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Growth response of Nile tilapia (*Oreochromis niloticus* L.) fed diets containing graded levels of anaerobically fermented palm kernel/cassava meals

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Abstract

A study was conducted to evaluate the growth response of Nile tilapia (*Oreochromis niloticus*) fed diets containing varying levels of fermented palm kernel/cassava meal. One hundred and fifty fingerlings of Nile tilapia with average weight of 3.7g were assigned to five dietary treatments in a complete random design. The fish were of 5 groups of 30 fish; each replicated trice, i.e. ten tilapia per replicate and reared in hapa nets in an outdoor tank. Soybean meal was replaced in the diets with fermented palm kernel/cassava meal at 0%, 10%, 20%, 30% and 40% respectively; the control diet had no palm kernel/cassava meal. Fish were fed at 3% body weight for 56 days. The growth response and nutrients utilization were evaluated based on feed conversion ratio (FCR), protein efficiency ratio (PER), and specific growth rate (SGR) as parameters. The highest FCR value of 0.92 was obtained from Diet 5 (40%) while the least value of 0.59 was obtained from the control group indicating that feed was better utilized by fish fed the control diet ($P<0.05$).The least value for specific growth rate (0.57) was obtained from Diets 5 (40%) while the value of 0.86 was obtained from the control group ($P<0.05$). Similar observation was recorded for feed intake, decreasing with increased PKM/cassava meal inclusions ($P<0.05$). This experiment has revealed that fermented palm kernel/cassava meal can be incorporated up to 10% in diets for Nile Tilapia (*Oreochromis niloticus*) without compromising growth.

Keywords: Cassava/Palm kernel meal, Growth, Anaerobic, Nile tilapia, Diets.

Introduction

Fish has been reported to be the cheapest source of animal protein in the third world countries (Bebe *et al*., 2005). Fish culture is assuming greater popularity as an alternative means to capture fisheries for increasing fish supply due to habitat degradation, over population and pollution of natural water bodies in developing countries including Nigeria (FAO, 2004; Singh *et al*., 2007). However, the scale of commercial fish culture is hampered by among other factors, the non-availability of suitable and cost effective supplementary feed. Consequently most small-scale and home-stead fish farmers resort to the primordial practice of feeding with single ingredient feeds which are usually in meal or bran form (Nnaji *et al*., 2010). The use of well-compounded pelleted feed considerably increases the profit margin of production. However, fish feeds are expensive and can account for over two-thirds of the variable cost in fish culture operations (Craig and Helfrich, 2002).

Cichlidae comprising Tilapia, *Sarotherodon,* and *Oreochromis* species are among the commercially important family farmed in tropical and sub-tropical countries. This is due to its fast growth, resistance to diseases and the ability to feed on the lowest trophic level. The adult of *Oreochromis niloticus* consume large quantities of plant materials, which are largely dominated by live algae, detritus and the associated microbes at adulthood (Agbabiaka, 2012a). Many agricultural by-products have been evaluated for inclusion in poultry and livestock feeds. However, only a few have been evaluated for their potentials as Tilapia feed (Liti *et al*., 2005; Liti *et al*., 2006; Waidbacher *et al*., 2006). This study was aimed at evaluating the optimum dietary inclusion of composite fermented cassava/PKC that will enhance performance of Nile Tilapia.

Materials and Methods

Description of study area: This research was carried out in the fish farm section of the Teaching and research farm of the Department of Fisheries and Aquaculture Technology of the Federal University of Technology Owerri (FUTO), Imo State. Owerri lies between latitudes 5^{o} 35'N and 6^{o} 10'N and longitudes 6^{o} 40'E and 7^{o} 11'E; 90m above sea level

and has annual mean temperature of 28-32^{o}C, annual rain fall of 192-194 cm and relative humidity of 77-78% annually (Federal Ministry of Aviation, 2001).

Source and processing of experimental materials: The cassava used for the studies was purchased from the open market in Obinze, Owerri West LGA; while the palm kernel cake or meal as well as other conventional feed ingredients such as maize, fishmeal, soybean meal, wheat offal, bone meal, vitamin-premix, and salt were purchased from Zion Farm Feed Mills, Egbu, Owerri, Imo state, Nigeria. The mixture of cassava/PKC (60:40) was subjected to 7 days of anaerobic fermentation, which at the end was sundried and milled.

Experimental diets: Five diets (CP = 35%) were formulated such that composite cassava and PKC meal was included at 0%, 10%, 20%, 30%, and 40% respectively (Table 1). Other feed ingredients were of the same quantities for all the diets. The feeds formulated were passed through pellet machine with size 2mm. Pelletized feeds were sundried until crispy (between 3-4 days depending on the sun intensity). The feeds were fed to the fish at 3% body weight shared into two between 7am-8am and 4pm-6pm daily throughout the duration of the experiment which lasted for 56 days. The diets were analyzed for proximate composition (AOAC, 1995).

