THE GROWTH PERFORMANCE OF *Oreochromis niloticus* FED GRADED LEVELS OF MUSSEL, *Mytilus edulis* SHELL AS POSSIBLE REPLACEMENT FOR DI-CALCIUM PHOSPHATE

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Abstract

This study was undertaken in order to evaluate the effect of the inclusion of Mytilus edulis shell (Mussel Shell Meal) collected from the Lagos Lagoon, University of Lagos Lagoon Front, in diets of Nile tilapia (Oreochromis niloticus), on the growth performance of the fish. Ten fingerlings each of O. niloticus were placed in plastic tanks and fed for 12 weeks with feed containing grinded M. edulis shell substituted for Di-calcium phosphate (DCP) at the rate of 0% (T_0), the control diet; 25% (T_1); 50% (T_2); 75% (T_3) and 100% (T_4). Each feeding regime was in triplicates. The mean water parameters during the experimental period were within the normal range for tropical fishes. Mean temperature was within the range of 27.78±0.57°C to 28.17±0.57°C, while hydrogen ion concentration ranged from 7.34±0.07 to 7.49±0.10. The dissolved oxygen level ranged from 6.19±0.633mg/l to 6.46±0.633mg/l. The proximate analysis of M. edulis shell showed a higher crude protein content compared to DCP. Fishes fed with diet 4 (T_3) recorded the highest value of mean weight gain (MWG= 7.61±3.34), protein efficiency ratio (PER= 6.74±3.34) and daily rate of growth (DRG= 0.09±0.00). The control diet 1 (T_0) recorded the highest value in voluntary food intake (VFI= 0.38±0.01), and lowest food conversion ratio (FCR= 1.54±0.85). This study showed that at 50 – 100% level of substitution of Di-calcium phosphate with M. edulis shell in the diet, O. niloticus had better growth performance. The higher rate of returns, benefit cost ratio and profit index were achieved in 75 – 100% inclusion.

Keywords: *Mytilus edulis, Oreochromis niloticus,* feed, diet, fish

INTRODUCTION

One of the essential prerequisites for the successful management of fish culture programme is a comprehensive understanding of feeding (Halver, 1972). Feed usually represent the single most expensive production cost in intensive aquaculture. Therefore, the need for a cost effective alternative feeding system arose. Aquaculture is one of the fastest growing food production sectors in the world and provide significant supplement and substitute to fishes brought from the wild (Hall *et al.*, 2011). The aquaculture sector is confronted with problem of high cost and irregular supply of conventional fish feed ingredients. However, Omitoyin (1995) and Aderemi *et al.*, (2004) observed that majority of feed ingredients required for the animal feeds can be met by using agro-industrial products, which are considered as wastes.

Oreochromis niloticus commonly referred to as the Nile tilapia are conspicuous members of the fresh water fauna of the tropics where temperature are suitable for their growth and reproduction as reported by Stickney (1979). In addition to the high growth rate of Nile tilapia and the consumer performance, Nile tilapia is also resistant to considerable levels of adverse environmental and management conditions (Mortuza and Al-Misned, 2013). It is a highly favored culture fish with worldwide acceptance. The dietary requirements of the Nile tilapia are well documented (NRC, 1983; Wilson, 1991). The efficiency of feed use and the sourcing of feed inputs for aquaculture are among the most important factors determining the economic profitability and environmental impacts of fish farming (Naylor, *et al.*, 2000). The nutritional quality of alternative feeds is important because it influences feed efficiency, fish growth, stress tolerance, and disease resistance (Hardy, 2010).

This study was conducted to investigate the effects of feeding various levels of diets containing the mussel, *M. edulis* shell as a substitute to Di-calcium Phosphate (DCP), on the growth of *O. niloticus* and the profit gained by reduction in the p0cost of the feed.

