, W_2 and W_1 represent – final and initial weight,

T_2 and T_1 represent – final and initial time (26)

Feed conversion ratio – Feed fed on dry matter/fish live weight gain

Protein efficiency ratio (PER) =Mean weight gain per gram of crude protein fed (27)

Protein intake (g) = Feed intake x crude protein of feed.

Apparent Net Protein utilization=Final Carcass protein - Initial Carcass Protein/Protein intake x 100

The Apparent Digestibility Coefficient was also evaluated using the formula;

$$(\%\ ADC) = 100 - \frac{(100 \times \%AIA \text{ of diets} \times \% \text{ Nutrient}}{\% \text{ AIA of faecal} \times \% \text{ Nutrient in diets}}$$

While, Acid insoluble Ash (AIA) as internal indicator (28) which was carried out according to the method of (29),

$$\%\ \text{Acid insoluble Ash (AIA)} = \frac{\text{weight of AIA}}{\text{weight of sample taken}} \times \frac{100}{1}$$

Statistical Analysis

Results of carcass composition, the evaluation of biological parameters, and all other data obtained were subjected to one way analysis of variance (ANOVA) using Turkey's test (30) at 5% probability level. Multiple parameter means comparison of treatments was according to Duncan multiple range tests (31). All statistics analyses including regression were executed using the software Minitab Release 14 and graphical analyses were plotted with Microsoft Excel Window 2007.

RESULT

From the result shown in Table 3, there were significant differences ($P<0.05$) in the growth parameters evaluated. The control diet (0% BNM) was not significantly different ($P>0.05$) from diet 4 (75% BNM) in their mean weight gains (2.49 and 2.41g respectively) while, diet 2 (25% BNM) exhibited a significantly higher ($P<0.05$) mean weight gain (MWG) of 2.56g than diet 4 (75% BNM; 2.41g) while diet 5 (100% BNM) gave significantly lower ($P<0.05$) MWG (1.86g).

Furthermore, there was no significant difference ($P>0.05$) in the specific growth rate (SGR) values among diets 1, 3, 4 and 5 which were significantly higher ($P<0.05$) than diet 2. However, the protein efficiency ratio (PER) values exhibited no significant differences ($p>0.05$) among the test diets except for the control diet that was significantly lower ($P<0.05$). The apparent nutrient protein utilization (ANPU) for various diets showed significant differences ($P<0.05$) among the diets, with diet 3 exhibiting highest value (14.18%) while diet 5 recorded lowest value (3.36%) On the percentage mortality, diet 2 had the highest mortality (13%) while diet 4 gave the lowest mortality (5%). The body composition also showed significant differences among diets (Table 4). Diets 3 and 4 gave a significantly higher ($P<0.05$) carcass body protein value of 61.31% than other diets, while diet 1 (control diet) had significantly low ($P<0.05$) body protein of (54.35%). Diet 2 gave a higher value for lipid, the least been diet 5, while diet 2 was significantly higher ($P<0.05$) than all diets. The ash content of diets also indicated significant differences ($P<0.05$), moreover, there were no significant differences ($P<0.05$) between diets 1and 3 while diets 2, 4 and 5 exhibited significant differences ($P<0.05$) from each other. However, diet 4 recorded the lowest value of ash (6.50) which makes it significantly different ($P<0.05$) from other diets. Diet 3 recorded the lowest value for moisture (13.00) which was significantly different ($p<0.05$) from other diets. The apparent digestibility coefficient (ADC %) of nutrients also indicated significant differences ($P<0.05$) among diets Table 5). Diets 1, 2, 3 and 5 recorded significantly high ($P<0.05$) protein digestibility values with no significant difference ($P>0.05$) among the diets while diet 4 was significantly ($P<0.05$) the lowest. On the lipid digestibility, diets 4 and 5 gave a significantly high ($P<0.05$) value while diets 1 and 2 recorded low digestibility. However, diets 2 and 4 exhibited a significantly high ($P<0.05$) fiber values while diets 1 and 3 were the lowest. The ash digestibility was significantly high ($P<0.05$) for diets 1 and 2 while diet 4 was lowest.

The growth curve gave an indication of diet 4 performing better than other diets followed by diet 3 while diet 5 whose performance in comparison with diet 2 earlier on was lower suddenly showed significant improvement at from the 5th week into the trial (figure 1).

