UTILIZATION EFFECTS OF SUBSTITUTING MAIZE WITH GRADED LEVELS OF RIPE AND UNRIPE BANANA (*MUSA SAPIENTUM*) PEELS IN THE DIET OF AFRICAN CATFISH (*CLARIAS GARIEPINUS*) JUVENILES

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ABSTRACT

Six diets were produced using graded levels of banana peels (5 %, 10 % and 15 % for both ripe and unripe banana peels) which were compared with the controlled diet containing maize in the diet of C. gariepinus juveniles. Feeds were fed to triplicate groups of ten fish each to satiation twice daily for ten weeks. There were significant differences ($p < 0.05$) in Mean Weight Gain (MWG) and Specific Growth Rate (SGR) amongst the experimental diets. The control diet had the highest MWG (58.40±5.27g) and SGR (1.877±0.09 %) while the least values of MWG (25.03 g) and SGR (0.35 %) were recorded in Diet 3(15 % unripe banana peels). The Feed conversion ratio, Protein efficiency ratio and Protein intake recorded significant differences ($P < 0.05$) between the control and the experimental diets. Similarly, significant differences ($P < 0.05$) were recorded in Profit Index, Incidence of Cost and Economic Investment Cost Analysis between the control and experimental diets. Histometry analysis of fish organs equally recorded significant differences ($P < 0.05$) between the control and other test diets. Although the Control diet had the best growth performance, it recorded the least profit index (1.87) while Diet 2 (10 % ripe banana) had the highest Profit Index (3.11). Hence, graded levels of plantain peel is a profitable alternative energy source for partial replacement of maize up to 10 % ripe and unripe banana peels in diet of C. gariepinus.

INTRODUCTION

African catfish appear as the major fish species cultured in sub-Saharan Africa, followed by tilapias. This is obviously related to continual improvement in mass propagation techniques and the development of quality water management along with quality feed development. Further growth in fish culture on the continent may however be hampered by the failure to meet the dietary requirements of the fish.

The dietary requirements of cultured fish are probably the most important factor influencing the success of any fish farming enterprise. The goal of any fish culture operation is to achieve maximum production of fish in the shortest time possible at the least cost. Fish feed are sourced from various classes of food especially protein and carbohydrates. Other sources of feed include fat and oil (lipids), vitamins and minerals (Aderolu *et al.*, 2009).

Carbohydrates are used in fish diet primarily as energy source and for their binding properties (Aderolu and Sogbesan, 2009). It can be added in excess of the amount that can be efficiently utilized for energy by the fish (Krogdahl *et al.*, 2005) and are important in formulated diets because they are cheaper than lipids and protein.

Maize, Sorghum, Potatoes, Cassava, Yam, Cocoyam, Guinea Corn amongst others are energy sources commonly used in the fish feed formulation, which have regular changes in price and are consumed by both man and animals resulting to competition. Since feeding represents the single most expensive production cost (Uys, 1988), scientists have resulted into using by-products/wastes such as biscuit waste, yam peels, plantain peels and banana peels amongst others as energy sources, which are less competed for, abundant, and not expensive.

Banana peel is a by-product utilized in the nutrition of livestock around the world. The peel has anti-nutritional factors, which are Hydrogen cyanide, Oxalate, Phytate and Saponins. These anti-nutrient contents of the peel indicate generally low values except Saponins (Adeniji *et al.*, 2007; Anhwange *et al.*, 2009). Hence, the objective of this study is to evaluate the effects of substituting maize with graded levels of ripe and unripe banana peels on the growth performance, nutrient utilization and economy of production of *C. gariepinus* juveniles.

MATERIALS AND METHODS

EXPERIMENTAL LOCATION

The experiment was carried out at the Nutrition Unit of the Department of Marine Sciences, University of Lagos, Akoka, Lagos, Nigeria.

EXPERIMENTAL FEED PREPARATION AND FORMULATION

Banana peels were got from ripe and unripe banana, sun dried and ground to powder, while other feed ingredients (fish meal, soybean meal, groundnut cake, maize, fish premix, dicalcium phosphate, vitamin C, palm-oil and salt) were bought from Sabina Pad Enterprises Ltd., Agege, Lagos. Ingredients were milled individually at the feed mill.

