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Research Article

Growth Performance of *Clarias gariepinus* (Burchell, 1822) Fed with *Vigna subterranea* at Different Inclusion Levels

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ABSTRACT

Vigna subterranea is an herbaceous legume from the family Fabaceae reported to contain 14-24% crude protein. The overdependence on fishmeal has led to inflation in the price of the fish feed thereby making fishes expensive. The experiment aims at evaluating the growth performance of *Clarias gariepinus* fed with *Vigna subterranea* at different inclusion levels. The effect of *Vigna subterranea* (Bambara nut) as an ingredient in the diets of *Clarias gariepinus* with an average body weight of 5.97±15 was evaluated over eight (8) weeks feeding trial. Six experimental diets were formulated at 0%, 10%, 20%, 30%, 40% and 50% inclusions of Bambara nut meal (BNM) and a control (commercial feed) labelled T1, T2, T3, T4, T5, T6 and T7 respectively. The seeds were processed by soaking in water, air dried, toasted and ground using a mortar and pestle to obtain Bambara nut meal used to replace fishmeal at different inclusion levels. The experiment was conducted using 25 litre capacity rubber tanks at the stocking density of 10 fingerlings per tank and replicated three times. Fish-fed T6 (50% inclusion of BNM) produced the best result, it was followed by T5 and T4 though there was no significant difference between the control (0% and commercial feed) and the formulated diets at p-value (<0.05). The study shows that processed BNM can replace fish meal in the diet of African Catfish at graded levels of up to 50%.

Keywords: Fishmeal; *Vigna subterranea*; Substitution; Clariid fish; Growth

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INTRODUCTION

Vigna subterranea also called Bambara-nut is one of the well-known plants in Africa, and is been favoured in terms of nutritional value and tolerance to adverse environmental conditions. It has been recorded as the third most important legume 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 (Wanyama, 2018; Jideani & Jideani, 2021). 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. It contains 6-12 % oil an amount that is lesser than that in peanuts (Mbuma *et al*., 2022)
Bambara nut has not been effectively cultivated or underutilized especially in hostile tropical environments. 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. Traditional processing techniques such as soaking, pouting or cooking have limited effects on the improvement of protein quality of grain legumes and deficiencies in some essential amino acids. In view of challenges posed by fishmeal in feed industry, research into alternative protein source such as Bambara nut in the diet of *Clarias gariepinus* becomes imperative. The essential amino acid content of Bambara groundnut such as lysine 6.82g/16gN, methionine

1.85g/16gN and cysteine 1.24g/16gN is comparable to that of soybean with 6.24g/16gN lysine, 1.14g/16gN methionine and 1.80g/16gN cysteine (Bala & Rano, 2022)

Processing methods such as dehulling, milling, soaking, cooking, fermentation, autoclaving, roasting and frying have been found to reduce/ eliminate anti-nutritional factors present in feed ingredients. Soaking, drying and milling processes significantly reduced the trypsin inhibitor, tannins, phytate and haemagglutinin of the Bambara nut. The nutritional implication of these reductions in the concentration of trypsin inhibitor is that it will lead to improvement in protein digestibility. Fermentation is a simple and cheap method to decrease the anti-nutritional factors contained in plants by-products (Pokharel, 2022).

The aim of this research was to evaluate the growth performance of Catfish fed processed *Vigna subterranea* for eight weeks of feeding trials.

MATERIALS AND METHODS

Study Area

The research was carried out in the Zoology Garden, Department of Biological Sciences, Kaduna State University located at Latitude 10.31^0 North and Longitude 7.26^0 East and 6.14 meters above the Sea Level

Source of *Vigna subterranea*

Twenty-five kilograms (25Kg) of *Vigna subterranea* were sourced from Station market within Kaduna metropolis, and taken to Biological Sciences Department, Kaduna State University for identification and authentication. The specimen was assigned the reference number KASU/BSH/7516. This method was adopted by Aminu and Ibrahim (2022).

Source of Experimental fish

One hundred and eighty (180) mixed sex's fingerlings of *Clarias gariepinus* were procured from the Federal Ministry of Agricultural and Rural Development Live House Mando Road Kaduna State. The fish were harvested, kept overnight, and transported early in a 25-liter capacity jerry can to the experimental site. The fish were fed with 2mm sized commercial feed containing CP of 40% for two weeks acclimatization period Cui *et al*. (2024).

Preparation and Processing of *Vigna subterranea*

Vigna subterranea seeds were washed and soaked in water for twenty-four hours, air dried and pulverised into fine powder using mortar and pestle to obtain Bambara nut meal tagged (BNM). This method was adopted by Saidu *et al*. (2023).