Experimental fish and design: A total of 150 Nile Tilapia (*Oreochromis niloticus)* fingerlings (3.7g) were purchased from a commercial fish hatchery at Owerri, Imo State, Nigeria. They were acclimatized and fed commercial feed for 7 days. Thirty fingerlings were randomly assigned to each of the five experimental diets in a completely randomized design. During the experimental period, routine management practices were maintained. The fish were starved 24 hours prior to commencement of the trail.

Data collection: The entire fish in each Hapa were batch weighed on the commencement of the trial, and weekly thereafter using a digital weighing balance. Weighed fish were usually returned into their respective Hapas. Feeding was adjusted weekly according to the new body weight; water was drained off the pond every fourteen days, and the pond refilled from the bore-hole water at the farm complex. Water chemistry was usually monitored and maintained as described by Boyd, (1979).

Statistical evaluation: Data collected was subjected to one way Analysis of Variance as described by Snedecor and Cochran, (1978) and where significant difference is indicated, such mean was compared using Duncan Multiple Range test as outlined by Obi, (1990).

Table (1): Composition of experimental diet fed to (*Oreochromis niloticus* L.)

Ingredients	Dietary inclusion (%)				
	0	10	20	30	40
Maize	35.00	29.00	23.00	17.00	12.00
Soybean	35.00	31.00	27.00	23.00	18.00
Cassava/PKM	-	10.00	20.00	30.00	40.00
Fish meal	20.00	20.00	20.00	20.00	20.00
Blood meal	5.00	5.00	5.00	5.00	5.00
Lysine	0.25	0.25	0.25	0.25	0.25
Methionine	0.25	0.25	0.25	0.25	0.25
Bone meal	0.20	0.20	0.20	0.20	0.20
Salt	0.25	0.25	0.25	0.25	0.25
Vit. /Min Premix	0.25	0.25	0.25	0.25	0.25
Vegetable Oil	0.20	0.20	0.20	0.20	0.20
Crude Protein (%)	35.10	35.10	35.10	35.10	34.80
ME (kcal/kg)	3136.4	3130.0	3121.45	3116.85	3096.35

ME: Metabolisable Energy.

Biological evaluation:

a) Mean Weight Gain (MWG) = Final weight – Initial weight

b) Specific Growth Rate (%day^{-1}) = $\frac{\text{Log of final weight – log of initial weight}}{\text{Period (days)}} \times \frac{100}{1}$

c) Feed Conversion Ratio (FCR) = $\frac{\text{Feed eaten (g)}}{\text{Weight gain (g)}}$

d) Protein Efficiency Ratio (PER) = $\frac{\text{Weight gain}}{\text{Protein intake}}$

e) Mean Growth Rate (MGR) = $\frac{\text{Weight gain (g)}}{\text{Time (days)}}$

f) Protein Intake = Total feed intake x % Crude protein in the diet.

Results and Discussion

Nutrient assay of test ingredient (Fermented Cassava/PKC): The result of the proximate analysis of the test sample showed that it contains 21.92% crude protein 12% ether extract, 6% crude fibre, 11.11% moisture content, 1.55 Ash, and 48.49% nitrogen free extract respectively (Table 2).

Feed intake: The total feed intake of the experimental *Oreochromis niloticus* were 4.48g, 4.10g, 4.04g, 3.89g and 3.72g for 0%, 10%, 20%, 30% and 40% dietary treatments respectively. There was a significant difference ($P<0.05$) between the control group and those fed palm kernel /cassava meal based diets.

Feed conversion ratio (FCR): The values obtained for feed conversion ratio of experimental fish were 0.59, 0.63, 0.77, 0.85 and 0.92 for 0%, 10%, 20%, 30% and 40% dietary treatments respectively. The control group had the best FCR value of 0.59 while the group fed 40% dietary inclusion of cassava/PKC diet recorded the least value of 0.92. There was a significant difference between the treatment groups fed the test diets beyond 10% ($P<0.05$), and the control diet.

Specific growth rate (SGR% day^{-1}): The highest value of 0.86 was recorded from *Oreochromis niloticus* fed 0% (control diet) while the least value of 0.57 was recorded from fish group fed with 40% cassava/palm kernel meal based diet. Though diets with 0% and 10% inclusions were significantly different ($P<0.05$) from diets with 30% and 40% inclusion, they are however similar to 20% inclusion.