Ingredients were measured using digital scale, and thoroughly mixed manually with hands in a bowl with hot water added to form homogenized dough. Each experimental diet was manually pelletized to obtain with 2 mm pellets.

The proximate analysis (crude protein, ash, ether extract, crude fibre and dry matter) of sun dried ripe and unripe banana peels were analyzed according to the Association of Analytical Chemists method (AOAC, 2004) at the Department of Animal Science, University of Ibadan (Table 1).

The control diet and six experimental diets were formulated with graded inclusion replacement of maize with ripe and unripe banana peels at 5, 10 and 15% respectively (Table 2).

EXPERIMENTAL FISH AND PROCEDURE

African catfish (*C. gariepinus*) juveniles were procured from Latia Global Investment. They were transferred in 50 litre plastic container to the Nutrition Unit of the Department of Marine Sciences in the early hours of the day to avoid heat stress. Fish were acclimatized for two weeks in 1000L plastic container during which they were fed with 2 mm commercial feed (Coppens from Holland). After acclimatization, fish were weighed (21.40±0.01g) and distributed into plastic tanks (52.5 × 33.5 × 21cm) at the rate of 10 juveniles per tank. A total of 210 juveniles catfish were stocked in 21 plastic tanks. The average weight gain of fish was determined on weekly basis by bulk-weighing.

The water for the experiment was sourced from a bore-hole in the Department of Marine Sciences while the water in the experimental tanks was changed every two days to maintain good water quality. The feeding of the juveniles was to satiation twice daily (09:30 and 17:30 hr) with the formulated diets.

GROWTH AND NUTRIENT UTILIZATION PARAMETERS

(1) $$\text{Mean Weight Gain (MWG)} = \frac{\text{Average weight gain (AWG)}}{\text{Number of days}}$$

(2) $$\text{Specific Growth Rate (SGR)} = \frac{(\log_e W1 - \log_e W2) \times 100}{T2 - T1}$$

Where; e = natural logarithm

T2-T1 = Experimental Period, W1 = initial weight, W2 = final weight

(3) $$\text{Feed Conversion Ratio (FCR)} = \frac{\text{Feed intake (FI)}}{\text{Weight gain}}$$

(4) $$\text{Voluntary Feed Intake (VFI)} = \frac{100 \times FI}{[(Wi + Wf) \times t]}$$

(5) $$\text{Protein Efficiency Ratio (PER)} = \frac{\text{Mean weight gain}}{\text{Protein content of food}}$$

Where $$\text{Protein Intake (PI)} = \frac{\text{Total feed intake}}{\text{Protein content of feed}}$$

COST ANALYSIS

Cost was based on the current prices of feed ingredients in the experimental locality (Nigeria) as of the time of the experiment. The economic evaluation of the diet were calculated from the method of New (1989)

(1) Incidence of Cost (IC) = $\frac{\text{Cost of feed}}{\text{Kg of fish produced}}$

(2) Profit Index (PIn) = $\frac{\text{Value of fish}}{\text{Cost of feeding}}$

(3) Estimated Investment Cost Analysis (EICA) = Cost of Feeding Juvenile + Cost of Stock

HISTOMETRY ANALYSIS OF FISH ORGANS

Fish were randomly picked from each tank and dissected using a dissecting kit; each organ was carefully traced and cut out. The organ was placed in a small transparent nylon bag and weighed (considering the weight of the nylon) using an electronic digital scale (KERN770, max.220g, d = 0.0001g) at the Department of Cell Biology and Genetics, University of Lagos. The percentage relative organ weight was calculated as follows:

$$\% \text{ Relative Organ Weight} = \frac{\text{Organ Weight}}{\text{Fish Weight}} \times 100$$

STATISTICAL ANALYSIS

The data collected throughout the experimental period were subjected to statistical test using analysis of variance (ANOVA). The Duncan's multiple range test (Duncan, 1955) was used to determine the position of the difference in mean.