MATERIALS AND METHODS

One hundred and eighty juveniles of the Nile tilapia *O. niloticus* were procured from a commercial fish farm (Oke fish farm) at Iyana-Ipaja, Lagos State, Nigeria. The fish were transported in an open 25L container to the Marine Research Laboratory of the University of Lagos and placed in holding tanks with clean fresh water for acclimatization. The *M. edulis* shells were collected from Lagos Lagoon and were washed in other to remove the heavy sediment loaded on their body. The shells were further processed by sun drying for two days after which they were grinded to powder and preserved dry. Acclimatization was done for 3 weeks (21 days) containing 42% cp. At the end of the acclimatization period, fish were starved for 24 hours prior to the commencement of the experiment to enable the fish empty their guts.

Experimental Set-up

15 rectangular plastic tanks (dimensions: 39.0 x 27.5 x 26.0cm) were used for the experiment. Each of the tanks disinfected and filled with dechlorinated tap water were stocked with 10 juveniles of *O. niloticus*. The water was filled to 2/3 of the volume of each tank (15 litres). The mean weight gain of the specimens in each of the experiment tanks was obtained at the end of every week. The tanks were labeled T_0, T_1, T_2, T_3, and T_4 (each in triplicates). The formulated feed (Table 1) was treated with *M. edulis* shell at different substitutions levels for Di-calcium Phosphate (DCP) as shown in Table 2.

Table 1: Percentage composition of formulated diets

Ingredient	Percentage inclusion				
	0%	25%	50%	75%	100
Indomine	16.79	16.79	16.79	16.79	16.79
Maize	16.79	16.79	16.79	16.79	16.79
Wheat offal	16.79	16.79	16.79	16.79	16.79
Groundnut cake meal	11.72	11.72	11.72	11.72	11.72
Soya beans meal (SBM))	11.72	11.72	11.72	11.72	11.72
Fish meal (FM)	11.72	11.72	11.72	11.72	11.72
Palm kernel cake (PKC)	11.72	11.72	11.72	11.72	11.72
Vitamin C	0.25	0.25	0.25	0.25	0.25
Di-calcium phosphate (DCP)	2.0	1.5	1.0	0.5	-
M. edulis shell (MES)	-	0.5	1.0	1.5	2.0

Table 2: Percentage inclusion of *M. edulis* shell in feed composition

Diet	Tank	Composition
1	T_0	100% Componded feed with only DCP (Control feed)
2	T_1	75% DCP in compounded feed and 25% *M. edulis* shell
3	T_2	50% DCP in compounded feed and 50% *M. edulis* shell
4	T_3	25% compounded feed and 75% *M. edulis* shell
5	T_4	100% *M. edulis* shell in compounded feed

Water Quality Maintenance: The water in the experimental tanks was aerated by an electric air pump (Shining model; horsepower 50 Hz). On daily basis, 50% of the water in each bowl was gently exchanged for fresh water every morning and 10% of the water was siphoned every evening. This was done to make sure that the water quality and standard were maintained. Water temperature was taken by mercury in glass thermometer and the hydrogen-ion concentration by a pH meter (Jenway model 9060). Dissolved oxygen and ammonia concentration were determined according to the method of APHA (1985).

Proximate Analysis

The grinded *M. edulis* shell was taken to the Animal Science Laboratory of the University of Ibadan for proximate analysis.

Weight |Measurement

The mean standard weight of the fish in each tank was determined at the beginning of the experiment and at the end of every week. The weight of all the fish in each tank was measured using weighing scale (Ohaus model Cs 5000, Capacity 5000X2g) and mean value was calculated.

Growth and Nutrient Utilization Parameters

The following indices were used to determine the biological evaluation of growth performance and nutrient utilization of the fish.

