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Effect of Replacing Maize with Cocoa Pod Husk in the Nutrition of *Oreochromis niloticus*

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ABSTRACT

The study was carried out to evaluate the potential of Cocoa Pod Husk (CPH) as a replacement for maize in the diet of *Oreochromis niloticus* (tilapia). Triplicated groups of 20 fish per plastic tank (replicate) with average weight of 0.9±0.2 g per fish were randomly allocated into 5 groups in a completely randomized design in an 8 week, trial. The treatment included the control diet (diet E) having maize as the only major energy source and diet A in which maize was completely replaced with cocoa pod husk, also diets B, C and D contained different proportions of maize and cocoa pod husk which ranged from 10-30 in percentage. Result revealed that 100% maize substitution with CPH had no significant effect on survival, weight gain and feed conversion ratio at reduced cost. The study suggests that CPH could suitably substitute up to 100% maize in the diet of *Oreochromis niloticus* with an irresistible increase in profit margin.

Key words: Maize, replacement, cocoa pod husk, nutrition, *Oreochromis niloticus*

INTRODUCTION

The rapid increase in the world population with unmatched food production has resulted in shortage of food supply, most especially protein rich food like fish and vegetables consumed by man and processed into feed for feeding farm animals and cultured fish (Adebowale and Olubamiwa, 2008). The problem facing fish culturists around the world is that of finding cheap and nutrient rich ingredients for the reduction in the cost of fish production, thus bringing down the cost of fish and making it affordable to the common man (Bayne *et al*., 1976). There is a high demand for fish, higher than its supply, which has resulted in high cost of fish and its products, preventing a large proportion of human population, especially in the developing countries from having access to fish (Ibe, 1999). Presently, in Nigeria and other developing countries, despite the recent relatively rapid expansion in the live stock industry, protein consumption is 75% below the FAO requirement (Ibe, 1999). This is due to the fact quantities produced are inadequate, a situation which is principally due to high cost of feeds and feed-stuff including the highly expensive fish meal, which together represent about 70% of the total cost of production (Ogunfowora, 1984).

The establishment of economically viable fish culture ventures requires the utilization of agro-industrial waste or by-product, such as cassava peels, rice bran, cocoa pod husk (Osei *et al*., 1990), kolanut husk (Osineye *et al*., 2008a), mango kernels (Teguia, 1995), shrimp waste and fish waste (Osineye *et al*., 2008b) cocoa bean cake (Odunsi *et al*., 1999) and yam peel (Fagbenro, 1988, 1996) as feed ingredient (Oluwabaimiwa *et al*., 2000). These maize-

substitutable ingredients have been shown to be highly efficient in replacing maize in the diets of monogastric animals. Falaye (1988) reported that large quantities of these crop residues and agro-industrial wastes that can be utilized as diets components are either wasted on less significant purposes or are denatured. *Oreochromis niloticus* is one of the most important tilapia species farmed in aquaculture in Africa and especially Nigeria (Sekoni *et al*., 2008). Olukunle (2006) realized the geometrical increase in human population and suggested a need to intensify fish culture by the way of developing suitable diets in supplementary forms for ponds or as a complete feed in tanks and raceways.

For the purpose of nutritional and economic benefits previous researchers have made attempt in recent times to increase the use of non-conventional plant and animal materials to replace conventional feed ingredients like maize and fish meal in livestock and fish feed ration. Teguia *et al*. (1993) has reported the suitability of plant ingredients on the basis of their valuable chemical components to design efficient fish diets. The utilization of a number of plant and animal wastes as feed components will reduce or eliminate environmental degradation and encourage profitable fish production ventures.

This study therefore focused on evaluating the effect of replacing maize with increasing levels of cocoa pod husk meal on the growth and performance of *Oreochromis niloticus*.

MATERIALS AND METHODS

Sample collection: Cocoa pod husk was collected from Igunshin, Ondo west local government, Ondo state and transported to Yaba College of Technology, Yaba, Lagos. The cocoa pod husk contains the ground and also ungrounded particles. The fingerlings of *Oreochromis niloticus* was obtained from a private farm in Lagos.

Experimental diets: There were five treatment groups, represented by 5 isocaloric and isonitrogenous diets, containing graded levels of cocoa pod husk, as depicted in Table 1, having 3 replicates each. The fingerlings were randomly allotted to each of the 5 diets in a completely randomly design.

Others feeds ingredients were purchased from Oko Oba feed mills Agege Lagos. The ingredients were thoroughly ground to become powdery and then made into 0.2 mm pellets. The pellets were sun dried for a day and stored in a dry and airy room to prevent fungal growth.