Table 3: Growth parameters of *Clarias gariepinus* fed Bambara nut meal for 56 days

Growth Parameters	Diet 1	Diet 2	Diet 3	Diet 4	Diet 5	SD±
Mean Initial Weight gain (g)	$0.94^{a}\pm 0.07$	$0.97^{a}\pm0.92$	$0.97^{a}\pm0.88$	$0.92^{a}\pm0.88$	$0.94^{a}\pm0.66$	±0.07
Mean Final Weight gain (g)	$3.43^{a}\pm0.24$	$2.62^{c}\pm0.60$	$3.53^{a}\pm0.49$	$3.33^{a}\pm0.56$	$2.80^{b}\pm0.32$	±0.43
Mean weight gain (g)	$2.49^{b}\pm0.24$	$1.65^{c}\pm0.12$	$2.56^{a}\pm0.47$	$2.41^{b}\pm0.05$	$1.86^{c}\pm0.25$	±0.32
Feed Conversion Ratio	$1.29^{a}\pm0.5$	$1.12^{a}\pm0.02$	$1.23^{a}\pm0.09$	$1.24^{a}\pm0.81$	$1.19^{a}\pm0.64$	±0.06
Specific Growth Rate (%/day)	$2.22^{a}\pm0.76$	$1.57^{b}\pm0.26$	$2.30^{a}\pm0.02$	$2.29^{a}\pm0.17$	$2.27^{a}\pm0.64$	±0.30
Protein Efficiency Ratio	$0.78^{b}\pm0.01$	$0.90^{a}\pm0.10$	$0.81^{a}\pm 0.01$	$0.81^{a}\pm0.01$	$0.83^{a}\pm0.01$	±0.01
Apparent Net Protein Utilization	$6.87^{d}\pm0.01$	$8.7^{c}\pm0.14$	$14.18^{a}\pm0.01$	$9.26^{b}\pm0.01$	$3.36^{e}\pm0.01$	±0.01
Mortality (%)	$3.30^{e}\pm0.01$	$13.36^{a}\pm0.01$	$6.67^{c}\pm0.01$	$5.00^{d}\pm0.01$	8.34±0.01	±0.01

Mean data on the same row carrying different superscripts differ significantly from each other ($p<0.05$)

Table 4: Body composition of *Clarias gariepinus* fingerlings fed graded levels Bambara nut for 56 days

Body Compositions (%)	Initial	Diet 1	Diet 2	Diet 3	Diet 4	Diet 5	SD±
Crude protein	$54.46^{a}\pm0.01$	$57.71^{b}\pm0.01$	$54.62^{c}\pm0.01$	$61.31^{a}\pm0.01$	$61.31^{a}\pm0.01$	$56.04^{b}\pm0.01$	±0.01
Crude fat	$20.40^{d}\pm0.01$	$22.01^{c}\pm0.01$	$25.71^{a}\pm0.01$	$23.04^{b}\pm0.01$	$23.00^{b}\pm0.01$	$18.00^{e}\pm0.01$	±0.03
Crude fibre	$3.70^{c}\pm0.01$	$6.06^{b}\pm0.06$	$5.30^{b}\pm0.01$	$5.10^{b}\pm0.01$	$5.10^{b}\pm0.01$	$5.20^{b}\pm0.01$	±0.03
Ash	$6.12^{d}\pm0.01$	$13.51^{c}\pm0.01$	$17.97^{b}\pm0.06$	$13.60^{c}\pm0.02$	$6.5^{d}\pm0.01$	$18.00^{a}\pm0.01$	±0.03
Moisture	$49.58^{a}\pm 0.06$	$33.33^{b}\pm0.59$	$21.00^{d}\pm0.01$	$13.00^{f}\pm0.10$	$14.00^{e}\pm0.01$	$24.00^{c}\pm0.01$	±0.00

Mean data on the same row carrying different superscripts differ significantly from each other ($p<0.05$)

Table 5: Apparent Digestibility Co-efficient (ADC %)

ADC (%)	25% BNM	50% BNM	75% BNM	100% BNM	SD±
Crude protein	$81.81^{b}\pm0.01$	$83.60^{a}\pm0.10$	$73.54^{c}\pm0.02$	$81.61^{b}\pm0.01$	±0.02
Crude lipid	$32.67^{c}\pm0.01$	$51.05^{c}\pm0.01$	$64.70^{b}\pm0.01$	$65.30^{a}\pm0.01$	±0.01
Crude fibre	$11.50^{b}\pm0.01$	$5.40^{c}\pm0.01$	$0.72^{c}\pm0.01$	$8.43_{d}\pm0.01$	±0.01
Ash	$18.37^{a}\pm0.59$	$5.40^{c}\pm0.01$	$7.90^{d}\pm0.01$	$13.01_{b}\pm0.01$	±0.01
Dry Matter	$81.63^{a}\pm0.59$	$85.47^{c}\pm0.01$	$92.1\ \ 0^{d}\pm0.01$	$84.18^{d}\pm0.01$	±0.01

