

EVALUATION OF SWEET POTATO (*Manihot esculenta*) PEEL MEAL DIET ON GROWTH PERFORMANCE OF CATFISH (*Clarias gariepinus*, BURCHELL, 1822)

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Abstract

This study evaluated the growth performance of *Clarias gariepinus* (Burchell, 1822) fed varying levels of sweet potato peel meals for 90 days, April - June 2019. Diets were formulated at 0%, 25%, 50%, 75%, and 100% levels of sweet potato peels meal inclusion represented as B₁, B₂, B₃, B₄, and B₅ (B₁= Control Group). 200 healthy fingerlings were used for the study. There were variations in the nutritional composition of the diets formulated with sweet potato peels used for the study. There were little variations in initial weights of *C. gariepinus* in the treatments, which did not show any significant difference ($P < 0.05$) in size. Diet B₁ (0%) gave the highest final weight (76.31g) and body weight gain (62.11g), which did not differ significantly ($P < 0.05$) from B₂ (25%) (68.40g) and (54.87g) respectively. The specific growth rate was highest in diet B₁ (0%) and can be compared with diet B₂ (25%) although this differs significantly ($P > 0.05$) with other treatments. The feed conversion ratio was also highest in B₁ (0%) and compare favourably with B₂ (25%), which differ significantly ($P > 0.05$) from other treatments. The protein efficiency ratio was highest in B₅ (100%) and lowest in B₁ (0%), which decreased with an increased level of sweet potato peels meal inclusion. There was a high survival rate of fish in the treatments with B₁ (0%) as highest and B₅ (100%) as lowest, which differ significantly ($P > 0.05$). It is recommended that 25% inclusion of sweet potato peels meal should be used for profitable fish production at present.

Keywords: Aquaculture, feed formulation, experimental diets, fish weight gain

INTRODUCTION

Aquaculture at the global level accounts for increased fish supply and is widely considered to have played a significant role in meeting increased demand for fish (Troell *et al.*, 2014). It has contributed immensely to the economic and social development of the country. This sub-sector of the economy is one of the fastest-growing annual food-producing sectors (FAO, 2010). Fish has been identified as the source of hope toward solving the global problem of malnutrition because of its richness in nutritive value above other animal sources of protein (Fasakin, 2008). It is consumed in various forms, as smoked, fresh, dried, chilled or frozen, and canned. Fish has contributed 50% of the annual protein intake particularly to the rural poor (FDF, 2011).

Nigeria a major consumer of fish where 1.5 million tons of fish annually (about 10kg per capita) is consumed. However, about 579,537 metric tons are locally produced through aquaculture and capture fisheries (USAID, 2008 cited in Nwokocha and Nwokocha, 2013) while above 900,000 metric tons are imported. The large dependency of the country on fish imports is affecting the economy and foreign reserves need to be addressed through the production of more fish. Aquaculture has assumed the fastest and expanding food production system and very important in bridging the gap between fish demand and supply in Nigeria (Talabi, 2012).

Non - ruminant animals which include fish and poultry feed ingredients represent 65 to

70% of the total cost especially in an intensive production system in Nigeria as in many developing countries (Tewe, 1997). The artificial feeds are compounded from plant and animal sources. It is one of the principal methods of increasing the production of fish cultivation. The high cost of fish feed is one of the problems hindering the development of aquaculture in Nigeria (Gabriel *et al.*, 2007). This has even canceled the profitability of fish farming thereby incapacitating the expansion of farms and lowering yield, thus resulting in fish scarcity and eventually the high cost of the few available ones to the disadvantage of the populace (Adikwu, 1992).

Over the years several studies have been carried out to improve the growth performance of fish using common and readily available feed ingredients in a culture system. This includes the works of Sogbesan *et al.* (2016) using varying levels of soaked plantain peels diets and El - Nadi *et al.* (2017) using graded levels of potato peels in the diet of fish. However, there is a scarcity of information that fully establishes the utilization of sweet potato peel meal in the diets of *Clarias gariepinus* fingerlings. Increased fish production depends on the quality of fish seed and more importantly quality of feed, which could give the needed nutritional requirement to fish. This could be achieved by fully utilizing a plant - a by-product, which provides the necessary nutritional needs of fish as well as low cost of production.

