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Research Article
Effect of Substituting Maize with Bambara (*Voandzeia subterrenea* Thouars) Waste Meal in the Practical Diets of *Tilapia niloticus* Fingerlings

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Abstract
Experiment was conducted to evaluate the growth performance of *Tilapia niloticus* fingerlings fed varying levels of Bambara waste meal based diets. Three hundred *Tilapia niloticus* fingerlings with a mean body weight of 3.5±0.1 g were assigned to five diets (CP = 32%) in which Bambara waste meal replaced maize at 0, 25, 50, 75, 100%, respectively in a completely randomized design replicated 3 times. The trial fish were fed at 5% b.wt., daily for a period of 84 days, data collected showed that body weight gain increased with increase Bambara waste meal in the diet ($p<0.05$). Similar observation was recoded for feed intake but there was significant ($p>0.05$). Difference in feed conversion ratio among the treatments. Data on economics of feeding shows that cost/kilogram of feed decreased progressively as the level of Bambara waste meal in the diet increased, which might be attributed to the cheap cost of Bambara waste meal as compared to that of maize which is expensive. Hence, Bambara waste meal could be recommended as a dietary supplement in the diet of *Tilapia niloticus* as it is the best means of reducing cost of production and also effective way of achieving the best output in terms of weight gain.

Key words: Weight gain, growth performance, diet supplement, *Tilapia niloticus*, economics

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Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

High cost of conventionl feed ingredient contributes to high cost of animal protein (High cost of production). This has led to searching for alternative ways of replacing some conventional feed ingredient with affordable and available conventional waste ingredients (Adegbola and Okonkwo, 2000). Lack of affordable energy rich feed is a challenge in the aquaculture industries. Fish meal has become a costly and scarce commodity in the sub-Saharan Africa Nigeria (Nyina-Wamwiza *et al*., 2007). However, soyabean that serves as the most utilizable plant source of protein in feed formulation have become expensive and had to be imported to meet local demands in sub-Saharan countries like Nigeria (Fagbenro and Adebayo, 2005; Shipton and Hecht, 2005). Bambara nut waste meal is a readily available and promising aqua diet ingredients (Mbata *et al*., 2007). Bambara nut (*Voandzeia subtervenae*) is a non oily leguminous seed which contains only about 6% of ether extract. It also contain an appreciable amount of lysine and minimum amount of trypsin and chymo-trypsin (Oyenuga, 1968). In accordance to Enwere (1998), Bambara nut has the following composition; moisture 9.7%, crude protein 16.0%, crude fat 5.9%, ash 2.9%, total carbohydrate 64.9%, it is fairly well supplied with calcium and iron though poor in phosphorus. Bambara is also richer in essential amino acid like lysine and methionine that is lacking in other known legumes. It also contains thiamine, riboflavin, niacin and carotene but very low in ascorbic acid (Oyenuga, 1968). Bambara meal is also a good source of essential amino acids like lysine and trypthophan, which are often limited in cereals as reported by Mbata *et al.* (2007). The protein content was reported to be about 24.14% according to Enyidi (2012) depending on variety and the carbonhydrate content was estimated to be 60% as reported by Enyidi and Mgbenka (2014).

Bambara nut is mainly processed into flour which is prepared and consumed in form of 'Okpa' popularly known among the Ibos of Nigeria (Enwere, 1988). In the production of the flower, the seed coats are partially removed by splitting the seeds in attriction mill, winnowing to remove loosened testa and converting the cotyledon into fine flour by milling several times in a hammer mill or any other form of mill followed by sieving, using sieves with 1 mm pores. Processing of Bambara nut results in fairly large inedible portion being discarded as waste. This inedible portion had been fed indiscriminately to livestock and used as soil manure. The fact that 'Okpa' remains a staple protein meal in most homes in Eastern Nigeria assures the availability of bambara waste as a potential feeding stuff in the diet of fish it is based on this premise that decision was made to evaluate the utilization of bambara meal waste by *Tilapia nilotica*.

MATERIALS AND METHODS

Experimental site and sample preparation: The experiment was conducted at the Department of Fisheries Technology, Lagos State Polytechnic, Ikorodu, Lagos State. The sample, Bambara waste meal was collected from the local millers at the Army Barrack in Odogunyan Lagos State. The Bambara waste meal was sieved to remove the shaft from the meal. Sample of the meal was analysed for proximate composition as shown in Table 1.

Feed formulation: The meal produced (Bambara waste meal) was mixed with other feeding ingredients to formulate five iso-nitrogeneous diets at 30% crude protein in which Bambara waste meal was to replace maize at 0, 25, 50, 75 and 100%, respectively, while the control diet (0%) contained no Bambara waste meal (Table 2). The diets produced were passed through a pelletizing machine of die 2 mm to produce pellets. Thereafter, the pelleted feeds were sun dried to crispy for 4 days to prevent the growth of moulds and were packed in water proof bags and labelled accordingly before storage at room temperature. These were later analysed using the method of AOAC (1995).

