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Effect of Mixed Feeding of Varying Dietary Crude Protein Levels on the Growth and Feed Utilization of *Clarias gariepinus* (Burchell, 1822) Fingerlings

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Abstract: A-56 day growth trial was conducted to investigate the effect of mixed feeding schedules of different dietary crude protein levels on growth and feed utilization of fingerlings of *Clarias gariepinus*. Three experimental diets of 25, 30 and 35% crude protein designated as Low Protein (LP), Medium Protein (MP) and High Protein diet (HP), respectively were prepared using locally available feed ingredients. Four different feeding schedules of High-Protein diet continuously (HP), Medium-Protein diet continuously (MP), Low-Protein diet continuously (LP) and mixed feeding of 1 day Low-Protein/1-day High-Protein (1LP/1HP) were tested. Fingerlings of mean weight 1.24±0.11 g were stocked in 12 plastic aquaria tanks of 65 L in capacity at 10 fish/tank. Fish were fed twice daily at 3% body weight day^{-1} and adjusted biweekly according to changes in weight of fish. Fish fed continuously on HP resulted in significantly ($p<0.05$) the higher growth rate and feed utilization among treatments. However, there were no significant differences ($p>0.05$) between the growth rates and feed utilization of fish fed 1-day Low-Protein/1-day High-Protein (1LP/1HP) and those fed continuously on MP. Fish fed continuously on LP had the least growth and feed utilization. This study show that feeding *C. gariepinus* continuously with 35% CP diet is more economical than the mixed feeding schedule of alternate day feeding of LP and HP diets.

Key words: Mixed feeding, protein levels, growth, feed utilization, *Clarias gariepinus*, fingerlings

INTRODUCTION

One of the major problems faced by rapidly growing aquaculture is the high cost of fish feed and this constitutes >50% of the total cost of production in intensified culture systems (Ali *et al*., 2005).

The attempt to reduce feed cost in aquaculture has led to the concept of mixed feeding. De Silva (2007) defined mixed feeding as feeding the fish on a high protein diet alternatively with a low protein diet over a predetermined period of time. This concept was based on the observation that the digestibility of feed varies from day to day following an apparent cyclic pattern (Ali *et al*., 2005).

Several experimental and field trials have been carried out on the adoption of mixed feeding schedules with a number of fish species which include, catla, *Catla catla*; rohu, *Labeo rohita* and common carp, *Cyprinus carpio* (Nandeesha *et al*., 2002); *Nile tilapia* (Santiago and Laron, 2002; Patel and Yakupitiyage, 2003; Bolivar *et al*., 2006) and *Channa striata* (Arun and Yakupitiyage, 2003). The use of mixed feeding schedules have been proved effective as means of reducing feed cost and nitrogenous input into aquaculture systems (Nandeesha *et al*., 2002). In support to the effective use of mixed feeding, El-Sayed (2008) reported that mixed feeding resulted in significant improvements in protein utilization efficiency without any significant decline in growth rate of *Nile tilapia*. To date, there have been no reports on the adoption of mixed feeding schedules on the intensive culture of *Clarias gariepinus* fingerlings. Hence, the objective of present study was to determine if the adoption of mixed feeding schedules would improve the growth performance and the feed utilization of *Clarias gariepinus* with a view to minimize the cost of production.

MATERIALS AND METHODS

Formulation and preparation of experimental diets: The experimental diets were formulated using Pearson-square method as described by Gohl (1985). Diets formulated were low protein (25%), medium protein (30%) and high protein (35%) and the formulation is shown in Table 1. Feed ingredients used for the preparation of the diets were purchased from a reputable commercial feed mill (Act Feed Mill, Agbara-Lagos) where the feed ingredients were ground in a hammer mill mixed by a mixer and steam pelleted before the feeds were sun dried and packaged.