RESULTS

The initial weight across diets did not show any significant difference ($P > 0.05$). However, there was significant ($P < 0.05$) decrease in Average Weight Gain (AWG) with increased inclusion of the test ingredients across the experimental diets (Table 3). The highest AWG (58.40±5.57 g) was recorded by the fish fed the control (CTR) diet, while the the least values (25.03±1.85 g, and 30.50±10.05 g) were recorded by 15 % inclusion of ripe and unripe banana peels respectively. The highest value (1.87±0.09 %day^{-1}) of specific growth rate (SGR) was recorded by the group fed the control diet while the least value (1.106±0.05 %day^{-1}) was recorded by 15 % inclusion of ripe banana peel (Diet 3). There was significant ($P < 0.05$) decrease in the Feed Intake (FI) between the control and the other test diets. Though, no significant difference ($P > 0.05$) was recorded among the unripe group. However, Feed Conversion Ratio (FCR), Protein Efficiency Ratio (PER) and Protein Intake (PI) recorded significant difference ($P < 0.05$) between the control and the experimental diets.

There were significant differences ($P < 0.05$) in the Profit Index (PIn), Incidence of Cost (IC) and Economic Investment Cost Analysis (EICA) of feed (Table 4). Diet 2 (10% ripe banana peel) had the highest Profit Index (3.11) while the CTR had the least value (1.87). The CTR had the highest values for the Incidence of Cost (0.370) and EICA (99.3355.19) while the least values were recorded in Diets 2 (0.20) and 3 (31.85±1.91) respectively. The histometry analysis of fish organs (heart, kidney, liver and intestine) recorded significant differences ($P < 0.05$) between the CTR and other test diets (Table 5). The least values for kidney and liver (0.1570.00% and 0.2060.01% respectively) were recorded by the fish fed the CTR while the highest values (0.3890.027% and 0.7020.265%) for kidney and liver respectively were recorded for fish fed Diet 1 (5% ripe banana peel inclusion).

Table 1: Proximate Analysis of Ripe and Unripe Banana Peels

	Dry matter	Crude protein	Ash	Ether extract	Crude fibre
Ripe banana peels	60.17	8.51	12.96	11.00	9.88
Unripe banana peels	60.01	6.85	11.72	5.00	8.00

Table 2: Composition of experimental diets (kg)

INGREDIENT	CONTROL DIET	DIET 1 RBP5%	DIET 2 RBP10%	DIET 3 RBP15%	DIET 4 UBP5%	DIET 5 UBP10%	DIET 6 UBP15%
MAIZE	30	24.5	19	14	24	19	13
RBP	0	5	10	15	0	0	0
UBP	0	0	0	0	5	10	15
SBM	27	25	23	22	26	27	26
GNC	15	17	19	20	15	14	14
FISH MEAL	25	25	25	25	26	26	27
FISH PREMIX	0.5	0.5	0.5	0.5	0.5	0.5	0.5
DCP	1	1	1	1	1	1	1
SALT	0.5	0.5	0.5	0.5	0.5	0.5	0.5
PALM-OIL	1	1.5	2	2	2	2	3
CALC. CP %	39.09	39.02	38.96	38.91	38.96	38.94	38.98
CALC. EE %	5.17	4.56	4.95	5.32	4.21	4.21	4.26
CALC. ENEGRY (KCAL/KG)	2948.78	2927.21	2904.89	2809.99	2904.80	2812.08	2767.19
FEED COST (₦)/KG	174.72	106.59	101.5	92.6	125.11	119.5	110.32

KEY
RBP: Ripe banana peel
UBP: Unripe banana peel
SBM: Soya beans meal
GNC: Ground nut cake
DCP: Di-calcium phosphate

Table 3: Growth performance and nutrient utilization of *Clarias gariepinus* juveniles fed graded levels of