(i) Mean Weight Gain. (MWG): This was calculated using the formula,

Mean Weight Gain (MWG) = Final mean weight (g)-Initial mean weight(g)

(ii) Percentage Weight Gain Per Week (PWG): This was calculated using the formula,

$$PWG = \frac{\text{Mean Weight gain per week (g)}}{\text{Initial mean weight (g)}} \times 100$$

(iii) Specific Growth Rate (SGR): This is the percentage rate of change in the logarithmic body weight. The SGR was calculated using the formula,

$$SGR\ (\%\ \text{per day}) = \frac{Log_e W_f - Log_e W_i}{\text{Times (in day)}} \times 100$$

Where W_f = Final body weight; Wi = initial body weight

(iv) Gross Efficiency of food conversion (GEFC): This was calculated with the formula,

$$GEFC = \frac{\text{Daily rate of growth}}{\text{Daily rate of feeding}}$$

(v) Food Conversion Ratio (FCR): This is the amount of unit weight of food that specimens were able to convert into unit muscle. It was determined by the formula,

$$FCR = \frac{\text{Feed intake (g)}}{\text{Total weight gain (g)}}$$

(vi) Protein Efficiency Ratio (PER): This was calculated from the relationship between the increments in the weight of fish (weight gain of fish) and protein consumed (Zeitoun, *et al.*, 1973; 1976).

$$PER = \frac{\text{Mean weight gain (g)}}{\text{Protein intake}}$$

(vii) Daily rate of growth (DRG): This was calculated with the formula below.

$$DRG = \frac{\text{Mean increase in weight per day (g)}}{\text{Body weight of fish (g)}}$$

(viii) Daily rate of feeding (DRF): This was calculated with the formula below

$$DRF = \frac{\text{Mean ration per day}}{\text{Body weight of fish}}$$

RESULTS

Water quality parameters: The mean water parameters during the experimental period are represented in Table 3 below. Temperature was within the range of 27.78 ± 0.57°C to 28.17 ± 0.57°C, while hydrogen ion concentration ranged from 7.34 ± 0.07 to 7.49 ± 0.10. The dissolved oxygen level ranged between 6.19 ± 0.633mg/L and 6.46 ± 0.633mg/L.

Table 3: Water quality parameters of the culture environments

Parameters	T_0	T_1	T_2	T_3	T_4
Temperature(^{0}C)	27.99±0.57	28.07±0.51	27.78±0.65	28.00±0.59	28.17±0.57
pH	7.44±0.01	7.49±0.10	7.44±0.08	7.39±0.13	*7.34±0.07*
D.O (mg/L)	6.19±0.63	6.31±0.91	6.47±0.08	6.31±0.69	6.37±0.61

Proximate Composition of *M. edulis* Shell

The result of the proximate analysis of the *M. edulis* shell is presented in Table 4 below. This showed a higher percentage of crude protein (6.75%) compared to the 2.0% of Di-calcium phosphate. This indicated that *M. edulis* shell may add more to the growth of a fish compared to di-calcium phosphate.

Table 4: Proximate composition of mussel shell meal

Components	Values
Crude protein (%)	6.75
Fat (%)	0.50
Ash (%)	61.58
Crude fiber (%)	15.69
Moisture content (%)	29.05
Energy Kcal/mole	291.00
Calcium (%)	33.39

Growth Performance And Nutrient Utilization

Result of nutrient utilization and growth performance at different feeding regime are represented in Table 5. T_3 recorded the highest value of mean weight gain (MWG= 7.61±3.34), protein efficiency ratio (PER= 6.74±3.34) and daily rate of growth (DRG= 0.09±0.00). The control diet 1 (T_0) recorded the highest value in voluntary food intake (VFI= 0.38±0.01), and lowest food conversion ratio (FCR= 1.54±0.85). The highest SGR of 1.35±0.13 was recorded in T_3, while the lowest value of 1.19±0.11 was recorded in T_2

Table 5: Growth parameters of *O. niloticus* fed with *M. edulis* shell.