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Table 1: Percentage composition of experimental diets

		Percentage crude protein		
Feed ingredients	Composition %	(25%) LP	(30%) MP	(35%) HP
Fish meal	72.00	16.76	21.90	27.06
Soybean cake	42.00	8.38	10.95	13.53
Groundnut cake	44.00	8.38	10.95	13.53
Maize	9.00	63.74	53.44	43.13
Premix	0.50	0.50	0.50	0.50
Oil	0.25	0.25	0.25	0.25
Di-calcium sulphate	2.00	2.00	2.00	2.00
Gross energy (kcal kg^{-1})	-	4293.00	4351.90	5249.40
Digestible energy (kcal kg^{-1})	2705.09	2705.09	2789.10	3340.80
Proximate composition				
Moisture (%)	-	7.58	7.02	7.61
Protein (%)	-	24.90	29.52	35.06
Lipid (%)	-	4.22	4.01	4.58
Fibre (%)	-	1.59	1.72	1.79
Total ash (%)	-	4.99	5.01	5.25
Nitrogen free extract	-	56.72	52.72	45.71

LP, MP and HP are low protein (25%), medium protein (30%), high protein (35%). Values are in percentages

Experimental set-up: Twelve plastic aquaria tanks of black colour were used for the experiment each having a 65 L capacity and depth of 52 cm. An electric aquarium aerator (Shining Beach model; horse power 50 Hz) was used to aerate water in the tanks through air stones. The experimental tanks were covered with mosquito nets to prevent fingerlings from jumping out of water.

Collection and acclimatization of experimental fish: *Clarias gariepinus* fingerlings of mean weight 1.24±0.11 g were collected from Sej Farms, Badagry, Lagos, Nigeria and were transported by means of black bowl half filled with water. On getting to Lagos State University Hatchery.

The fish were sorted into uniform size range and were allotted randomly into 12 plastic aquaria tanks of 65 L in capacity and 52 cm depth at a rate of 10 fish per bowl. The fish were allowed to acclimate for 7 days during this period they were fed on commercial diet (Copens). At the end of the acclimatization period, fish were starved for 24 h prior the commencement of the experiment to enable the fish empties their guts.

Feeding trial: Fingerlings were fed twice daily at the rate of 3% of their body weight on daily basis with three experimental diets for 56 days. There were four treatments in triplicate. The triplicate of each treatment was fed Low Protein (25%, LP), Medium Protein (30%, MP), High Protein (35%, HP) and mixed feeding schedule of one day Low-Protein/one day High-Protein (1 LP/1 HP). The fish were collectively weighed per tank at the commencement of the experiment and mean weight was calculated and recorded. Fish were reweighed biweekly and feed weights were adjusted accordingly.

Water maintenance and quality: The source of the water used for the experiment was from a bore hole. 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 get rid of left over feed and fecal matter. Water temperature was taken by mercury in glass thermometer and pH by a pH meter (Jenway model 9060). Dissolved oxygen and ammonia concentration were determined according to the method of APHA (1985). The water temperature varied between 26-28°C, pH ranged from 6.8-7.5, dissolved oxygen levels varied from 4.0-5.5 mg L^{-1} while ammonia concentration in water was between 0.03-0.05 mg L^{-1} throughout the experimental period.

Chemical evaluation of experimental fish: Samples of the experimental fish at start and end of the experiment and the experimental diets were analyzed for their proximate composition according to the methods of AOAC (1995). Moisture was obtained by drying the sample at 105°C in an oven until constant weight was obtained. Crude protein was determined by using the microkjeldah digestion method (N×6.25). Crude lipid by soxhlet extraction method. Ash content by combustion in muffle furnance to constant weight at 600°C. Crude fibre was done by using the acid/base digestion process. Nitrogen free extract was calculated by taking the sum values for crude protein, crude lipid, crude fibre, total ash and moisture and subtracting these from 100.