Feed formulation of the experimental diet

The experimental feeds were formulated using Pearson's Square Method, incorporating maize as an energy source, groundnut cake and fishmeal as protein sources, and *Bambara nut* meal as a partial fishmeal replacement at inclusion levels of 0%, 10%, 20%, 30%, 40% and 50%. Other ingredients, including vitamin premix, wheat offal, rice bran, methionine, lysine, and water, were also added. The mixture was pelleted to a size of 3 mm using a local pelleting machine at Uyama Agro Nigeria Limited, Kaduna. This method was adopted by Apollo *et al*. (2021).

Experimental Design

The experiment consists of seven treatments each representing 0, 10, 20, 30, 40, and 50 percent inclusions of Bambara nut meal to replace fishmeal in diet T1, T2 T3, T4, T5, and T6 that were formulated. Each of these treatments was replicated thrice. The controls (T7 or commercial feed) have no inclusion of Bambara nut meal. Twenty-one plastic tanks of 25 litres capacity were used at the stocking density of 10 fish per tank. Feeding was twice a day at 5% body weight in the morning around 9:00 am, and evening around 4:00pm throughout the eight weeks experimental period. Water was changed every 24hours in order to avoid stressing the fish throughout the eight-week experimental period as adopted by Afia *et al*. (2020).

Growth performance

Weight and length of the experimental fish were taken using weighing balance and metre rule respectively once in every two weeks to determine the total weight gain (TWG) and total length gain as adopted by Aminu and Ibrahim (2022).

Performance evaluation

During the experiment, fish performance was based on productivity indices on growth performance and nutrient utilization efficiencies as described by Abo-Taleb *et al*. (2021).

Total feed intake (TFI)

Total feed intake was estimated by summing the weekly feed intakes during the period of the experiment (Sun *et al*., 2022).

Total weight gain (TWG)

Total weight gain was obtained as the difference between the initial weight and the final weight gained of the experimental fish using the formula below:

Total weight gain (TWG) = final weight – initial weight (Al Sulivany *et al*., 2024)

Total percentage weight gain (TPWG %)

Total percentage weight gain was calculated using the formula below:

TPWG = Total weight gained **/** Initial weight x 100% (Al Sulivany *et al*., 2024).

Feed conversion ratio

From the feed consumed by each group of fish and weight gained, the feed conversion ratio (FCR) was calculated using the expression adopted by

FCR = Feed Intake / Net weight gain (Elvy *et al*., 2022).

Protein Efficiency Ratio

Protein Efficiency Ratio (PER) was calculated from the weight gain obtained from the test subject divided by its intake of a particular feed protein during the test period. Hence

PER = Gain in body mass (g)/ Protein intake (g) (Hoskin, 2023).

Data Analysis

Analysis of Variance (ANOVA) was used to evaluate significant differences among experimental fish fed different inclusions of *Vigna subterranea* and the controls. P-value < 0.05 was considered to be significant. The statistical package used was Statistical Analysis System (SAS) version 9.4.

RESULTS

Initial and Final Length of *Clarias gariepinus* Fed with *Vigna subterranea* for Eight Weeks Feeding Trials

The average initial length of *Clarias gariepinus* at the commencement of the experiment ranged from 5.97±0.15 to 6.10±0.44 cm. Statistical analysis (p > 0.05) revealed no significant difference in the initial weights across all treatments, indicating a uniform distribution of the experimental fish (Table 1).

Table 1 shows that the final length gain of *Clarias gariepinus* fed Bambara nut meal at different inclusion levels for eight weeks of feeding trials was between 15.1±0.06cm to 16.2±0.06cm. At p-value >0.05, the least significance difference (LSD) indicated that there was significant difference between the treatments and the control fed commercial feed.

Average Initial and Final Weight Gain of *Clarias gariepinus* Fed with *Vigna subterranea* for Eight Weeks Feeding Trials

The average initial weight of the experimental fish before the start of the feeding with Bambara nut meal for eight weeks was between 4.33±0.05 and 4.83±0.10. The result of Analysis of Variance revealed that there was no significant difference at p-value (<0.05) (Table 2).

The final weight of the experimental fish fed Bambara nut meal for eight weeks was between 22.7±0.15g and 25.5±0.06g. The highest result was found in Treatment 1 and 7 which produced 22.7±0.15g and 26.7±0.10g respectively. This is followed by Treatment 2, 4, 5, 6, and 7 with the values of 22.66±0.10g, 25.5±0.06g, 22.6±0.10g, 22.6±0.10g, and 22.6±0.6g respectively. The result of analysis of variance (ANOVA) shows that there was no significant difference at p-value (<0.05) with the control (Table 2).