Experimental fish and design: Three hundred *Tilapia* fingerlings with an average of 3.5$\pm$0.1 g b.wt., were purchased from a commercial hatchery in Ibadan (State Ministry of Agriculture and Natural Resources) Oyo State. They were acclimatized for 7 days and fed with control diet

Table 1: Determined proximate composition of the maize, Bambara waste meal and experimental diets

Parameters	Maize	Bambara waste meal	0 (%)	25 (%)	50 (%)	75 (%)	100 (%)
Dry matter	97.40	91.88	95.00	95.09	95.15	95.22	95.25
Crude protein	10.00	19.90	30.10	30.71	31.41	32.12	32.82
Crude fibre	6.50	6.20	6.50	6.40	6.30	6.20	6.00
Ether extract	0.50	7.06	6.12	6.18	6.25	6.30	6.38
Ash	7.50	3.21	5.10	4.80	4.60	4.40	4.00
Nitrogen free extract	70.10	56.51	58.20	56.50	36.00	55.10	53.60

Table 2: Gross composition of experimental diet

	BWM (%)				
Ingredients	0	25	50	75	100
Maize	47.00	35.25	23.50	11.75	-
Bambara waste meal	-	11.75	23.50	35.25	47.00
Fish meal	23.00	23.00	23.00	23.00	23.00
Soya meal	20.25	20.25	20.25	20.25	20.25
Bone meal	0.50	0.50	0.50	5.00	5.00
Fish premix	0.25	0.25	0.25	0.25	0.25
Salt	0.25	0.25	0.25	0.25	0.25
Vitamin C	0.25	0.25	0.25	0.25	0.25
Starch binder	1.00	1.00	1.00	1.00	1.00
lysine	0.50	0.50	0.50	0.50	0.50
Methionine	0.50	0.50	0.50	0.50	0.50
Calculated analysis					
Crude protein	30.1	30.71	31.41	32.12	32.82
Metabolizable energy (kcal kg^{-1} ME)	2393.93	2380.53	2367.12	2353.78	2340.31

BWM: Bambara waste meal

(0%) subsequently, they were randomly assigned to the five treatment diet at 60 fish per treatment in hapa measuring 1.1 by 0.9 m suspended in outdoor concrete tank measuring 3.3×3.3 m. Each treatment is replicated trice in a completely randomized design having 20 fish per replicate. They were fed the experimental diet for a period of 12 weeks at the rate of 5% b.wt., per day, showed between morning (7-8 am) and evening (5-6 pm). The water is changed every other day to allow for good performance of the fish.

Data collection and statistical analysis: The experimental fish (fingerlings) in each hapa were weighed at the beginning of the experiment and fortnightly, using a digital weighing balance and returned into the respective hapas thereafter, their feed intake were adjusted according to the new body weight gained fortnightly.

Data on feed intake, weight gained and feed conversion for the five groups was collected and subjected to analysis of variance, where significant differences was detected, means separated using multiple range test as outlined by Obi (1990).

RESULTS AND DISCUSSION

The chemical composition of the bambara waste meal showed that the crude protein of bamabara waste meal (19.9%) was greater than that of maize 10% while the crude fibre of (BWM) 6.2% was almost the same as that of maize 6.5% as shown in Table 1. The crude protein of BWM in this report was recently similar to 16.00% of crude protein reported by Enwere (1998). The chemical composition of the experimental diets revealed that the crude protein and crude fibre content of the feed were within the recommended values as reported by Fagbenro and Arowosoge (1991).

However, the crude protein content of the diets increased with increased dietary inclusion of bambara waste meal as shown in Table 1. This is attributed to superior crude protein content of the test ingredient used over maize as shown in Table 1.

The acceptance of bambara waste meal diet could be attributed to the organoleptic qualities of Bambara nut waste meal (Mbata *et al*., 2007) and also fish meal. Bambara nut waste meal is known to have 30% neutral sugar present as glucose and galactose (Minka and Bruneteau, 2000). The immediate acceptance of the diets by the fish could as well be affected by the neutral sugars in the diets. Effect of organoleptic status of ingredients are important factor in considering aquaculture feed additive (Glencross *et al*., 2007). However, the nutritional performance of the fish based on treatment feed was very distinct. The weight gain and specific growth rate of the fish fed Bambara waste meal diet were superior to the control group (p<0.05). It should also be noted that cultured fish in concrete ponds and other artificial enclosures depends solely on the nutrient from the feed for growth with little or no contribution from natural food, hence the general increase in weight of the trial fish was an indication that all the diets met the nutrient requirement for growth in *Tilapia niloticus* fingerlings. Particularly the crude protein (CP = 32%) and perhaps the protein energy ratio (Fagbenro and Arowosoge, 1991; Agbabiaka, 2010).

