Pakistan Journal of Nutrition 6 (3): 271-275, 2007
ISSN 1680-5194

Effect of Feeding Different Grain Sources on the Growth Performance and Body Composition of Tilapia, (*Oreochromis niloticus*) Fingerlings Fed in Outdoor Hapas

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Abstract: The study investigated the growth performance and body composition of tilapia, *Oreochromis niloticus* (L) fingerlings (4.70g ± 0.09) fed Isonitrogenous and Isoenergetic diet of 25% crude protein containing different grain sources (maize, wheat, rice, sorghum and millet) designated DT1, DT2, DT3, DT4 and DT5 respectively. The study lasted for 56 days. Fish fed a diet containing maize gave the highest mean weight gain (MWG) of 6.05g; highest specific growth rate (SGR) of 1.47; best food conversion ratio (FCR) of 3.31 and the best Protein efficiency ratio (PER) of 0.93. Fish fed diet containing rice gave the poorest MWG of 4.70g and the poorest SGR, FCR and PER values. However, there is no significant difference in the values of SGR, FCR, PER and ANPU recorded for the five diets ($P > 0.05$). There was a difference in MWG of Fish Fed Diet 1 (Maize compared to the fish fed Rice and Millet ($P<0.05$). The maize diet produced fish with higher ether extract and Crude Protein in the body than fish fed the other grains. The difference in ether extract and crude protein among the five diets was however not significantly different ($P>0.05$). It can be concluded that cereal grains inclusion in the diet of Tilapia up to 57.90% can be effectively utilized by the fish with maize being the best followed closely by sorghum while rice remain the poorest in terms of growth response and nutrient utilization.

Key words: Tilapia, fingerlings, cereal grains

Introduction

Tilapia is a common fish in tropical fish farms and its prolific breeding abilities makes it to dominates most ponds and water bodies where the population is not checked. Tilapia are voracious diurnal feeders which could be macrophagous or microphagous depending on the genus in question. The Genus Oreochromis feed on zooplaktons, phytoplantons, detritus and benthic organisms (Halver, 1989).

Although no dietary requirement for carbohydrates has been demonstrated in fish diet (NRC, 1983), It has been suggested that appropriate level of carbohydrates in fish diet be provided so that protein and lipids will not be catabolized disproportionately for the supply of energy and metabolic intermediaries for the synthesis of other biologically important compounds. (Wilson, 1994; Shiau and Huang, 1990).

The experimental grains used for this study, maize, wheat, rice, sorghum and millet are cereal grains with almost equal caloric and nitrogenous composition. The grains are generally 68-72% starch, with 10-12% protein (Halver, 1989). However, due to genetic environmental interactions some could have crude protein as low as 8%.

Since, food is the main operating cost of fish production in captivity, precise information on nutritional requirement as well as factors affecting it, is necessary in order to formulate and manufacture economical and nutritionally balanced complete diets tailored to the needs of different fish species. (Al-Ogaily *et al.*, 1996).

The relative utilization of dietary carbohydrates by fish varies and appears to be related to their complexity. In general, the complex carbohydrates such as starch and dextrin are utilized by most fishes better than simple sugar like glucose (Akiyama *et al.*, 1982; Anderson *et al*., 1984; Shiau and Lin 1993).

Al-Asgah and Alli, 1994 observed that maize grain at 25% in tilapia diet showed better growth performance and nutrient utilization in comparison with other carbohydrate sources such as corn starch, dextrin, sucrose and glucose. However, the performance of *O. niloticus* has been reported to decrease with the increasing level (25-43%) of maize grain in the diet (Al-Ogaily *et al.,* 1994). Viola and Arieli (1983) also reported a decrease in the performance of both carps and tilapia when fed pelleted diets containing high levels (65-75%) of different grains. Shalaby *et al.* (1989) reported that wheat, maize, and rice increased the growth performance of common carp more than barley and sorghum when fed fish meal-soybean meal diets with cereal grains and grain by-products. Viola and Arieli (1983) has reported that both carp and tilapia react differently to various feed grain sources. Al-Ogaily *et al*., 1996 who fed different grain sources to Tilapia reported that the best growth performance was obtained for sorghum based diet whereas barley based diet gave the poorest growth performance. Wheat and other grains contain albumins which inhibit the "-amylase activity in fish. However the carp is able to regulate its amylolytic activity and can make up for the inhibition by secreting

three to four times higher amounts of amylase (Hofer and Stumbaner, 1985; Sturmbauer and Hofer, 1986. Bergot (1993) reported that wheat starch appeared to be the most digestible form out of a series of seven untreated carbohydrate sources. However, the digestibility of starch is affected not only by the source and nature of carbohydrate but also by the level of its incorporation (Al-Ogaily *et al.,* 1996).