This study aims to evaluate the use of sweet potato peel meal for the growth of *Clarias*

garipepinus fingerlings. This will contribute to the increase in fish production at a relatively low cost, increase income for fish farmers and as well contribute to improved nutrition through the consumption of more animal protein.

MATERIALS AND METHOD

Experimental site

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

Collection, transportation, and acclimatization of experimental fish

Two hundred (200) healthy fingerlings of *Clarias garipepinus* was purchased at a commercial hatchery in Minna, Niger State, were used for the study. Experimental fish was transported to Biology Department laboratory, Ibrahim Badamasi Babangida, Lapai, Niger State using 50 liters Jerican containing clean water.

Fish collected were kept in the laboratory for fourteen days (2 weeks) before the commencement of the feeding trials. This helped to acclimatize them to the laboratory condition. During this period fish was fed with 1mm of foreign feed (Coppens) in the morning (8:00 am) and evening (6:00 pm). The water was changed every two days.

Source and preparation of experimental ingredients

Sweet potato peel

This was obtained at Lapai main market. It was thoroughly washed to remove dirt and those rotten thrown away. The peels were then sun-dried for three (3) days. The dried peels were then milled into powder, sieved, and a fine particle-sized product was obtained.

Other feed ingredients

Groundnut cake, soybean, fish meal, white maize, palm oil, premix, and starch were also purchased at Lapai main market. Soybean was toasted and processed into the finest powder. The inclusion level of the ingredients was weighed to their proportions for feed formulation. Starch was added as a binder in holding the feed together and palm oil was also added and mix thoroughly. Hot water was added to bring about the binding ability to a dough-like paste for smooth pelleting using a pelleting machine. The resulting pellets were then sun-dried to remove moisture and prevent fungal growth, sieved to obtain finer feed size, packaged in air-tight polythene, and stored in a dry place.

The experimental set-up, feeding trials

Fifteen (15) transparent plastic aquaria of dimension (60 x 30 x 30 cm) was set for the 5 treatments with three triplicates of 10 fingerlings in

each aquarium. The fingerlings were randomly selected, length and weight taken, and then transfer into each aquarium and fed twice daily at 3% body weight (8 am and 6 pm). Fish were starved for 24 hours before the commencement of feeding trials to empty their bowels.

Feeding trials were done for 90 days (3 months). The water in each aquarium was changed every two days, to avoid the accumulation of faecal wastes in the water.

Fish sampling and measurement

Fish sampling was done every two weeks to determine the growth rates. This involved measurement of length (standard and total) and weight using measuring board in centimeters (cm) and a digital top loading digital weighing balance, Model SF – 400 (Onu *et al.*, 2017) in grams (g) respectively. Mortality was also determined by counting and recording dead fish in each aquarium.

Measurement of water quality parameters

Temperature (°C), pH, and dissolved oxygen (mg/l) were monitored for each aquarium during the experiment. The temperature was measured using a thermometer (glass - in-mercury), and pH with the aid of pH meter once daily and dissolved oxygen was determined weekly using DO meter).

Proximate analysis of the potato peel meal and experimental diets

Potato peel meal and the experimental diets - B₁ (0%), B₂ (25%), B₃ (50%), B₄ (75%), and B₅ (100%) were subjected to proximate analyses according to AOAC (A.O.A.C., 2005).

Growth parameters evaluation

At the end of the 90 days (experimental period) fish in each aquarium was collectively weighed weekly for the determination of growth parameters as follows:

Body weight gain =

$$\frac{\text{Final weight (g)} - \text{initial weight (g)}}{\text{Initial weight (g)}}$$

$$\text{Growth rate} = \frac{\text{Weight gained (g)}}{\text{Duration of experiment}}$$

Specific growth rate (%) =

$$\frac{\ln \text{ final weight (g)} - \ln \text{ initial weight (g)} \times 100}{\text{Feeding period (day)}}$$

where:

ln = natural logarithm

Food Conversion Ratio (%) =

$$\frac{\text{Wet body gain} \times 100}{\text{Protein intake (g)}}$$

$$\text{Protein efficiency ratio} = \frac{\text{Wet body gain}}{\text{Protein intake (g)}} \times 100$$

$$\text{Survival rate (\%)} = \frac{\text{Stocking rate} - \text{mortality}}{\text{Stocking rate}} \times 100$$

Statistical analysis

Data collected were subjected to descriptive statistics to compute the means, standard deviations, minimum and maximum value. Analysis of variance (ANOVA) was carried out to test for the significant difference at a 95% confidence level. Post-hoc using the new Duncan Multiple Regression Test (NDMRT) was used to rank for differences in means. Special Package for Social Sciences (SPSS) Version 20 was used as a statistical package.