Evaluation of growth and feed utilization parameters: The weight gained by fish was calculated as: Final mean weight of fish and Initial mean weight of fish. The percentage weight gain was calculated from the formula:

$$\text{Percentage weight gain} = \frac{(Y - X)\,100}{X}$$

Where:
Y = Final mean body weight (g)
X = Initial mean body weight (g)

Specific Growth Rate (SGR) was calculated as:

$$SGR = \frac{\text{Log}_e\, W_2 - \text{Log}_e\, W_1}{T_2 - T_1} \times 100$$

Where:
W_2 = Weight of fish at time T_2 in days
W_1 = Weight of fish at time T_1 in days
Log_e = Natural log of base e

The Food Conversion Ratio (FCR) is expressed as the proportion of dry food fed per unit live weight gain of fish calculated as:

$$FCR = \frac{\text{Weight of dry fed (g)}}{\text{Live weight gain (g)}}$$

Feed intake was calculated as:

$$\text{Feed intake (g)} = 3\% \text{ Body weight of fish day}^{-1}$$

The protein intake was calculated according to the formula:

$$\text{Protein intake (g)} = \text{Feed Intake (g)} \times \text{Percentage Protein in the diet}$$

Protein efficiency ratio was calculated as:

$$PER = \frac{\text{Gain in weight of test fish (g)}}{\text{Protein consumed (g)}}$$

Gross Energy was calculated according to the caloric value of protein 5.65, NFE 4.1 and lipid 9.45 kcal kg^{-1} (Brett, 1973). Digestible Energy was calculated according to the caloric value of protein 3.5, NFE 2.5 and lipid 8.1 Kcal Kg^{-1} (NRC, 1993). All growth data were subjected to one-way Analysis of Variance (ANOVA). The significance of difference between means was determined by Duncan's multiple range test ($p = 0.05$) using SPSS for Windows (Version 11). Values are expressed as means±SD.

RESULTS AND DISSCUSION

The results of growth and feed utilization of *Clarias gariepinus* fingerlings fed continuously on High Protein (HP), Medium Protein (MP), Low Protein (LP) and alternate mixed protein diets (1 LP/1 HP) are shown in Table 2.

Fish fed high-protein diet continuously performed significantly better than other diets ($p<0.05$) while those on low-protein diet continuously showed poorest growth. The Specific Growth Rate (SGR) of fish fed continuously on a high-protein diet was significantly higher ($p<0.05$) than other treatments.

The FCR also followed the same trend among the treatments. Fish fed continuously with low-protein diet had lower PER than other groups. There were no significant differences in the results of growth and feed utilization of fish fed on medium-protein diet and those on mixed feeding (1 LP/1 HP). The biweekly weight changes of fish fed on different feeding schedules are graphically shown in Fig. 1. Fish fed on HP had the best growth

Table 2: Growth and feed utilization of *Clarias gariepinus* fingerlings fed on experimental diets

	Treatments			
Parameters	LP	MP	HP	Mixed
Initial weight	1.22±0.280[a]	1.23±0.240[a]	1.13±0.180[a]	1.19±0.07[a]
Final weight	2.61±0.160[a]	2.93±0.390[b]	3.62±0.100[c]	2.86±0.14[b]
Weight gain	1.19±0.120[a]	1.71±0.150[b]	2.49±0.030[c]	1.67±0.07[b]
Percentage weight gain	87.83±28.87[a]	141.22±14.37[b]	222.42±32.22	140.01±3.22[b]
Specific growth rate	1.25±0.210[a]	1.95±0.480[b]	2.90±1.080[b]	2.10±0.61[b]
Feed intake	1.11±0.070[a]	1.24±0.160[a]	1.53±0.040[b]	1.20±0.05[a]
Protein intake	0.27±0.020[a]	0.36±0.040[b]	0.53±0.010[c]	0.35±0.01[b]
Food conversion ratio	2.75±0.350[a]	1.89±0.390[b]	1.44±0.440[b]	1.88±0.52[a]
Protein efficiency ratio	1.26±0.200[a]	1.36±0.050[a]	1.40±0.100[a]	1.33±0.11[a]

LP, MP, HP and mixed are low protein (25%), medium protein (30%), high protein (35%) and mixed feeding (25 and 35% alternate), respectively. Values are means±SD of treatments triplicate