Parameters	Control Diet	Diet 1(5%) Ripe banana peels	Diet 2(10%) Ripe banana peels	Diet 3(15%) Ripe banana peels	Diet 4(5%) Unripe banana peels	Diet 5(10%) Unripe banana peels	Diet 6(15%) Unripe banana peels
IWG	21.400 ± 0.00	21.400 ± 0.00	21.400 ± 0.00	21.367 ±0.05	21.400 ±0.00	21.367 ±0.05	21.367 ±0.07
FWG	79.800 ±5.57^{a}	62.067 ±5.06^{b}	61.800 ±4.78^{b}	46.400 ±1.90^{c}	58.833 ±7.20^{b}	53.200 ±6.35^{bc}	51.867 ±1.08^{c}
AWG	58.400 ±5.57^{c}	40.667 ±5.06^{b}	40.400 ±4.78^{b}	25.033 ±1.85^{c}	37.433 ±7.20^{b}	31.833 ±6.36^{bc}	30.500 ±10.05^{bc}
SGR	1.877 ±0.09^{a}	1.517 ±0.11^{b}	1.512 ±0.10^{b}	1.106±0.05^{c}	1.437±0.17^{b}	1.296±0.17^{bc}	1.249±0.26^{bc}
VFI	1.450±0.09	1.453±0.08	1.430±0.24	1.533±0.03	1.631±0.38	1.445±0.15	1.695±0.24
FI	102.93±11.5^{a}	84.76±2.25^{ab}	83.83±19.4^{ab}	72.733±1.66^{b}	92.300±27.8^{ab}	75.000±2.38^{ab}	87.66±17.6^{ab}
FCR	0.568±0.02^{a}	0.479±0.05^{ab}	0.489±0.05^{ab}	0.344±0.02^{c}	0.419±0.09^{bc}	0.425±0.09^{bc}	0.348±0.06^{c}
PER	1.457±0.07^{a}	1.229±0.14^{ab}	1.255±0.13^{ab}	0.882±0.05^{c}	0.756±0.25^{bc}	1.091±0.24^{bc}	0.893±0.17^{c}
PI	40.144±4.50^{a}	33.059±0.89^{ab}	32.696±7.59^{ab}	28.366±0.64^{b}	35.997±10.8^{ab}	29.250±0.93^{ab}	33.352±6.23^{ab}

All values on the row with different superscript are significantly different ($p<0.05$)

KEY

AWG: Average Weight Gain

IWG: Initial Weight Gain

FWG: Final Weight Gain

Table 4: Economic analysis of *C. gariepinus* juveniles fed graded levels of ripe and unripe banana peels

Parameter s	Control Diet	Diet1(5% Ripe)	Diet2(10% Ripe)	Diet3(15% Ripe)	Diet4(5% Unripe)	Diet5(10% Unripe	Diet6(15% Unripe
PIn	1.870 ± 0.11 d	2.88 ± 0.22^{a} b	3.11 ± 0.43^{a}	2.89 ± 0.08^{ab}	2.23 ± 0.52^{a}	2.49 ± 0.35^{ab}	2.28 ± 0.31^{cd}
IC	0.378 ± 0.01 ab	0.22 ± 0.02 bc	0.20 ± 0.02^{c}	0.26 ± 0.01^{bc}	0.30 ± 0.06^{ab}	0.29 ± 0.06a b^{c}	0.32 ± 0.06^{a}
EICA	99.335 ± 5.1 9^{a}	51.12 ± 6.0 1^{b}	49.70 ± 5.25^{b}	31.85 ± 1.91 c	52.48 ± 12.4 9^{b}	50.87 ± 11.2 4^{b}	38.43 ± 7.50^{c}

All values on the row with different superscript are significantly different ($P<0.05$)

Table5: Histometry analysis of fish organs

Parameters	Control diet	Diet 1 (5% ripe)	Diet 2 (10% ripe)	Diet 3 (15% ripe)	Diet 4 (5% unripe)	Diet 5 (10% unripe)	Diet 6 (15% unripe)
Heart	0.107 ± 0.012^{ab}	0.119 ± 0.007^{a}	0.072 ± 0.005^{b}	0.117 ± 0.008^{a}	0.119 ± 0.003^{a}	0.105 ± 0.017^{ab}	0.116 ± 0.005^{a}
Kidney	0.157 ± 0.000^{d}	0.389 ± 0.027^{a}	0.280 ± 0.100^{bc}	0.323 ± 0.06^{ab}	0.230 ± 0.035^{bcd}	0.317 ± 0.080^{ab}	0.199 ± 0.012^{cd}
Liver	0.206 ± 0.01^{c}	0.702 ± 0.265^{a}	0.492 ± 0.101^{ab}	0.396 ± 0.129^{bc}	0.327 ± 0.040^{bc}	0.481 ± 0.119^{ab}	0.282 ± 0.091^{bc}
Intestine	1.526 ± 0.128^{a}	1.501 ± 0.071^{a}	1.492 ± 0.098^{a}	1.361 ± 0.229^{ab}	1.384 ± 0.254^{ab}	1.153 ± 0.138^{b}	1.445 ± 0.165^{ab}