This study is therefore designed to evaluate the growth and body composition of different grain sources obtained from southern guinea agro ecological zone of Nigeria fed to *Oreochromis niloticus* and to compare the result with earlier works.

Materials and Methods

Four hundred fingerlings of *Oreochromis niloticus* was obtained from a homogenous source at the fish hatchery of University of Agriculture, Makurdi-Nigeria and were acclimatize in an indoor wooding trough for seven days. From this stock 10 fish were randomly picked and taken to the laboratory for initial proximate body composition.

Ten net hapas with mesh size 1.6mm were constructed (1 x 1 x $1m^3$) and were serially arranged in an earthen pond measuring 25 x 15 x $1.5m^3$. The hapas were suspended in the pond using Kuralon ropes tied to two parallel thicker rope across the pond surface. Three quarter (¾) of the height of the hapas were submerged in the water. Into each of these hapas was 25 fingerlings of *O. niloticus* (2.70g ± 0.09) stocked. Five dietary treatment was used with each treatment triplicated. The total weight of the fish in each hapa were taken prior to commencement of feeding. The experimental diets used was an isonitrogenous and isoenergetic feed of 25% crude protein made from feedstuff sourced locally as in Table 1. The ground feedstuffs were thoroughly mixed, and wet mixed using hot water (60^oC) to form a tough dough which was pelleted using an electric motor pelleter. The dough was forced through the dice of 3mm dimension. The pellets were collected in tray, sun dried, packaged and stored until required. Fishes were fed 5% of body weight twice daily at 0.8 hours and at 16 hours. The weight of fish was taken weekly and feed adjusted as appropriate. Also, during weighing the hapas were washed to remove algae and other materials that could clog the meshes thereby preventing adequate water circulation.

The moisture content, ash, crude protein (CP), ether extracts (EE) crude fibre (CF) and Nitrogen free extract (NFE) of the experimental diets and the experimental fish were determined according to the procedures described in “methods of analysis”by the Association of official analytical Chemist (AOAC) 1990. Water quality parameters measured include temperature, dissolved oxygen, PH, Ammonia, (NH_3), Ammonia Nitrogen (NH_3-N), Nitrate Nitrogen (No_3-N), nitrite Nitrogen (No_2- N) and were found to be at desirable levels.

The following growth and nutrient utilization were measured.

(i) Mean weight gain (MWG) determined by subtracting the mean final weight (MFW) from mean Initial Weight (MIW).

(ii) Specific growth rate (SGR) was estimated from the relationship of the differences in weight periods in accordance with Brown (1957).

$$SGR = \frac{\text{Log}_e W_2 - \text{Log}_e W_1}{T} 100$$

Where W_1 = Weight (g) at stocking
W_2= Weight (g) at end of experiment
T = Duration of Experiment in days
Log_e = Natural logarithms.

(iii) Food conversion ratio (FCR) was determined from the relationship of feed intake and net weight gain, after (Broody, 1945)

FCR = Feed Fed / Weight gain

(iv) Protein efficiency ratio was determined from the relationship between weight gain of fish and protein consumed (Zeiotoun *et al*., 1973)

Protein Intake = Final Carcass Protein minus Initial Carcass Protein.

(v) Apparent Net protein utilization (ANPU)

ANPU = Weight gain / Protein intake

Protein Fed = Determined by formulation and confirmed through laboratory analysis.

Results

Table 1 shows the inclusion levels of ingredients used for this experiment and their proximate composition. Table 2 shows the carcass proximate composition of the experimental fish taken before commencement and after the experiment. The result showed that there is a significant difference ($P<0.05$) between the initial carcass protein and final carcass protein. Also the initial carcass ash and ether extract was significantly different ($P<0.05$) from the ones obtained for the final.