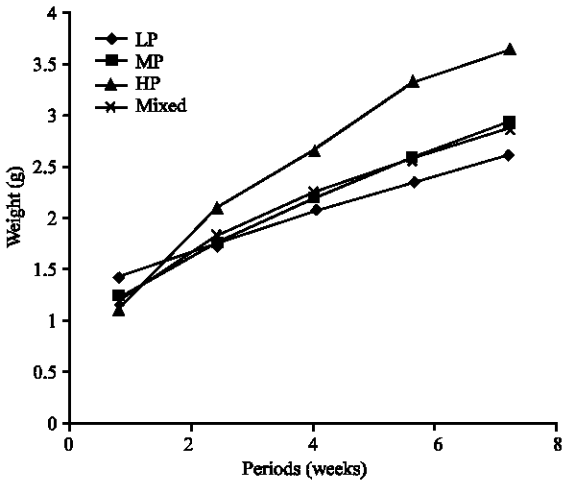

Fig. 1: Weight changes of fingerlings of *Clarias gariepinus* fed on different feeding schedules

followed by mixed feeding and MP and the least with LP. The results of the proximate composition of fish fed on various feeding schedules are shown in Table 3. Fish fed continuously on LP had the lowest percentage body fat (4%) while fish fed on HP had the highest fat deposition of 4.8%. The final body protein was not affected by the different treatments.

The results of the current study demonstrated that fish fed continuously on a high protein diet grew significantly better than those fed on mixed feeding of one day low-protein/one day high-protein diets. Fish fed continuously on low-protein diet had the least growth rate. This trend is consistent with other growth and feed utilization parameters. This finding is similar with the research of Sevgili *et al.* (2006) who reported that rainbow trout, *Oncorhynchus mykiss* fed on a high

Table 3: Proximate composition of fish carcass

		Final			
Parameters	Initial	LP	MP	HP	Mixed
Moistire	14.01±0.32	14.32±0.11	14.20±0.28	14.25±0.21	14.19±0.25
Fibre	1.35±0.11	1.51±0.04	1.51±0.02	1.50±0.02	1.54±0.04
Ash	9.02±0.07	10.18±0.18	10.32±0.20	10.64±0.08	10.20±0.11
Lipid	2.81±0.08	4.00±0.08	4.46±0.15	4.80±0.07	4.45±0.21
Protein	56.01±0.22	59.56±0.38	60.16±0.16	60.57±0.13	60.44±0.13

LP, MP, HP and mixed are low protein (25%), medium protein (30%), high protein (35%) and mixed feeding (25 and 35% alternate), respectively.Values are mean±SD of treatments triplicate

protein diet significantly grew better than those on various mixed feeding schedules. The result is also in line with the research of Hashim (1994) who found that best growth performance was observed in *Channa striata* fry maintained at 35% crude protein diet. Fry fed on alternating protein levels did not improve growth rate. This research was however in contradiction with the research of Nandeesha *et al*. (2002) in *Cyprinus carpio*; Arun and Yakupitiyage (2003) in *Oreochromis niloticus*; and Ali *et al*. (2005) in *Pangasius hypophthalmichthys*. These researchers observed that mixed feeding schedule of low protein diet alternated with high protein diet resulted in best growth or similar growth with those fed continuously on high protein diet.

The results of the present finding did not support the hypothesis of De Silva and Perera (1983, 1984) that when fish are provided a high protein throughout the rearing period, feed utilization efficiency could be reduced with time. This hypothesis was first tested with *Nile tilapia*, *Oreochromis niloticus* and in Asian cichlid, *Etroplus suratensis*. De Silva (1985) suggested that alternating high protein diet with low protein diet could be a possible solution to reducing feed and production costs.

In the present investigation, *C. gariepinus* fingerlings (1.14 g) might not exhibit daily variation during the course of this research, thus did not support the hypothesis of mixed feeding schedule. However, a number of experimental research had been conducted on the adoption of mixed feeding schedule with a number of fish species, some of these have been summarized by El-Sayed (2008). The conflicting report of the present study with some earlier and recent researchers might be due to the different quality of the diets used different experimental conditions and differences in the physiological state of the different fish species.

On the basis of the results of this study, it may be necessary to feed *C. gariepinus* fingerlings continuously on high protein diet in order to maintain maximum growth and feed utilization. There is however, the need to intensify research into using a number of mixed feeding schedule with alternating protein levels rather than the one used in the present investigation.