All values on the row with different superscript are significantly different ($p<0.05$)

DISCUSSION

The present study showed significant decrease in the growth parameters (mean weight gain, specific growth rate, and relative growth rate) with increased inclusion of the test ingredients. This was similar to the work of Solomon *et al.* (2007), when they fed different grain sources to *Oreochromis niloticus* fingerlings. Keembiychetty and De Silva (1993) also reported decrease in weight gain at high fibre load when they fed diets containing Cowpea, *vigna catiang* and Black Grain, *Phaseolus mungo* Seeds to juvenile *O. niloticus*. Reasons for this result could be due to high fibre level which accumulates to increase cell wall materials and non-soluble polysaccharides which invariably limit the rate of digestion and nutrient absorption (Aderolu and Oyedokun, 2009). According to Keembiychetty and De Silva (1993), high fibre diets result in increase in weight of excreta and poor nutrient absorption. Also, it could be due to decrease in feed intake observed across the test diets. Since the experimental fish could not consume enough feed to take care of their growth therefore, rate of growth is expected to diminish. This observation also agreed with Ponigrahi and Powel (1991), who reported that for efficient growth rate, feed intake must correspondingly increase to meet up with the anticipated growth rate of the animal.

However, the observed reduction in feed intake with increased test ingredient inclusion could probably be due to poor diet palatability because according to Glencross *et al.* (2007) feed intake in fish is a measure of ingredient palatability. Though, the poor palatability recorded may be due to the presence of anti-nutritional factors which include hydrogen cyanide, oxalate, phytate and saponins in banana peel (Anhwange *et al.*, 2009). The presence of anti-nutritional factors in feed can reduce feed palatability, nutrient utilization or growth (Hardy and Kissil, 1996).

In addition, *C. gariepinus* showed better nutrient utilization and growth performance with ripe banana peels compared to unripe banana peels this could be as a result of the anti-nutritional factors that are higher in unripe banana peels. According to earlier reports the nutritional value of Musa spp. (Banana) fruits varies with cultivar, stage of ripeness, soil and climatic conditions under which the fruits were cultivated (Baiyeri andUnadike, 2001; Adeniji *et al.*, 2007).

According to Adams *et al.*, 1996, organ indices and condition can be used as indicators of change in nutritional and energy status of fish. Hence, the liver enlargement recorded in the catfish juvenile can be associated with increased detoxification by enzymes, as it was reported in rainbow trout (Oikari and Nakari, 1982) and white sucker (McMaster *et al.*, 1991) exposed to bleach kraft mill effluents. The increase in size of the liver may also be as a result of increased functioning capacity of the organ, such as sequestration of red blood cell as reported by Gabriel *et al.*, 2010. The present study recorded reduction of intestinosomatic index values after the inclusion of the test ingredients. This may probably be a result of loss of appetite due to the presence of anti-nutritional factors in banana peels and concomitantly resulted in reduction of total body weight (Abdel-Hamed, 2009). This result is also in agreement with several other works where changes in intestinosomatic index values were used as indicator of physiological conditions and body loss caused by reduced feed intake (Abdel-Tawwab *et al.*, 2006; Abdel-Tawwab *et al.*, 2007).

Although the Control diet had the best growth performance compared with other test diets, it recorded the least profit index (1.87) while Diet 2 (10% ripe banana peel) had the highest Profit Index (3.11). Therefore, the economic viability of replacement of maize with graded levels of ripe and unripe banana peels indicated that there was reduction in the cost of diets as the quantity of maize was being replaced with different inclusion levels of ripe and unripe banana peels.

CONCLUSION

The results obtained in this study revealed the fact that graded levels of ripe and unripe banana peels are profitable alternative energy sources for partial replacement of maize up to 10 % ripe and unripe banana peels in feeding of catfish, *C. gariepinus.*

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