Table 3 shows the weekly mean weight gain of *Oreochromis niloticus* fed different grain sources. The result showed fishes fed the five diets gave at least 0.85g mean weight gain (MWG) in week 1 of the experiment but the mean weight gain in week 1 was not statistically significant ($P>0.05$). The result equally showed that fish fed Diet 1 which was the maize based diet gave the best MWG, SGR, FCR and PER values followed by fish fed diet 4 which was the sorghum based

Table 1: Inclusion levels of ingredients in experimental diets and its proximate composition

Ingredients	Diets				
	Diet 1	Diet 2	Diet 3	Diet 4	Diet 5
Fishmeal	6.15	6.15	6.15	6.15	6.15
Soybean	28.95	28.95	28.95	28.95	28.95
Maize	57.90	-	-	-	-
Wheat	-	57.90	-	-	-
Rice	-	-	57.90	-	-
Sorghum	-	-	-	57.90	-
Millet	-	-	-	-	57.90
Mineral Premix	3.5	3.5	3.5	3.5	3.5
Vitamin Premix	3.5	3.5	3.5	3.5	3.5
Proximate Composition:					
Moisture	7.80	8.00	7.50	7.55	8.55
Crude Protein	24.68	25.81	24.17	5.08	24.57
Ash	9.00	8.50	8.30	8.40	8.06
Ether Extracts	8.20	8.50	8.30	8.40	8.06
Crude Fibre	10.80	11.20	10.40	11.30	12.00
Nitrogen Free Extracts	39.52	37.79	41.63	39.47	37.67

Table 2: Proximate Composition of Carcass of the Experimental Fish (*Oreochromis niloticus*)

	Initial Body Composition	Final Body Composition					
		Diet 1	Diet 2	Diet 3	Diet 4	Diet 5	± S.E
Crude Protein	14.40^{b}	16.28^{c}	16.17^{c}	15.86^{c}	16.25^{c}	16.08^{C}	± 0.21
Ash	4.25^{a}	5.00^{b}	4.84^{b}	4.90^{b}	5.20^{b}	4.70^{b}	± 0.23
Ether Extract	4.47^{a}	6.20^{c}	5.89^{c}	5.97^{c}	6.14^{c}	6.11^{c}	± 0.22
Moisture	74.20^{c}	72.10^{b}	72.84^{b}	73.24^{b}	72.26^{b}	73.10^{b}	± 0.23

Values on the same row with the same superscripts are not significantly different (P>0.05).

Table 3: Weekly mean weight gain of *Oreochromis niloticus* fed different grain Sources for 56 days

	Diet 1	Diet 2	Diet 3	Diet 4	Diet 5	± SEM
WK 1	0.95^{a}	0.85^{a}	0.90^{a}	0.90^{a}	1.05^{a}	0.21
WK 2	1.6^{b}	1.45^{b}	1.15^{a}	1.70^{a}	1.10^{a}	0.14
WK 3	0.5^{a}	0.65^{ab}	0.75^{a}	0.80^{b}	0.45^{a}	0.19
WK 4	0.9^{b}	0.7^{b}	0.55^{a}	0.50^{a}	0.65^{ab}	0.22
WK 5	0.25^{a}	0.50^{b}	0.50^{b}	0.60^{b}	0.46^{b}	0.16
WK 6	0.50^{a}	0.60^{a}	0.40^{a}	0.50^{a}	0.35^{a}	0.17
WK 7	0.95^{a}	0.40^{a}	0.30^{a}	0.30^{a}	0.45^{a}	0.2
WK 8	0.40^{b}	0.45^{b}	0.20^{a}	0.35^{b}	0.45^{b}	0.18
Total	6.50	5.60^{a}	4.70^{a}	5.65^{a}	4.96^{a}	0.093

[a] Value on the same row with the same superscripts are not significantly different (P>0.05).

diet. The poorest growth response was recorded for fishes fed Diet 3 which was the rice based diet with a MWG values of 4.70g as against 6.05g for Diet 1. However there was no significant difference in the SGR, FCR, PER and ANPU value among fishes fed the five diets (P>0.05).

Discussion

The results obtained in this study showed that *O. niloticus* fingerlings fed the five grains based diet responded well in terms of growth to the diets. The inclusion of the grains at 57.90% inclusion level did not give any deleterious effects on the fingerlings. The inclusion level used in this study though higher than 25% used by Al-Ogaily *et al.*, 1996; Wilson, 1994 and Al-Asgah and Alli, 1994. The fish still responded and utilized the diets well as evidenced by the increased body protein for fishes fed the five diets.