Specific Growth Rate (SGR) of *Clarias gariepinus* Fed with *Vigna subterranea* for Eight Weeks Feeding Trials

The specific growth rate (SGR) of the experimental fish-fed Bambara nut meal for eight weeks ranged from 2.77±0.03 to 3.13±0.00. Treatment 3 has the highest value of 3.13±0.00, followed by Treatment 2 with 2.91±0.02. The lowest value was observed in the control (commercial feed) with 2.77±0.03. The result of the analysis of variance revealed that there was a significant difference at p-value (<0.05) when compared with the control (Table 3).

Feed Conversion Ratio (FCR) of *Clarias gariepinus* Fed with *Vigna subterranea* for Eight Weeks Feeding Trials

The feed conversion ratio of the experimental feed fed Bambara nut meal for eight weeks ranged from 2.16 – 2.29. The best result was observed in Treatment 3 with 2.16, followed by Treatment 4 with 2.18. The least was observed in the control with 2.29 (Table 3).

Survival Rate of *Clarias gariepinus* Fed with *Vigna subterranea* for Eight Weeks Feeding Trials

The result of analysis of variance shows that there was hundred percent survival rate of the experimental fish fed experimental feed (Bambara nut meal) at different inclusion level (Table 3).

Table 1. Average Body Length (cm) of the *Clarias gariepinus* fed *Vigna subterranea* for eight weeks feeding Trials

Parameter	T1 (0%)	T2 (10%)	T3 (20%)	T4 (30%)	T5 (40%)	T6 (50%)	Commercial
W1	5.80±0.25^{e}	6.03±0.25^{e}	6.10±0.36^{e}	5.97±0.15^{e}	6.10±0.36^{e}	6.10±0.44^{e}	6.10±0.26^{e}
W2	10.6±0.15^{d}	10.7±0.12^{d}	10.8±0.20^{d}	10.9±0.12^{d}	10.8±0.20^{d}	10.8±0.20^{d}	10.9±0.10^{d}
W4	12.1±0.10^{c}	12.2±0.06^{c}	12.5±0.06^{c}	12.4±0.12^{c}	12.1±0.06^{c}	12.1±0.06^{c}	12.1±0.06^{c}
W6	14.6±0.21^{b}	14.6±0.06^{b}	14.7±0.06^{b}	14.8±0.00^{b}	14.6±0.00^{b}	14.6±0.06^{b}	14.6±0.06^{b}
W8	15.8±0.12^{a}	15.8±0.06^{a}	16.2±0.06^{a}	16.0±0.06^{a}	15.1±0.06^{a}	15.1±0.06^{a}	15.1±0.06^{a}
p value	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

Values are given as mean standard deviation. In each column, means with the same letter are not significantly different ($p < 0.05$), T1= Treatment 1, T2= Treatment 2, T3= Treatment 3, T4= Treatment 4, T5= Treatment 5, T6= Treatment 6

Table 2. Mean Body weight (g) of the *Clarias gariepinus* fed Bambara nut meal for eight weeks Feeding Trials

Parameter	T1 (0%)	T2 (10%)	T3 (20%)	T4 (30%)	T5 (40%)	T6 (50%)	Commercial
W1	4.50±0.17^{e}	4.33±0.05^{e}	4.63±0.06^{e}	4.50±0.11^{e}	4.53±0.12^{e}	4.63±0.21^{e}	4.83±0.10^{e}
W2	6.67±0.12^{d}	6.63±0.15^{d}	6.63±0.12^{d}	6.70±0.17d	6.80±0.17^{d}	6.73±0.12^{d}	6.67±0.06^{d}
W4	10.7±0.12^{c}	11.1±0.06^{c}	13.5±0.06^{c}	12.3±0.06^{c}	10.5±0.06^{c}	10.9±0.06^{c}	10.8±0.06^{c}
W6	15.2±0.10^{b}	15.5±0.10^{b}	18.4±0.10^{b}	17.5±0.10^{b}	15.4±0.10^{b}	15.6±0.06^{b}	15.7±0.06^{b}
W8	22.7±0.15^{a}	22.66±0.10^{a}	26.7±0.10^{a}	25.5±0.06^{a}	22.6±0.10^{a}	22.6±0.10^{a}	22.6±0.6^{a}
p value	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

Values are given as mean standard deviation. In each column, means with the same letter are not significantly different ($p < 0.05$), T1= Treatment 1, T2= Treatment 2, T3= Treatment 3, T4= Treatment 4, T5= Treatment 5, T6= Treatment 6

Table 3. Feed Utilization Parameters Survival Rate of *Clarias gariepinus* Fed with *Vigna subterranean* for Eight Weeks Feeding Trials