RESULTS

Formulation of experimental diets

The diets were formulated at 45% crude protein using the Pearson method. Five diets containing different levels of sweet potato peel inclusion were formulated. The diets contained 0%, 25%, 50%, 75%, and 100% inclusions to replace an equal amount of white maize meal and designated as B₁, B₂, B₃, B₄, and B₅ (Table 1).

Table 2 shows the nutritional composition of sweet potato peel used to formulate the experimental feed during the period of study. The various percentages of these parameters are as follows.

Moisture contents, crude protein, and crude lipid values were 9.45%, 29.05%, and 0.00% respectively. Others include 15.44%, 5.67%, 7.89%, and 29.05% of crude fibre, total ash, carbohydrate, and nitrogen-free extract (NFE).

The proximate composition of the experimental diets presented in table 3 showed that the moisture of B₁, B₂, B₃, B₄, and B₅ was 8.89%, 10.32%, 10.19%, 10.00%, and 10.49% with B₅ as highest and B₁ as the lowest. The crude fibre was 15.30% for B₁, 15.11% for B₂, 15.00% for B₃, 14.59% for B₄, and 15.15% for B₅ with B₁ as highest and B₄ as lowest.

Crude protein was highest in B₁ with 32.39% followed by B₅ with 32.10% and B₂ with 29.89% as lowest. Crude lipids were highest in B₅ (5.11%) followed by B₄ (4.32%) and the lowest was B₁ (3.74%). Total ash was highest in B₂ (5.50%) followed by B₅ (5.32%) and B₄ (4.98%) was lowest.

Carbohydrate was highest in B₄ (5.25%) followed by B₁ (5.10%) then B₃ (5.03%) while B₂ (4.97%) was lowest. Nitrogen-free extract (NFE) was highest in B₂ (32.12%) followed by B₄ (32.00%) and B₅ (31.76%) as lowest.

Table 4 shows the growth response of *Clarias gariepinus* fingerlings fed varying levels of sweet potato peel meal. There were little variations in the initial weight of fish, which did not show any significant difference ($P < 0.05$) from others during the study period.

B₁ recorded the highest final mean weight (76.31 g) followed by B₂ (68.40 g) and B₃ (53.60 g) was the lowest. B₁ was significantly different ($P > 0.05$) from treatments B₃, B₄ and B₅.

Bodyweight gain (BWG) of the fish was highest in B₁ (75.31 g) followed by B₂ (67.40 g) and the lowest was B₃ (52.60 g). B₁ was also significantly different ($P > 0.05$) from treatments B₃, B₄ and B₅.

Table 5 shows the various feed utilization of *C. gariepinus* fingerlings fed varying levels of sweet potato peel meal. There were variations in growth rates, specific growth rate, feed conversion ratio, protein efficiency ratio, and survival rate of fish during the period of study.

The specific growth rate was highest in B₁ (1.39) and B₃ (1.03) was the lowest. The feed conversion ratio was highest in diet B₁ (2.59) and lowest being B₅ (2.28). The protein efficiency ratio was highest in B₅ (1.08) and the lowest being B₁ (0.52). B₁ (100%) had the highest survival rate while B₅ with 85.00 % was the lowest.

There were significant ($p > 0.05$) in growth rates, specific growth rate, feed conversion ratio, protein efficiency ratio, and survival rate during the period of study.

DISCUSSION

Feed is very important in the production of fish because nourishment is very key in their growth performance. Therefore knowing the composition of the major ingredient is quite important. The proximate composition of sweet potato peel in this present study revealed that crude protein content was 29.05%, which is greater than the 23.10% and 4.66% reported by Apata *et al.* (2012) and El-Nadi *et al.* (2017) respectively. Similarly, crude fibre for this study (15.44%) was greater than 3.71% as reported by El-Nadi *et al.* (2017), and ash content (5.67%), which was greater than 4.02% reported by Apata *et al.* (2012). This could be due to the methods of processing, variety of the potato, and the location of cultivation. This implies that the peel used in this study could be a good substitute for other plant sources in feed formulation.