Mean growth rate (MGR): The mean growth rate of *Oreochromis niloticus* were 0.13g, 0.12g, 0.09, 0.08g and 0.07g for 0%, 10%, 20%, 30% and 40% dietary treatments respectively. There were no significant difference ($P>0.05$) among the treatment groups.

Weight gain: There were no significant difference ($P>0.05$) in weight gain among the control group and those fed 10% cassava/palm kernel meal diet, but were significantly different ($P<0.05$) from groups fed 20, 30 and 40% cassava/PKC based diets respectively. The mean weight gain of the fish were 7.55g, 6.52g, 5.25g, 4.59g and 4.06g for dietary treatment 0%, 10%, 20%, 30% and 40% respectively (Table 4).

The crude proteins of all the diets fall within the recommended range of 30 – 35% for tilapia (Eyo, 2001; Omoniyi and Fagade, 2003; Portz and Liebert, 2004). There was reduction in values of crude protein as dietary inclusion of cassava/palm kernel meal increased comparatively, perhaps due to superior crude protein of soybean (Aduku, 1993; Eyo, 2001).

Table (2): Proximate composition of the composite test ingredients

Parameters	Concentration (%)
Moisture	11.55
Crude Fiber	6.00
Crude Protein	21.92
Ether Extract	12.00
Ash	1.55
NFE	48.49

NFE= Nitrogen Free Extracts

Table (3): Growth performance of Nile tilapia (*Oreochromis Niloticus*) fed anaerobically fermented cassava/palm kernel meal

Parameters	Dietary treatments					
	0%	10%	20%	30%	40%	SEM
Initial weight of fish (g)	3.7	3.7	3.7	3.7	3.7	0.00
Final weight of fish (g)	11.25	10.22	8.95	8.29	7.76	0.70
Mean weight gain (g)	7.55^{a}	6.52^{a}	5.25^{ab}	4.59^{b}	4.06^{b}	0.70
Total feed intake (g)	4.48^{a}	4.10^{ab}	4.04^{b}	3.89^{b}	3.72^{b}	0.15
Feed Conversion Ratio	0.59^{a}	0.63^{a}	0.77^{b}	0.85^{b}	0.92^{b}	0.07
Protein efficiency "	5.62^{a}	5.29^{a}	4.33^{b}	3.93^{c}	3.64^{c}	0.40
Mean growth rate (g)	0.13^{a}	0.12^{a}	0.09^{a}	0.08^{a}	0.07^{a}	0.01
Specific growth rate (% per day)	0.86^{a}	0.79^{a}	0.69^{ab}	0.63^{b}	0.57^{b}	0.06

^{a,b,c} Means on rows with same superscript are not significantly different ($P>0.05$), SEM= standard error mean.

The general increase in the body weight of the experimental fish in all treatments is an indication that all treatment diets were adequate in dietary protein and other nutrients required by tilapia. Similar results were obtained when tilapia fingerlings were fed on different grains (Solomon *et al.,* 2007). The feed intake of the experimental fish may have been influenced by dietary fiber. The control diet (0%) recorded the highest feed intake of 4.48g while the least value of 3.72g was recorded from the fish on 40% cassava/palm kernel meal based diet. The feed intake of the fish decreased with increased dietary level of cassava/palm kernel meal. This agrees with the report that voluntary feed intake of monogastrics such as fish and chicken have been established to be a function of dietary fibre concentration (Agbabiaka, 2012b).

However, reduction in the feed intake and the nutrient utilization as cassava/palm kernel meal increased in diets might be due to anti-nutrients of the cassava/palm kernel meal such as phytate, phenols and tannins which have been implicated to give bitter taste and induce a lower feed intake in monogastrics (Zein *et al.,* 2005). Similar report was reported by Agbabiaka *et al.* (2011) when dried rumen digesta (DRD) replaced soybean meal in diets of African Catfish (*Clarias gariepinus*) which was attributed to alkaloids, saponins and anti-nutrients in the DRD. Ofojekwu *et al.,* (2003) also reported decreased weight gain of *Oreochromis nilocutus* as levels of palm kernel meal increases in the diets. The feed conversion ratio (FCR) of the experimental diets showed that cassava/PKC at 0% and 10% dietary inclusion were better utilized by the fish.

The mean weight gain of the fish was highest in control diet (0%) with value of 7.55g while the least value of 4.06g was recorded at 40% cassava/palm kernel meal inclusion. There was no significant difference ($p<0.05$) among the experimental groups fed diets containing cassava/palm kernel meal based diet beyond 10% inclusion.

Conclusions

The results from this study showed that fermented cassava/palm kernel meal can be included in *Oreochromis niloticus* diets up to 10% dietary level as reflected in values obtained from mean weight gain and specific growth rate without compromising performance ($p>0.05$). This will definitely lead to significant reduction in fish feed cost if implemented.

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