The maize based diet gave the best growth response and the best nutrient utilization parameters (SGR, FCR, PER, ANPU) over other grains. Inclusion of maize at this high level (57.50) has improved the growth performance and nutrient utilization by *O. niloticus* at a level significantly different from the growth value obtained for fishes fed rice based diet. Al-Asgah and Alli, 1994 equally reported that inclusion of maize grain at 25% level in tilapia diet improved growth performance in comparison with other carbohydrate sources like corn starch, dextrin, sucrose and glucose. The level of inclusion of grains in this study (57%) does not decrease growth and nutrient utilization as the fish never lost weight neither was any deleterious effect manifested. Viola and Arieli (1983) however reported that inclusions of grains at high levels (65-75%)

Table 4: Nutrient utilization by *Oreochromis niloticus* fed different grain sources for 56 days

Parameter	Diet 1	Diet 2	Diet 3	Diet 4	Diet 5	± SEM
MIW (g)	4.70[a]	4.60[a]	4.65[a]	4.65[a]	4.85[a]	0.093
MFW (g)	10.75[b]	10.20[b]	9.35[b]	10.30[b]	9.80[b]	0.24
MWG (g)	6.05[c]	5.60[a]	4.70[b]	5.65[b]	4.95[b]	0.24
SGR	1.47[d]	1.42[d]	1.27[d]	1.42[d]	1.26[d]	0.201
FCR	3.31[e]	3.42[e]	4.00[e]	3.52[e]	3.94[e]	0.28
PER	0.93[e]	0.86[e]	0.82[e]	0.88[e]	0.82[e]	0.042
ANPU	16.67[a]	15.30[a]	14.29[a]	15.64[a]	14.60[a]	0.4

F – LSD 0.05. Values on the same row carrying the same superscripts are not significantly different (P>0.05)
SEM = Standard Error of Means MIW = Mean Initial Weight MFW = Mean Final Weight SGR = Specific Growth Rate
FCR = Food Conversion Ratio PER = Protein Efficiency Ratio ANPU = Apparent Net Protein Utilization.

decreased growth performance in both carp and tilapia. The best growth performance recorded for fish fed maize based diet in this study is at variance with the reported work of Al-Ogaily *et al.* (1996) who reported that the best growth performance was recorded in sorghum based diet while the barley based diet was the poorest as against the rice based diet that was the poorest in this present study. Wheat and other grains have been reported to contain albumins which inhibit the "-amylase activity in fish. However the carp is able to regulate its amylolytic activity and can make up the inhibition by secreting three to four times higher amounts of amylase (Hofer and Stumbaner, 1985). Also significant amount of amylase have been found in Tilapia (Moriaty, 1973; Nagase, 1964) and the amylolytic activity is dispersed along the entire intestine (Fish, 1960). Maize appeared to be most digestible for *O. niloticus* as the growth performance of fish fed maize based diet has shown in this study. However, the digestibility of starch is affected not only by the source and nature of carbohydrate but also by the level of its incorporation. The Apparent good digestibility of maize by *O. niloticus* in this study agrees with the observation of Popma (1982) who observed that Nile Tilapia can digest over 70% of the energy of raw corn starch. Also, the relatively good SGR and body condition factor in *O. niloticus* used for this study fed grains sources at 57% inclusion level is suggestive that *O. niloticus* might also be able to regulate amyloytic activity like carp.

The knowledge of the body composition of fish and factors affecting it allows the assessment of fish health, determination of efficiency of transfer of nutrients from the food to the fish make it possible to predictably modify carcass composition (Al-Ogaily *et al.,* 1996). The result of carcass composition in this study are in accordance with the growth performance results. The fish fed the maize based diet showed a lower body moisture though not statistically significant (P>0.05) but a higher fat content in comparison with other grains. This observation agrees with the reported work of Al-Ogaily *et al*., 1996. The nature of the cereal grains seems not to affect the Crude protein and ash content of fish as observed in this study as their was no significant difference in the values of Crude protein and ash (P>0.05). Similar results was earlier reported by Anderson *et al*., 1984, Al-Asgah and Alli, 1994 for *O. niloticus*.

The result of this study suggest that cereal grains even at inclusion level 57% can support growth of *O. niloticus* without any deleterious effect on fish health.

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