The proximate composition of the diets in this study revealed various constituents and their proportions. This gives an insight of feed quality for fish production. The diets showed variations in their nutritional components. Crude protein is an important component of fish feed because of the role it plays in the growth and health of fish. The highest value recorded in B₁ with 32.39% and 29.89% in B₂ did not show much difference, which is an indication that these diets contain a reasonable quantity of protein. This could give better growth performance of fish if fully utilized. Carbohydrate is an important source of energy for fish activities. This was highest in B₄ (5.25) and lowest in B₂ (4.97) although there was no much difference in these values across the

diets. This implies that the diets could provide sufficient energy for the fish. Crude fibre is very important in fish feed because it plays an important role in digestion. The highest crude fibre was recorded in B1 and lowest in B4 although there were not many variations in the values recorded during this study. This shows the good digestibility nature of the diets produced.

The growth of fish in other words is determined not only in feed quality but also in its utilization.

The sizes of the fish subjected to the various diets during this study with mean initial weight as highest in B1 (14.20 g) and lowest in B2 (13.53 g) did not differ significantly ($P < 0.05$). This implies that although there are few differences in the sizes of fish, samples belong to the same age group.

B1 with 0% inclusion of potato peel meal, which recorded the highest mean final weight (76.31 g) differs significantly ($P > 0.05$) with other diets except for B2 having 25% inclusion of final weight of 68.40 g. This may be due to the level of feed utilization by the fish, which determines the provision of all necessary nutrients for fish growth. Omoregie *et al.* (2009) did report 0% sweet potato peel inclusion to have given fish the highest weight gain, which tallies with the findings of this study.

The final weight and body weight gain of fish decreases as the level of potato peel meal increases especially in 0% - 50% inclusion levels. This observation was also reported by Omoregie *et al.* (2009) using sweet potato peel meal inclusion in *Tilapia zilli* diets. This may be due to differences in diets acceptability by fish amongst others. B2 with 25% inclusion of potato peel meal performed best among the inclusions and did not differ significantly ($P < 0.05$) from B1 with 0% inclusion may also be due to the same reason. Olukunle (2006) did report the highest percentage of weight gain in 25% sweet potato inclusion. This tallies with the findings of the study.

The suitability of inclusion or substituting an ingredient for another in the diet of fish and even other non - ruminant animals is important. Their assessment can be determined using some key parameters that enable the best diet to be known and produced. These parameters include specific growth rate, feed conversion ratio, protein efficiency, and survival rate of fish amongst others.

The specific growth rate of diet decreases as the inclusion levels of potato peel meal increases (0% - 50%) inclusion levels, which differ significantly ($P > 0.05$). This could be due to the quantity of feed consumed by the fish, hence influencing the growth rate.

The feed conversion ratio observed in this study decreased with an increased level of sweet potato meal inclusion. This may be due to the non - palatability of the diet, which has contributed to its poor utilization by fish. It is expected that increase

in feed conversion ratio slows down the growth rate of fish.

Protein efficiency ratio deals with the gain of weight by fish in relation to the quantity of protein consumed. Diet B5 with 100% inclusion having the highest protein efficiency ratio (1.08%) differ significantly from other diets, though did not give the best weight among the diet treated with potato peel meal. This implies that the protein consumed by this fish was not fully utilized for growth.

The survival rate of fish in feeding trials is very important because it helps to determine how safe an ingredient is to fish once included in the diet. The survival rate varies in the different treatments. B1 with 0% of inclusion did not record any mortality, which differs significantly ($P > 0.05$) from other diets except diet B3 with 50% inclusion. This may be due to fish's inability to consume the feed as expected or differences in the water quality. The rate of survival of fish in these treatments especially B2 and B3 can be compared favourably with B1.

CONCLUSION

Sweet potato meal is a good ingredient that can be utilized in the formulation of *C. gariepinus* fingerlings diets for better growth and survival.

The growth response of sweet potato gave the best result at B2 (25%) inclusion compared to B1 (0%) inclusion, although B4 (75%) and B5 (100%) can be compared with B2. There was a high survival rate throughout the study, although this shows significant differences ($P > 0.05$) from B1 (0%).

RECOMMENDATION

25% inclusion of sweet potato meal is recommended for the diet of *C. gariepinus* fingerlings although 75% and 100% could be used.