	Different Feeding Regimes				
Parameters	T_0	T_1	T_2	T_3	T_4
Mean Weight Gain	6.36±3.11^{a}	6.88±3.11^{ab}	6.67±3.17^{ab}	7.61±3.34^{c}	7.18±3.12^{c}
Daily Rate of Growth	0.08±0.01^{a}	0.080.01^{ab}	0.08±0.00^{ab}	0.09±0.00^{c}	0.09±0.00^{bc}
Relative Weight Gain	187.83±2.96^{a}	192.19±1.24^{ab}	172.74±0.46^{a}	210.58±2.34^{b}	204.97±2.65^{b}
Specific Growth Rate	1.26±0.27^{a}	1.28±0.33^{b}	1.19±0.11^{a}	1.35±0.13^{b}	1.33±0.29^{b}
Protein Efficiency ratio	5.71±3.11^{b}	6.12±3.11^{ab}	5.82±3.17^{a}	6.74±3.34^{b}	6.05±3.12^{ab}
Food Conversion Ratio	1.54±0.85^{a}	1.65±0.86^{ab}	1.57±0.63^{a}	1.82±0.61^{b}	1.63±0.63^{ab}
Voluntary Food Intake	0.38±0.01^{b}	0.35±0.01^{ab}	0.35±1.00^{ab}	0.34±0.00^{a}	0.37±0.00^{b}
Protein Intake	20.66±0.13^{a}	23.13±0.00^{a}	23.80±0.33^{b}	27.64±0.00^{c}	26.61±0.13^{c}
Daily Rate Of Feeding	4.15±0.01^{a}	4.17±0.01^{a}	4.25±0.00^{a}	4.18±0.00^{a}	4.39±0.00^{a}

The values of the cost analysis are presented in Table 6. From the result, it could be seen that the highest rate of returns in feed fed to fish was in the diet 4 (T_3).

Table 6: Economic indices of the diets fed *O. niloticus* during the experiment

Parameters	T_0	T_1	T_2	T_3	T_4
Cost of Feed (¦)	0.17	0.16	0.16	0.14	0.14
Value of Fish (¦)	3.42	3.66	3.69	3.93	3.74
Protein Intake (¦)	20.66	23.13	23.80	27.64	26.61
Protein Index	1.12	1.13	1.15	1.13	1.19
Rate of Returns	800.28	1008.48	1025.06	1480.22	1360.57
Benefit cost ratio (BCR)	61.64	62.76	57.36	61.87	52.30937

NB: There was cost placed on the processing of the *M. edulis* shell

DISCUSSION

The water quality parameters observed in both the control tanks and the test diets tanks were within similar ranges, and within the optimum ranges recommended for tropical fish culture (King, 1998; Soyinka and Kusemiju, 2011)).

This study showed that the nile tilapia, *O. niloticus* utilized all diets fed, irrespective of the level of the mussel shell inclusion. There were slight differences in the growth parameters observed between the fish fed the control diet and the test diets. The fish fed the control diet had the lowest Food

Conversion Ratio (FCR), followed by T_2, which contained 50% *M. edulis* shell. The highest and thus the worst FCR was in 75% *M. edulis* shell inclusion. In the works of Ayoola and Madueke (2012), the best FCR was obtained in 100% *M. edulis* shell meal fed to *Clarias gariepinus*. The variation may probably be due to the different trophic feeding spectra of the species. *O. niloticus* is herbivorous, while *C. gariepinus* is omnivorous in feeding habit.

However, *O. niloticus* fed with 75% *M. edulis* shell meal (T_3) had the highest mean weight gain, while the fishes fed the control diet (T_0) had the least. Additionally, T_3 had the highest SGR, while T_0 had the least. This signified that *M. edulis* shell at 75% inclusion was well utilized for production of fish flesh and bone. In the same manner, the T_3 had the highest protein efficiency ratio, while T_0 had the least PER. This probably was responsible for the higher mean weight gain in T_3 than T_0.

The rate of returns is highest with fishes fed with diet containing 75% *M. edulis* shell and least in control diet. This indicated that feed with 75% *M. edulis* shell replacing DCP had greater profit than that with 100% DCP.

CONCLUSIONS

The present study showed that the nile tilapia, *Oreochromis niloticus* efficiently utilized the graded levels of the mussel, *Mytilus edulis* shell additives as replacement for di-calcium phosphate at 50 – 100% inclusion of the mussel. The highest rate of returns was at 75% inclusion level.

RECOMMENDATIONS

Further studies should be carried out to analyse the growth performance and nutrient utilization of *O. niloticus* fed *M. edulis* at 50 – 100% inclusion level, so as to verify the variations observed in the present study.

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