Experimental procedure: *Oreochromis niloticus* fingerlings were procured from Agboola's fish farm, Lagos and transported to Yaba College of Technology Yaba Lagos. The fingerlings were acclimatization for 48 h. The feeding trials were conducted in 15 circular tanks of 35 L capacity. Dichlorinated water supply was from environmental biology laboratory. Stale water was drained

Table 1: Composition of experimental diets

	Diets (%)				
Composition (%)	A	B	C	D	E
Fish meal	57.00	57.00	57.00	57.00	57.00
Cocoa-pod husk	40.00	30.00	20.00	10.00	-
Maize	-	10.00	20.00	30.00	40.00
Premix	2.50	2.50	2.50	2.50	2.50
Salt	0.50	0.50	0.50	0.50	0.50
	100.00	100.00	100.00	100.00	100.00

out of the tanks everyday to prevent fouling. Twenty fingerlings per tank (replicate) of average weight of 1 g were used. The fingerlings were fed *ad-lib* 3 times daily i.e., 7 a.m. 1 p.m. and 7 p.m. for 8 weeks. Fish were weighed weekly and feed adjusted accordingly. Faecal samples were collected in the forth week by siphoning. Unconsumed feed was also siphoned. The samples were bulked for each replicate, sun-dried and kept in freezer for digestibility studies. Mortality was monitored weekly and recorded.

Chemical analysis: Dry Matter (DM) of the samples was determined by drying in an oven at 65°C to constant weight, ground through a 1 mm screen and used for chemical analysis. Nitrogen concentration was analyzed by the Kjeldahl method, crude protein content was calculated (N×6.25) ash was the residue after ashing the samples in a muffle furnace at 550-600°C, ether extract and crude fibre were measured all determined as described by AOAC (1990). Digestibility values were determined using acid insoluble ash this is measured as:

$$\text{AIA (\%)} = \frac{\text{Weight of ash} - \text{weight of AIA}}{\text{Weight of ash}} \times 100$$

$$\text{Digestibility coefficient} = \frac{\text{\% AIA in feed} \times \text{Nutrient in feaces}}{\text{\% AIA in feaces} \times \text{Nutrient in feed}}$$

Gross energy values of samples were determined using a Gallenkamp Oxygen Ballistic Bomb Calorimeter with thermochemical grade benzoic acid as a standard. Weight gain, dry matter intake, feed conversion ratio, degree of mortality and digestibility co-efficient were determined.

Cost evaluation of experimental diets was based on the current prices of the ingredients in the market. Cost of transporting the cocoa pod husk from Igunshin, Ondo West. Local Government Area, Ondo State to Yaba College of Technology (the site of experiment) was recorded.

Statistical analysis: All data were subjected to analysis of variance (ANOVA) at $p \leq 0.05$ level of significance using the SAS (1999).

RESULTS AND DISCUSSION

Various nutrients present in the Isonitrogenous and isocaloric diets, containing 44.0±0.4% crude protein and 2,750 kcal kg^{-1}, gross energy has been presented in Table 2. These values are higher than the recommended values (Oguntunga, 1975; NRC, 1984). The crude fibre contents (with the exception of diets A and B), ether extract and ash contents are within the recommended limits (NRC, 1984).

Mean voluntary DM 1 value (g day^{-1}) of the fish varied from 0.11-0.15 (Table 3). Treatment effects were not significant. All the fish groups consumed between 5.0-7.0% of their body weights which is greater than 3.0% (NRC, 1982) and 3.0-5.3% (Herrera *et al*., 1996) as the minimum recommended for maintenance and growth, respectively.

Mean weight gain (g day^{-1}) of the fish groups varied from 1.15-1.79. treatment effects were significant ($p<0.05$). fish group on cocoa pod husk as sole energy source (treatment) recorded the highest weight gain, a result comparable to that obtained with poultry (Sobamiwa and Longe, 1994) although, this same treatment group recorded the highest faecal output and this is attributable to high crude fibre content, which was not digestible by the fish. Table 4 consists of raw data from which some values of mean weight gain were obtained.

Table 2: Determined proximate composition and gross energy of diets

	Diets (%)				
Composition (g/100 g DM)	A	B	C	D	E
Crude protein	43.60	43.74	44.06	44.31	44.44
Crude fibre	9.37	7.34	5.27	3.44	1.41
Ether extracts	3.01	3.32	3.62	3.94	4.26
Ash	4.10	3.50	2.90	2.00	1.20
Dry matter	98.61	98.46	98.12	97.91	97.68
Energy (kcal kg^{-1} DM)	2,630.00	2,691.40	2,716.80	2,779.20	2,901.60

Table 3: Growth response and nutrient utilization of experimental fish

	Treatment					
Growth parameters	A	B	C	D	E	SEM
Initial weight (g)	1.90	2.00	2.20	1.80	2.10	0.150
Final weight (g)	3.69^{a}	3.56^{a}	3.57^{a}	2.95^{c}	3.37^{b}	0.230
Mean weight gain (g)	1.79^{a}	1.56^{b}	1.37^{c}	1.15^{d}	1.27^{c}	0.270
Feed cost (kg^{-1}) (N:K)	72.40	80.10	91.40	109.00^{k}	120.00^{k}	-
Faecal output (g/fish/day)	0.02^{a}	0.015^{c}	0.019^{a}	0.017^{b}	0.018^{b}	0.002
No of mortality	7.00	6.00	-	9.00	1.00	3.840
Dry matter intake	0.12	0.11	0.15	0.13	0.14	0.001
Survival rate (%)	86.70^{c}	90.00^{b}	100.00^{a}	85.00^{c}	93.30^{b}	4.120
Experimental period	56.00	56.00	56.00	56.00	56.00	-
Feed conversion ratio	0.06^{b}	0.07^{b}	0.10^{a}	0.10^{a}	0.10^{a}	0.220
No. of fish	60.00	60.00	60.00	60.00	60.00	-

