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EFFECT OF REPLACEMENT OF SOYABEAN (*Glycine max)* MEAL WITH BAMBARA NUT *(Vign asubterranea*) HULL MEAL IN THE DIET OF AFRICAN CATFISH (*Clariasgariepinus*) JUVENILES

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ABSTRACT
Bambara nut (Vignasubterranea) hull meal is produced as a waste product during the processing of Bambaranut into human food. This waste product is usually discarded. A study was therefore conducted in the Laboratory of the Department of Fisheries and Aquaculture, Faculty of Agriculture, Prince AbubakarAudu University, Anyigba to determine the effect of replacing soya bean (Glycine max) meal with Bambara nut hull meal in the diet of African catfish (Clariasgariepinus) juvenile. Five diets were formulated with replacement of soya bean meal with Bambara hull meal at 0% replacement, designated as D1, 25% replacement D2, 50% D3, 75% D4 and 100% D5, were used to feed one hundred and fifty(150) juveniles of Clariasgariepinus with the initial weight of 18± 1.35g in bioassay of five units with three replicate. The experiment was designed as Completely Randomized Design (One Way ANOVA) with five treatments and three replicates. The data collected were subjected to Analysis of Variance.The significance of the means was determined by least significant difference (LSD) using the SPSS version 23 (2015) statistical software package. The result of the physicho-chemical parameter of the water of the bioassay water was within the optimal range recommended by WHO for the culture of fresh water fishes. The results of growth performance, feed utilization and survival ofClariasgariepinus juveniles fed with different level substitution of soya beans meal with bambara nut hull meal diets showedthe highest weight gain (16.33g) was recorded in the diet two (D2) having 25% replacement, although there was no significant difference (p<0.05) between D2 and D1. However, D5 having 100% replacement had the lowest weight gain (4.33g). Feed Conversion Ratio, Feed Conversion Efficiency and Specific Growth Rate were better with D2 than others. Survival Rate was higher in all other diets than the control diet (D1). This study therefore showed that Bambara nut hull meal contains necessary growth factors required for Clariasgariepinus juveniles and 25% replacement is recommended for use. The study also acknowledged that Clariasgariepinus can tolerate and survive more with the diets containing Bambara nut than diets containing only soya bean meal as the survival rate were higher range from60-70 %in all the diet containing Bamara nut hull meal than with only soya beans meal control,60%.
KEY WORDS: Replacement, Soyabeans meal, Bambara nut hull meal, African Cat fish, Juveniles.

INTRODUCTION

Aquaculture is one of the fastest growing food productions in the world and the product (fish) has continued to be the source of hope towards solving global malnutrition (Ajibade*et al.*, 2021).
Fish is an important source of high-quality protein in human diet, providing about 16% of the animal protein consumed by the world population (Adewole and Alaleye, (2014 ;udo and Ozor 2022) and is also an important source of vitamins A, B, D and E as well as calcium, iron and iodine (Hassan *et al.*, 2017). Fish has the highest of easily metabolizable high quality protein, fats, vitamins, calcium, iron and essential amino acids when compared with other sources of animal protein such as poultry and beef (Ajibade*et al.*, 2021).

In fish culture, the fish culturist is interested in the growth of the fish to meet the table size as quickly as possible and this leads to the rummage around for better ways of promoting fish growth at less expensive cost of feeding (Suman *et al.*, 2023). In fish farming, many research have been carried out on the use of plant protein as an alternative to promote growth with maximum survival rate. Nonetheless, nutrition in fish farming though critical but still remain a challenge (Bayo*et al.*, 2019). Feed cost broadly represents around 70% of total operational cost because proteins are the high-priced dietary source of semi-intensive or intensive grow out farming operation (Hossain *et al.*, 2020a, Hossain *et al.*, 2020b). One of the biggest targets of successful aquaculture is to attain highest growth by investing lowest inputs at lowest price.