All the Bambara waste meal diets supported growth rate more than the control diet. Perhaps, due to the medium where fish lives which might have encouraged the growth of phytoplanktons. The improved weight gain in Bambara waste meal treatment can also be due to the fibre content of the deit being lower than that of the control diet as revealed in Table 1.

Table 3: Performance characteristics of fish fed different levels of dietary Bambara waste meal (0-12) weeks

	Treatment diets (%)				
Parameters	0	25	50	75	100
Initial weight (g)	3.5	3.50	3.50	3.50	3.50
Final weight (g)	120.30[b]	125.52[b]	130.64[b]	135.54[a]	140.64[a]
Weight gain (g)	116.806	122.026	127.146	132.04[a]	137.14[a]
Total feed intake (g)	40.02[b]	41.52[b]	41.89[a]	42.05[a]	42.30[a]
Mean growth rate	1.56	1.57	1.58	1.59	2.00
Feed conversion ratio	0.34[a]	0.34[a]	0.33[ab]	0.32[b]	0.31[b]
Mortality rate	0.00	0.00	0.00	0.00	0.00

[a,b]Means with superscript within rows are not significantly different (p>0.05)

Table 4: Economics of feeding varying levels of Bambara waste meal to *Tilapia niloticus*

	Dietary levels of Bambara waste meal (%)					
Parameters	0	25	50	75	100	SEM
Cost per kilograms of feed (N/Fish)	177	176	175	173	172	ND
Cost of feed consumed (N/Fish)	1612.47	1684.05	1779.75	1799.01	1845.56	ND
Feed cost per kilogram gain	159.33[b]	146.52[b]	131.83[b]	122.40[a]	111.85[a]	0.006

SEM: Standard error mean, ND: Not detected, values with different superscript letters are not significantly different (p>0.05), cost of feed is multiplied by feed intake, cost per kilogram of feed is multiplied by the feed conversion ratio, Naira exchange presently at 135-1 US Dollar

It is also probable that the common processing techniques, for Bambara nut such as grinding employed in this study have the ability to modify the nutritive value of the Bambara waste thus ensuring more nutrient availability to the fish. This view is in harmony with the report of Just (1982) that common processing techniques such as grinding, pelletizing, etc., could modify the nutritive value of diets.

Though all the dietary treatments have fibre concentration within the recommended range of 14% for *Tilapia* spp (David, 1985).

Bright (1996) and Kehinde (2009) reported better utilization of cassava peel by African giant snail, which was in agreement with the findings of Omole *et al.* (2004) when snails were fed bread waste meal.

The feed intake of the trial fish is directly proportional to the dietary level of the Bambara waste meal. It has been reported that feed intake of the monogastrics including fishes is a function of the dietary energy, that is animals will continue to eat until the energy requirement is met (Esonu, 2000). However, the feed conversion ratio of the treatment diets showed no significant difference (p>0.05). Nevertheless, the quality of protein of Bambara waste meals has been reported to influence its utilization (Oyenuga, 1968).

It could be observed also that all the diets containing Bambara waste meal were lower in concentration of nitrogen free extract, lipids and crude fibre which are main source of dietary energy, relative to the control (maize) diet. This might have been a major significant factor responsible for higher feed intake by the fish fed the test diets as shown in Table 3. This is in agreement with the finding of Vantsawa *et al.* (2008) that energy content of feed/diet is inversely proportional to the feed intake, which was also observed when maize offals was fed to laying chickens.

Data on economics of feeding in Table 4 shows that cost/kilogram of feed decreased progressively as the level of the Bambara waste meal in the diet increased. The economics of gain shows that T5 had the lowest cost of feed intake followed by 4, 3, 2 and 1 respectively. This is understandable as the Bambara waste, which is comparatively cheap, replaced the more expensive maize in the diet. The value obtained for feed cost per kilogram gain further suggest that 100% level of inclusion is the optimal level of Bambara waste meal in the diet of *Tilapia niloticus*.

The overall no mortality recorded from this study showed that the physicochemical parameters of the pond water was not adversely affected by the Bambara waste meal and are within the recommended ranges for *Tilapia niloticus* fingerlings (Boyd, 1979).

CONCLUSION

This study has shown that Bambara waste meal diet can be utilized by *Tilapia niloticus*, hence, can replace the more expensive maize, thereby, reducing the cost of production and control environmental filth associated with waste in general in Nigeria. Therefore inclusion of up to 100% Bambara waste in the diets of *Tilapia niloticus* will help produce cheaper and affordable tilapia fish for the table. T herefore, fish farmers are encouraged to use this level of Bambara waste meal in compounding rations for their Tilapia fingerlings.

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