Parameter	T1 (0%)	T2 (10%)	T3 (20%)	T4 (30%)	T5 (40%)	T6 (50%)	Commercial
FBG (g)	22.7±0.15^{c}	22.6±0.10^{c}	26.7±0.10^{a}	25.5±0.06^{b}	22.6±0.10^{c}	22.6±0.10^{c}	22.6±0.6^{c}
IBW (g)	4.50±0.17^{d}	4.33±0.05^{e}	4.63±0.06^{b}	4.50±0.11^{d}	4.53±0.12^{c}	4.63±0.21^{b}	4.83±0.10^{a}
WG (g)	18.2±0.31^{c}	18.2±0.06^{c}	22.1±0.15^{a}	21.0±0.06^{b}	18.1±0.06^{cd}	17.9±0.21^{cd}	17.8±0.10^{d}
PWG (%)	404.3±22.6^{b}	409.8±4.79^{b}	476.3±9.05^{a}	467.4±1.28^{a}	398.7±11.0^{b}	388.4±22.0^{bc}	370.9±8.91^{c}
SGR (%)	2.89±0.08^{b}	2.91±0.02^{b}	3.13±0.00^{a}	2.87±0.04^{b}	2.87±0.04^{b}	2.83±0.08^{cb}	2.77±0.03^{c}
FI (g)	40.77	40.22	47.74	45.78	40.73	40.63	40.76
FCR	2.24	2.21	2.16	2.18	2.25	2.27	2.29
PI	21.4	22.2	22.3	21.4	21.1	20.9	20.7
PER	0.85	0.82	0.98	0.97	0.86	0.86	0.86
Survival (%)	100	100	100	100	100	100	100

Values are given as mean standard deviation. In each column, means with the same letter are not significantly different ($p < 0.05$). FBW: Final Body Weight; IBW: Initial Body Weight; WG: weight gain; PWG: percentage weight gain; SGR: specific growth rate; FI: feed intake; FCR: feed conversion ratio; PER: protein efficiency ratio FCR=Feed Intake (FI)/Weight Gain (WG) Protein Intake (PI)=FI*percent protein in feed PER=WG/PI

DISCUSSION

The growth performance of the *Clarias gariepinus* fed with *Vigna subterrane* at different inclusion levels revealed that, the average initial weight at the onset of the feeding trials, there was no significant difference among the Treatments and the control at p-value (<0.05). This also showed that all the treatments and the control were given an equal chance to compete in attaining a particular weight gain. While the average weight gain at the end of eight weeks feeding trials is in conformity with result obtained by Jahan *et al*. (2021) who worked on evaluation of the partial replacement of dietary fish meal with fermented or untreated soybean meal in juvenile silver barb, *Barbonymus gonionotus*. This is in conformity with work of Mohammed *et al*. (2024) who experimented on the growth performance of *Oreochromis niloticus* fed Bambara nut and concluded that incorporating up to 50% Bambara nut meal does not have a detrimental effect on the growth. This is consistent with the result obtained by Ishiwu *et al*. (2020) who worked on the assessment of growth performance of African catfish (*Clarias gariepinus*) fed with feed produced from blend of pigeon pea (Cajanuscajan). Bambara groundnut (*Vigna subterranea*) and fish meal and concluded that it is possible to produce quality Catfish feed from bend Pigeon pea, Bambara nut and fishmeal.

However, this result is similar with that of Hekmatpour *et al*. (2023) who worked on Replacement effects of soybean meal with sesame seed cake on growth, biochemical body composition, and economic efficiency of *Cyprinus carpio* formulated diet and concluded that omparable growth performance and measured physiological responses indicated that Soy bean meal could be replaced by 75 to 100% Sesame seed cake in the formulated diet of *Cyprinus carpio* juveniles. The result also agreed with that of Oliva-Teles *et al*. (2022) who worked on Replacing fish meal and fish oil in industrial fish feeds. The result is also consistent with that of Al Sulivany *et al*. (2024) who worked on influence of dietary protein content on growth performance, feed efficiency, condition factor, and length-weight relationship in *Cyprinus carpio* during the summer season.

The result of feed conversion ratio obtained in this research is similar with that of Yusuf *et al*. (2024) who worked on effect of replacement of Soyabean (glycine max) meal with Bambara nut (*Vigna subterranea*) hull meal in the diet of African Catfish (*Clarias gariepinus*) juveniles, they concluded that Bambara nu hull meal contains necessary growth

factors required for *Clarias gariepinus* juvenile and 25% is recommended for use.

The survival rate of *Clarias gariepinus* fingerlings fed *Vigna subterranea* suggested that all diets including the control were suitable for the fish and met its nutritional requirement which may be due to the processing method applied to the seeds. This result is in conformity with that of Yusuf *et al*. (2024) who acknowledged that *Clarias gariepinus* can tolerate and survive more with the diet containing Bambara nut meal than that of Soybean meal.

CONCLUSIONS

The study reveals that the *Clarias gariepinus* fed Bambara nut meal at different inclusion levels and commercial (control) produced a final weight gain that ranges between 22.6±0.10 and 26.7±0.10. It is concluded that Bambara nut Meal can replace fish meal up to 50% inclusion level.

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