As aquaculture production becomes more and moreintensive in Nigeria, fish feed will be a significant factor towards increasing the productivity and profitability of aquaculture (Udo and Ozor, 2022). The need to intensify fish culture so as to meet the ever increasing demand for fish has made it essential to develop suitable diets either in supplementary forms for fish pond or as complete feed for tanks and other artificial enclosures. High fish feed cost is primarily due to high protein requirement of fish (35-42%) which is derived majorly from soyabean meal and fish meal (Ajibade*et al.*, 2021). Soyabean meal, a high-priced feed ingredient, is generally considered one of the major sources of protein for aquafeed production because of its higher protein along with stable amino acids, higher digestible energy and micro nutrients. (Sumon*et al.*, 2023). Effort to reduce fish feed cost have therefore been geared toward fish meal replacement with cheap ingredients. However, the price of soyabean which is a supplementary protein source in fish diet is also soaring due to impact of competition by man and livestock; this therefore calls for a search for its alternatives, hence the study on Bambara nut (Udo and Ozor, 2022).

Bambara groundnut is a highly nutritious legume, climate resistant, grown in most of African countries, in the middle belt region of Nigeria in Kogi, Enugu, Kwara, Niger states (Nizikou, 2019). Bambara groundnut, according to Nzikou2019) is highly Proteinous between 19-20% crude proteins and have high amino acids, vitamins and mineral. Bambara nut is processed into consumable food and taken in various form as source of protein in Nigeria (Abiodun and Adepeju, 2011). Despite the nutrient composition, Bambara nut are still among the lesser known and underutilized crop in Nigeria. Onyimonyi*et al.*,(2007) reported that Bambara nut pods, shells and offalsare the by-product of processing the seeds into flour for human consumption. The offal or hull is produced after splitting the seeds in an attrition mill to remove the shells, winnowing to remove loosened testa and converting the cotyledons into fine flour by milling several times followed by sieving.

In Nigeria, several amounts of offal or hull are been discarded as wastes (Onyimonyi*et al.*, 2007). In Anyigba, where this study is conducted, Bambara nut is being cultivated in a large scale of the land and climate conducive for the crop. As a result, various human food is produced from the Bambara nut which attract the processing of the seed into flour and consequently, large amounts of hull or offal are discarded as a waste. However, Upkabi*et al.*, (2012) reported the nutritional composition of the hull of Bambara nut to contain 21% Crude Protein, 13% Crude Fibre, 9.7% Moisture, 4.6% Ash, 4.7%Ether extract.

This research therefore studied the effect of replacing soybean meal with Bambara nut hull meal in the diet of *Clariasgariepinus* juvenile for eight weeks in water changing bioassay.

2.0 MATERIALS AND METHODS

2.1 Study Area

The research was conducted in Fish Research Farm of the Department of Fisheries and Aquaculture, Prince AbubakarAudu University Anyigba, which lies between latitude $7^0$28’45.7”N and longitude $7^0$11’54.2”E. The average temperature of the area is 26℃, maximum 30℃ and minimum 20℃. It has an average rainfall of (21456.6mm) which is obtained within 130-145 days. The relative humidity is 50-85. Anyigba is within the guinea savanna zone characterized by a period of (6-7 months) rainfall and a period of (5-6 months) of dry season (Ifatimehin*et al*., 2012).

2.2 Collection and processing of ingredients

Bambara nut *(Vignasubterranea)* hulls (testa)was collected from the processors of Bambara nut in Anyigba who produced (MoiMoi). The hull was produced as a by-product of processing Bambara nut in which the nut is soaked in water overnight then peeled by rubbing between the palms. The hull produced was then dried and grind into powder to form the hull meal using hammer mill.
The other ingredients such as soyabean meal, maize etc., were purchased from Kado fish market Abuja.

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2.3Feed Formulation

Feeds or diet were formulated using Pearson’s square methods in combination with trial-and-error methods (Falaye, 2015). All diets were formulated on dry matter basis using the proximate composition of the feed ingredient. Diet formulation is shown table 1.

2.4 Feed Milling and Drying

The formulation was done by converting percentage into weight basis. The ingredients were measured using top load weighing balance (Camry kitchen weighing balance). Each diet was weighed and mixed thoroughly with a mixer and then 10% of cassava starch was used as a binder. Hot water was added into the mixture and the pellets using pelletizing machine. This was sun dried according to different treatment for 15minutes (Udo, 2017)

Table 1. The Formulated Experimental Diets with Percentage Replacement of Soya beans meal with Bambara nut Hull Meal.