CONCLUSION

In this study, *Clarias gariepinus* fingerlings performed best in terms of growth and nutrient utilization when fed continuously on high protein diet. The concept of mixed feeding on alternating low protein with high protein diet would not be an economical feeding strategy for *C. gariepinus* fingerlings.

REFERENCES

AOAC, 1995. Official Methods of Analysis of the Association of Official Analytical Chemist. 16th Edn., AOAC International, Arlington, VA., USA.

APHA, 1985. Standard Methods for the Examination of Water and Wastewater. 17th Edn., American Public Health Association, Washington, DC., pp: 1268.

Ali, Z., A. Hossain and A. Mazid, 2005. Effect of mixed feeding schedules with varying dietary protein levels on the growth of sutchi catfish, *Pangasius hypophthalmus* (Sauvage) with silver carp, *Hypophthalmichthys molitrix* (Valenciennes) in ponds. Aquacult. Res., 36: 627-634.

Arun, B.P. and A. Yakupitiyage, 2003. Mixed feeding schedules in semi-intensive pond culture of *Nile tilapia*, *Oreochromis niloticus*, L.: Is it necessary to have two diets of differing protein contents?. Aquac. Res., 34: 1343-1352.

Bolivar, R.B., E.B.T. Jimenez and C.L. Brown, 2006. Alternate-day feeding strategy for *Nile tilapia* grow-out in the Philippines: Marginal cost revenue analysis. N. Am. J. Aquac., 68: 192-197.

Brett, J.R., 1973. Energy expenditure of Sockeye salmon *Oncorhynchus nerka*, during sustained performance. J. Fish. Res. Board Can., 30: 1799-1809.

De Silva, S.S. and M.K. Perera, 1983. Digestibility of aquatic macrophyte by cichlid *Etroplus suratensis* with observations on the relative merits of three indigenous components as markers and daily changes in protein digestibility. J. Fish Biol., 23: 675-684.

De Silva, S.S. and M.K. Perera, 1984. Digestibility in *Sarotherodon niloticus* fry: Effects of dietary protein level and salinity with further observation on variability in digestibility. Aquaculture, 38: 293-306.

De Silva, S.S., 1985. Performance of *Oreochromis niloticus* (L.) fry maintained on mixed feeding schedules of different protein contents. Aquac. Fish Manage., 16: 621-633.

De Silva, S.S., 2007. Reducing feed costs through adoption of mixed feeding schedule practices in semi-intensive aquaculture. Int. Aquac. Feed, 10: 18-22.

El-Sayed, A.F.M., 2008. Reducing feed costs in semi-intensive tilapia culture. Int. Aquac. Feed, 11: 32-34.

Gohl, B.O., 1985. Tropical Feeds. 2nd Edn., United Nations Food and Agriculture Organization, Rome.

Hashim, R., 1994. The effect of mixed feeding schedules of varying dietary crude protein content on the growth performance of *Channa striata* fry. Asian Fisher. Sci., 7: 149-155.

NRC. (National Research Council), 1993. Nutrient Requirements of Fish. National Academy Press, Washington, DC., USA., pp: 114.

Nandeesha, M.C., B. Gangadhara and J.K. Manissery, 2002. Further studies on the use of mixed feeding schedules with plant and animal-based diets for common carp *Cyprinus carpio* (Linnaeus). Aquac. Res., 33: 1157-1162.

Patel, A.B. and A. Yakupitiyage, 2003. Mixed feeding schedules in semi-intensive pond culture of *Nile tilapia*, *Oreochromis niloticus* L.: Is it necessary to have two diets of differing protein contents?. Aquac. Res., 34: 1343-1352.

Santiago, C.B. and M.A. Laron, 2002. Growth and fry production of *Nile tilapia*, *Oreochromis niloticus* (L.) on different feeding schedules. Aquac. Res., 33: 129-136.

Sevgili, H., Y. Emre, M. Kanyilmaz, I. Diler and M. Hossu, 2006. Effects of mixed feeding schedules on growth performance, body composition, nitrogen and phosphorus balance in rainbow trout, *Oncorhynchus mykiss*. Acta Ichthyologica et Piscatoria, 36: 49-55.