Means having different superscripts within a row are significantly different at $p<0.05$

Table 4: Weekly weight gain (g)

	Treatments					
Week	A	B	C	D	E	SEM
1	0.31^{a}	0.20^{b}	0.18^{b}	0.10^{c}	0.12^{c}	0.004
2	0.22^{a}	0.20^{b}	0.17^{c}	0.18^{c}	0.20^{b}	0.001
3	0.20^{b}	0.29^{a}	0.17^{c}	0.18^{c}	0.13^{d}	0.002
4	0.23^{a}	0.24^{a}	0.18^{b}	0.11^{c}	0.19^{b}	0.003
5	0.17^{a}	0.18^{a}	0.19^{a}	0.11^{b}	0.12^{b}	0.002
6	0.25^{a}	0.19^{b}	0.15^{c}	0.17^{b}	0.17^{b}	0.002
7	0.17^{b}	0.15^{c}	0.19^{a}	0.16^{c}	0.16^{c}	0.001
8	0.23^{a}	0.13^{c}	0.18^{b}	0.18^{b}	0.18^{b}	0.003

Means having different superscripts within a row are significantly different at $p<0.05$

The relatively lower (NRC, 1982) metabolizable energy required by fish for maintenance and growth (Table 2), which recorded high Nitrogen Free Extract (NFE) levels in faeces, explains why the effect of high energy density in maize was not apparent when compared to that of cocoa pod husk in the fish performance.

The relatively lower gross energy of diet A, was adequate enough to meet the requirements of the group, resulting in effective feed utilization, as reflected in the values recorded for mean feed conversion ratio, which significantly ($p<0.05$) varied between treatments A and E, with insignificant gradation between these two extremes. Treatment A (on only cocoa pod husk) recorded the lowest feed conversion ratio.

Table 5: Digestibility test results

	Treatments					
Parameters	A	B	C	D	E	SEM
NFE in faeces (%)	31.66^{e}	32.10^{d}	34.15^{c}	35.82^{b}	36.70^{a}	1.32
NFE in feed (%)	39.92	39.75	39.53	39.31	39.69	0.21
AIA value for faeces (%)	90.01^{a}	89.15^{a}	89.14^{b}	87.20^{c}	86.70^{d}	1.01
AIA value for feed (%)	87.01^{a}	86.91^{a}	86.16^{b}	85.35^{c}	84.00^{d}	0.32
Digestibility co-efficient (%)	76.90^{e}	78.00^{d}	83.10^{c}	89.10^{b}	90.00^{a}	5.10

Means having different superscripts within a row are significantly different at $p<0.05$

Digestibility values (%) varied from 76.9-90.0 (Table 5), treatment effects were significant ($p<0.05$) i.e., digestibility of rations decreased with increasing quantities of cocoa pod husk, but despite this the performances of all the treatment groups were comparable with treatment a (on cocoa pod husk based ration) recording the lowest cost (Table 3).

CONCLUSION AND APPLICATION

Insignificantly higher faecal output due to slightly lower digestibility coefficient of cocoa pod husk, may bring about slightly higher rate of pond water renewal in order to prevent water fouling. However, when other result parameters were considered, the following deductions and applications can be made.

Up to 100% maize replacement with cocoa pod husk is possible in fish diet, without adverse effect on survival and performance.

Significant savings of cost could accrue from total replacement of maize with cocoa pod husk; Fish Farmers in South-Western Nigeria, who use on-farm feeds will find the adoption of the results of this study practicable and worthwhile.

RECOMMENDATION

The result of this study on CPH as a feed stuff (major energy store) in fish diets as presented in Table 3 revealed that up to 100% maize substitution with CPH has no significant on feed intake, average daily weight gain, feed conversion ratio and survival. Cocoa-pod husk is a by-product during cocoa production constituting an environmental nuisance and costing the government so much money to render it physically, chemically biologically harmless. Harnessing this by-product and utilizing it in the formulating and compounding of livestock (especially fish) feed, will not only eradicate its environmental disturbance in the cocoa producing areas, but will remove the rivalry for maize between man and animals thus bringing about a great reduction in the cost producing of fish and other livestock. From the result the comparable feed intake of diets A and other diets (B, C, D and E) suggests an equally comparable palatability of the treatments both of which constitute large proportion of there respective diet, though, CPH has higher crude fibre which is responsible for higher faecal output in Treatment A than other treatment. The close similarity of these parameters on the five diet indicates that they were equivalent in biological efficiency. The combination of similar feed conversion ratio and gram weight gain of test diet in comparison with the control is a comparison development. It indicates the biology and economic suitability of the use of CPH in complete replacement for maize in the diet of *Oreochromis niloticus*.

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