S/N	INGREDEINTS(g)	0%(D1)	25%(D2)	50%(D3)	75%(D4)	100%(D5)
01.	Bambara nut (hull meal)	0	75	150	225	300
02.	Soya bean meal	300	225	150	75	0
03.	Blood meal	100	100	100	100	100
04.	Fish meal	200	200	200	200	200
05.	Groundnut cake	200	200	200	200	200
06.	Wheat offal	100	100	100	100	100
07.	Cassava flour	50	50	50	50	50
08.	Bone meal	20	20	20	20	20
09.	Lysine	10	10	10	10	10
10.	Methionine	10	10	10	10	10
11.	Vitamin premix	10	10	10	10	10

2.5 Collection Bioassay Fish

One hundred and eighty juveniles of African cat fish *(C. gariepinus)* were purshased from the Department of Fisheries and Aquaculture Farm, Prince AbubakarAudu University Anyigba. They were acclimated for one week (7 days) in a holding tank before stocking in the bioassay units. During this period, they were fed with commercial feed containing 42% crude protein.

2.6 Experimental procedure

The bioassay was designed as a completely randomized design (CRD) with five treatments and each treatment replicated three times.

Treatment 1 which has zero Bambara nut hull inclusion served as a control. Various replacement levels were designed. T1:0%BGn, T2:25%BGn, T3:50%BGN, T4:75%BGn, T5:100%BGn.

2.7Stocking, feeding and water management

The juveniles were stocked at stocking density of 10 fish per plastic bowl (100cm in diameter, 50 Litres of water capacity). The water level was 40Litres and covered with ethylene net of mesh size of 2cm to prevent the fish from jumping out. The mean body weight of the juvenile was 18±1.67g. Fish were stocked into the plastic bowls using scoop net. The experimental units were randomly arranged to receive similar treatment and for homogeneity of the bioassay. The fish were fed twice

daily as recommended by marimuthu*et al.*, (2010) with various experimental diet at 3% of body biomass. The bioassay waters were partially changed every three days by siphoning the uneaten feeds and fecal materials out and replaced the water to the former level. The waters were completely changed every week when the weight of the fish were measured and the units cleaned. And the feed adjusted to meet the new weight of the fish in each unit of the bioassay.
Physico-chemical parameters such as; temperature, pH, Ammonia and dissolved oxygen were monitored thrice a week and recorded.

2.8 Growth parameter measured

Data on fish growth measured were recorded weekly using an electronic top load digital weighing balance (model). Weekly weight gain, final weight gain, feed conversion efficiency, protein efficiency ratio and survival rate were the growth parameters calculated. Thus;

Weight Gain (g) following the method (Mustapha *et al.,* 2014)
WG= Final weight ‑ initial weight(FW-IW)
.**Mean weight Gain**= mean final weight ‑ initial mean
MWG=MFW‑ IMW
.
Percent Weight Gain (%) following the method (Mustapha *et al.*, 2014).

$$\textbf{PWG} = \frac{MFW-IMW}{T} \times 100.$$

Specific Growth Rate (SGR) following the method of fomali (2010), Eyo and Ekanem (2011), Mustapha *et al*., (2014).

$$\textbf{SGR} = \frac{LnLogW2 - LnLogW1}{T - t} \times 100$$

Where; LnLogW2= Natural Log of Final Weight
LnLogW1= Natural Log of Initial Weight
T – t = Time Period (Days)

Feed Conversion Ratio (FCR)

Thiswas calculated as the dry weight of the feed consumed divided by the weight gain by the fish. Following the method of Sawhres and Grandotra (2010), Eyo and El (2011), Mustapha (2014).

$$\textbf{FCR} = \frac{\text{Weight of Feed Consumed(g)}}{\text{Weight Gained (g)}}$$

Feed Conversion Efficiency (FCE)

This was calculated by dividing weight gained by the weight of feed consumed. Following the method of Eyo& El (2011), Mustapha (2014).

$$\textbf{FCE} = \frac{\text{Weight Gained(g)}}{\text{Weight of Feed Consumed(g)}}$$