Mean data on the same row carrying different superscripts differ significantly from each other ($p<0.05$)

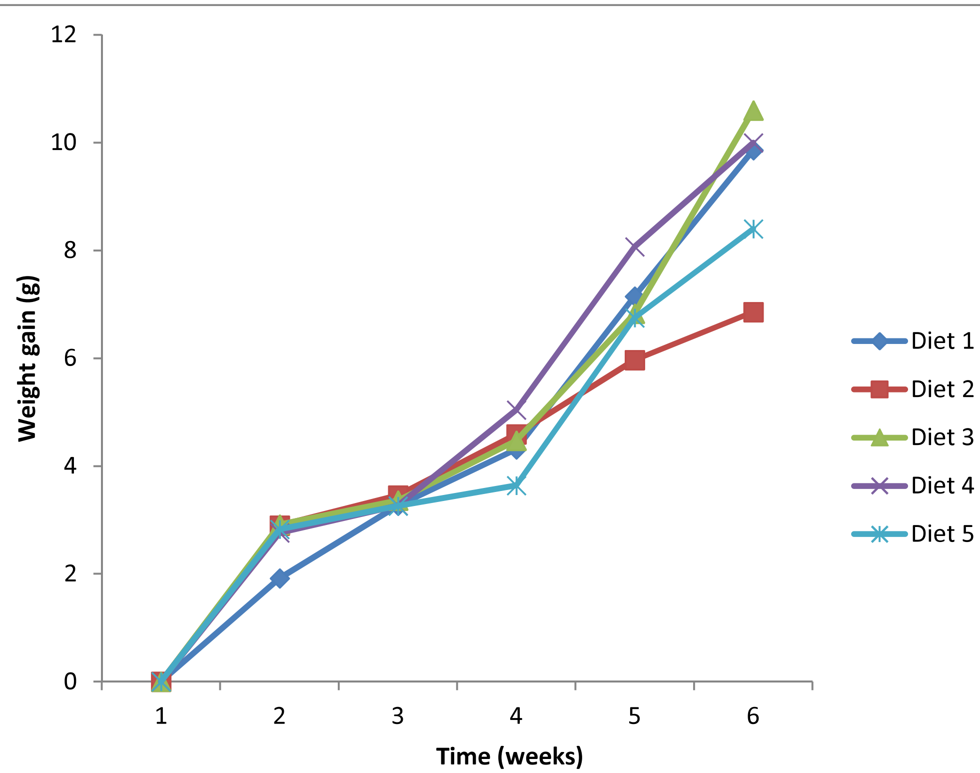

Fig. 1: Growth Response of Clarias gariepinus fed varying inclusion levels of Bambara nut meal for 56 days

DISCUSSION

The results obtained indicated acceptance of diets which was reflected in the growth and body compositions of *Clarias gariepinus,* (fig. 1) this is in agreement with (13) who reported that, Bambara nut seed has enough quantity of carbohydrate, protein and fats with relatively high proportion of lysine and methionine as percentage of the protein. This is also corroborated by (32) who reported that, Bambara groundnut is a good source of minerals and can be helpful in formulating a balanced diet. (5) reported that Tilapia performed well on a diet containing 50% pigeon pea *Cajanuscajan*) and Bambara nut (*Vigna subterranean* L.) as replacement for fishmeal. However, (33) reported decline in growth and feed digestibility when cotton seed meal was stepped up from 25% to 75% in the diet of *Oreochromis niloticus*, he then pronounced a maximum of 50% replacement for fishmeal. (34) reported depressed growth and even mortality of tilapia after been given up to 100% Cotton seed meal of the feed and recommended an inclusion level of about 50%. The least growth performance as obtained from this research was from fish fed 100% Bambara ground nut meal. This indicates that Bambara nut cannot be used exclusively in the diet of *Clarias gariepinus* which stresses the unique attribute of fishmeal in fish feed. (35) reported better growth performance and feed utilization efficiency in Asian Catfish (*Clarias batrachus*) fed feeds with animal protein than those of plant as observed with soybeans meal despite its high protein profile. The low performance could be attributed to poor feed efficiency of plant protein compared with fishmeal (36). However, the performance of *Clarias gariepinus* fed bambara nut meal in this experiment can be compared with the utilization of cotton seed meal by *Oreochromis niloticus* in the work of (33) that reported inclusion level up to 75% in its diet without any adverse effect.

Conclusion

In conclusion, it can be deduced from the study that, 75% of bambara nut meal would replace fishmeal in the diet of *Clarias gariepinus* without any adverse effects on its growth and body compositions.

Recommendation

Farmers can adopt the inclusion of bambara nut meal at 75 % fishmeal replacement level in the formulation of Catfish feed.

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