Further research using other inclusion levels and possibly processing methods of sweet potato peel meal should be carried out

Fish weight gain translates to income for farmers, therefore 25% inclusion is most profitable for fish production at present

This type of study should be done on other cultured fish, such as *Tilapia*, *Heterobranchus* species, and even Carp.

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Table 1: Percentage (%) composition of experimental diets (45% crude protein)

Parameter	B ₁ (0%)	B ₂ (25%)	B ₃ (50%)	B ₄ (75%)	B ₅ (100%)
Fish meal	18.0	18.0	18.0	18.0	18.0
Soybean meal	18.0	13.4	9.00	4.5	0.00
Groundnut cake	28.5	28.5	28.5	28.5	28.5
SPMM	0.00	4.6	9.0	13.5	18.0
Maize	31.5	31.5	31.5	31.5	31.5
Vitamin premix	1.5	1.5	1.5	1.5	1.5
Palm oil	1.5	1.5	1.5	1.5	1.5
Starch	1.0	1.0	1.0	1.0	1.0
Total	100	100	100	100	100

SPPM: Sweet potato peel meal

Table 2: Proximate composition (%) of sweet potato peel

Composition	Percentage (%)
Moisture Content	9.45
Crude Protein	29.05
Crude lipid	-
Crude fibre	15.44
Total Ash	5.67
Carbohydrate	7.89
Nitrogen Free Extract (NFE)	29.05

Table 3: Proximate composition of experimental diets fed *Clarias gariepinus* fingerlings

Parameter (%)	B 1 (0 %)	B 2 (2 5 %)	B 3 (5 0 %)	B 4 (7 5 %)	B 5 (1 0 0 %)
Moisture	8.89	10.32	10.19	10.00	10.49
Crude Fibre	15.30	15.11	15.00	14.59	15.15
Crude Protein	32.39	29.89	30.12`	30.49	32.10
Crude Lipids	3.74	3.97	4.00	4.32	5.11
Total Ash	5.22	5.50	5.23	4.98	5.32
Carbohydrate	5.10	4.97	5.03	5.25	5.00
NFE	30.89	32.12	31.77	32.00	31.76

Table 4: Growth response of *Clarias gariepinus* fingerlings fed varying levels of sweet potato peel meal

Diets	Initial Weight (g/fish)	Final Weight (g/fish)	Body Weight Gain (g/fish)
B1 (0%)	14.20±1.66 ^a	76.31±16.82 ^a	62.11±16.82 ^a
B2 (25%)	13.53±2.12 ^a	68.40±15.83 ^a	54.87±15.83 ^a
B3 (50%)	13.90±1.63 ^a	53.60±14.01 ^b	39.70±14.01 ^b
B4 (75%)	13.97±1.86 ^a	65.00±14.04 ^b	51.03±14.04 ^b
B5 (100%)	13.73 ±1.37 ^a	63.01±11.27 ^b	49.28±11.27 ^b

Values in the same column with different superscript letters are significantly different (P>0.05) from each other

Table 5: Feed utilization parameters and survival rate of *Clarias gariepinus* fed varying levels of sweet potato peel meal

Diet	SGR	FCR	PER	SR (%)
B1(0%)	1.39± 0 . 1 4 ^a	2.59± 0 . 0 2 ^a	0.52± 0 . 0 1 ^a	100.00± 0 . 0 0 ^a
B2(25%)	1.32± 0 . 1 5 ^a	2.51± 0 . 0 5 ^a	0.60± 0 . 0 3 ^{a b}	97.22± 3 . 9 0 ^{a b}
B3(50%)	1.03± 0 . 1 6 ^b	2.49± 0 . 0 3 ^b	0.93± 0 . 0 5 ^a	94.4 4 ± 7 . 5 0 ^a
B4(75%)	1.23± 0 . 2 8 ^b	2.38± 0 . 0 1 ^b	1.02± 0 . 0 1 ^b	88.90± 9 . 1 1 ^{a b}
B5(100%)	1.22± 0 . 2 2 ^b	2.28± 0 . 0 8 ^b	1.08± 0 . 0 2 ^a	85.00± 1 4 . 7 2 ^b

Values in the same column with different superscript letters are significantly different (P>0.05) from each other

SGR: - Specific Growth Rate

FCR: - Feed Conversion Ratio

PER: - Protein Efficiency Ratio

SR: - Survival Rate