Protein Efficiency Ratio (PER)
This is the weight of the fish divided by the weight of protein consumed. Following the method of Eyo& El (2011), Mustapha (2014).

$$\textbf{PER} = \frac{\text{Weight Gain of Fish}}{\text{Protein Intake}}$$

Survival Rate (SR)%

$$\textbf{SR} = \frac{\text{Total Number of Alive at the End X 100}}{\text{Total Stocked}}$$

2.9 Data Analysis
All the data collected from the studies were subjected to Analyses of Variance (ANOVA). The significance of the means was determined by least significant difference (LSD) using the SPSS version 23 (2015) statistical software package.
2.10 Chemical Analysis
Samples of the experimental diets were analyzed for their proximate composition using the methods outlined by AOAC, (2000)

3.0 RESULTS AND DISCUSSION

3.1 Proximate Composition of Experimental Dietsand Bambara nut Hull Meal

The result of proximate composition of Bambara groundnut hull meal(Table 2) showed 7.49% Moisture, 3.15% Ash, 2.73% Fibre, 3.92% Fat, 23.98% Protein and 58.73% NFE. The formulated bioassay diets showed variation in the proximate composition. This is shown in Table 2.

Table 2. Proximate Composition of Bambara nut Hull Meal and Experimental Diets Containing Different Level of Bambara Hull Meal.

Parameter	D1	D2	D3	D4	D5	B. Nut	SEM	LOS
Moisture	5.15^b	5.52^b	48.80^c	3.50^d	5.46^b	7.49^a	0.29	*
Ash	5.75^a	5.48^a	5.58^a	5.70^a	5.38^a	3.15^b	0.22	*
Fibre	4.92^a	4.55^b	4.69^b	4.80^a	3.89^c	2.73^d	0.18	*
Fat	7.53^a	7.15^a	6.46^b	6.89^b	6.30^b	3.92^c	0.28	*
Protein	58.52^a	56.91^a	52.67^b	54.66^a	50.53^b	23.98^c	2.84	*
NFE	18.13^c	20.43	27.78^b	24.49^b	28.45^b	58.73^a	3.29	*

3.2 Water Quality Parameters

Physico-chemical parameters of the bioassay water are shown in Table 3 though fluctuating are within the optimum range.

Table 3. Physico-Chemical Parameters of Bioassay Water During the Feed Trials.

Parameters	Diet 1	Diet 2	Diet 3	Diet 4	Diet 5
Dissolved Oxygen (mg/l)	4.93±1.00	4.90±1.01	4.97±0.93	4.93±1.02	4.89±1.28
Temperature (℃)	26.94±0.12	26.48±0.01	26.32±0.10	26.29±0.02	26.08±0.10
pH	7.04±0.11	6.93±0.08	7.05±0.01	6.97±0.03	7.02±0.18
Ammonia (mg/l)	0.04±0.01	0.03±0.01	0.03±0.01	0.03±0.01	0.03±0.01

3.3 Growth Performance and Feed Utilization of *Clariasgariepinus* Fed with the Different Experimental Diets

The results of growth performance, feed utilization and survival of *Clariasgariepinus* juveniles fed with different level of substitution of soya beans meal with bambara nut hull meal diets showed that highest weight gain (16.33g) was recorded in the diet two (D2) having 25% replacement, although there was no significant difference ($p<0.05$) between D2 and D1. However, D5 having 100% replacement had the lowest weight gain (4.33g). Feed Conversion Ratio, Feed Conversion Efficiency and Specific Growth Rate were better in D2 than others. Survival Rate was higher in all other diets than the control diet (D1).This is shown in table 4.

Table 4. Growth performance and feed utilization of *Clariasgariepinus* fed with the different experimental diets

Parameters	D1	D2	D3	D4	D5	SEM	LOS
IMW	17.67^b	17.33^b	17.33^b	18.67^a	19.00^a	0.54	*
FMW	32.00^a	33.67^a	29.33^b	29.00^b	23.33^c	1.15	*
FI	7.12^a	7.44^a	6.55^b	6.99^b	5.8^c	1.85	*
WG	14.33^a	16.33^a	12.00^b	10.33^b	4.33^c	1.25	*
%WG	87.70^b	95.60^a	17.67^c	55.00^d	22.80^e	1.25	*
SGR	0.34b	0.38^a	0.30^b	0.25^c	0.13^d	0.02	*
FCR	0.50^c	0.46^d	0.55^c	0.67^b	1.34^a	0.01	*
FCE	2.01^a	2.20^a	1.83^b	1.50^b	0.75^c	0.58	NS
PE	58.52^a	56.91^a	52.67^b	54.66^b	50.53^c	8.63	*
PER	0.25^b	0.29^a	0.23^b	0.19^c	0.09^d	0.18	*
SR	60^c	70^b	80^a	70^b	70^b	0.80	*

Figures with the same letter superscript along the rows are not significantly different (p<0.05).
SEM- Error Means Square, NS-Not Significant.

3.4 Discussion

Physico-chemical parameters of the bioassay water as shown in the tables fluctuate slightly but within the optimum range recommended for the culture in fresh water in tropics by the World Health Organization (WHO, 2014).

Dissolved oxygen of 4.93 in Diet 1 which is the control and Diet 5 is 4.89. Hence, there was no significant difference (p<0.05). Among the physico-chemical parameters of the bioassay water monitored. The range of values measured for the pH, dissolved oxygen, temperature and ammonia concentration of water fell within the recommended range needed for optimal fish production (Boyd and Lichktopple, 2014). The proximate composition of the Bambara nut hull in this study is slightly different from that of Ani*et al.,*(2012), especially in protein 23% and 18.2%. The difference in the protein value could be due to the differences in the processing of Bambara nut. However, there was no significance (p<0.05) in other proximate composition apart from the protein values in this study with the findings of Amaetule*et al.*, (2011). Growth performance, feed utilization and survival of *Clariasgariepinus* juvenile feed with substitution of soya bean meal with various levels of Bambara nut hull meal for 56 days, reveals that the higher weight gain was recorded in the Diet D2, while the lowest recorded in diet D5. However, there was no significant difference (p<0.05) between weight gain in Diet1and Diet 2.Specific Growth Rate was highest in D2 (0.38) and lowest in D5 (0.13).Feed Conversion Ratio is better with D2 and (0.46) than D5 (1.34).Feed Conversion Efficiencyis highest in D2 and lowest in D5.Survival Rate was higher with the other diet aside control which show that juveniles of *C. gariepinus* tolerate Bambara nut than soya bean. From this study, fish fed with Bambara nut hull meal diet at levels of 25% replacement recorded appreciable weight gain, percentage weight gain and specific growth rate compared with the control diet. This finding did not agree with the findings of Udo and Ozor, (2022) who recorded the highest weight gain with the level of replacement of 50%. However, the finding of this study tally with the finding of that of Adewumi and Adeyemi, (2018)who recorded highest weight gain, specific growth rate and others with the replacement value of 25%.

Enyidi and Mgbenka, (2005) also reported that Bambara nut waste meal can supplement up to 59% of fish meal in the diet of the larvae of *Clariasgariepinus.*

This shows that Bambara nut contains necessary growth factors required for *C. gariepinus*. This study utilized the husk of Bambara nut which was regarded as a waste and if the use of 25% replacement recorded higher growth rate, then the waste should be recommended 100% for *Clariasgariepinus* diet**.**

4.0 CONCLUSION AND RECOMMENDATIONS

4.1 Conclusion

The most expensive major ingredients in fish feed are the soya beans and fish meal. This study has demonstrated that the waste product (hull)meal of Bambara nut which is to be discarded was used to replace soya bean meal in the diet *C. gariepinus* to the level of 50%. This will summarily reduce the cost of fish feed since Bambara nut hull meal has been demonstrated to have the potentials of replacing soya bean meal to the level up to 50% in the diet of *C. gariepinus* juvenile without adversely affecting growth performance and feed utilization. However, diet D2 and D3 with 25% and 50% replacement respectively gave the optimum, Daily Gain, Specific Growth Rate and Feed Conversion Ratio.

4.2 Recommendations

Therefore, Bambara nut hull meal has been shown to make a balanced food as it contains sufficient quantities of nutrient necessary for fish growth and should be recommended for use as a soya bean partial replacement in fish culture. More researches are needed on the adult stages.

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