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Influence of Feeding Frequency on Feed Intake and Nutrient Utilization of Juvenile *Clarias gariepinus*

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Abstract: The effect of four feeding frequencies on feed intake and nutrient utilization of juveniles of *Clarias gariepinus* (mean weights of (8.6+0.004 g) were determined in the laboratory of the Department of Marine Sciences, University of Lagos. Two tanks were used for each feeding frequency i.e., two replications for each treatment. The fishes were fed at 5% of their body weight daily at the four feeding frequencies (Once, twice, thrice and 4 times). Feed intake of all groups did not display any significant differences ($p>0.05$) in terms of daily feed intake and mean weekly feed intake although, there was an increasing trend in the total feed intake FFA<FFB<FFD<FFC. The feed intake in thrice daily feeding frequency was higher than 4 times daily feeding frequency. There was no significant difference between weight gained and nutrient utilization. The carcass and muscle components (protein, lipid and ash) did not reveal any significant difference ($p>0.05$). Twice daily feeding frequency had the lowest Food Conversion Ratio (FCR) of 6.25 while, the highest value of 4.76 was in 4 times daily feeding frequency. Protein Efficiency Ratio (PER) was highest in once daily feeding frequency and lowest in twice daily feeding frequency. Also, Productive Protein Value (PPV) was least in once daily feeding frequency and highest in twice daily frequency. Survival Rate (SR) was lowest in twice daily feeding frequency and highest in four times feeding frequency. The total protein intake (CPI) was highest value in thrice daily feeding frequency and lowest in once daily feeding frequency. Generally, nutrients were best utilized in 3 times daily.

Key words: Feeding frequency, feed intake, nutrient utilization, juvenile, *Clarias gariepinus*, Productive Protein Value (PPV), Food Conversion Ratio (FCR), Protein Efficiency Ratio (PER), Survival Rate (SR), Total Protein Intake (TPI)

INTRODUCTION

The cost of fish feed is considered as the highest share of total cost in any intensive aquaculture operation. Therefore, feed quality and feeding strategies are of great importance in fish nutrition science.

Optimal feeding strategies improve growth, survival and Food Conversion Ratio (FCR) and assist in managing food wastage, reduce size variation and ultimately increase production efficiency.

The optimum feeding frequency for max growth of fish varies depending on the fish species, fish size, culture conditions, environmental factors, dietary nutrient (protein and energy level). Evidence presented by Sena and Trevor (1995) indicated that with increased feeding frequency of carps, specific growth rate, protein efficiency ratio, percentage protein rationed, percentage dietary energy retained in the carcass were all increased.

The effect of feeding frequency on fish growth and food conversion efficiency have been examined for several species, including channel catfish (*Ictalamus punctatus*) Noeske *et al.* (1985) rainbow trout (*Oncorhynchus mykins*). Reddy *et al.* (1994) and plaice (*Pleuronectes platessa*) (Sena and Trevor, 1995).

Feeding rates vary with the species size and age of fish as well as environmental factors (Grayton and Beamish, 1977).

Sena and Trevor (1995) suggested that manual feeding frequency several times per day is the most appropriate for intensive grown tilapia. Therefore, this study was designed to reveal the effect of different feeding frequencies on feed intake and nutrient utilization on juvenile *Clarias gariepinus*.

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MATERIALS AND METHODS

Experimental set-up: The experiment was carried in the marine science laboratory of University of Lagos and acclimatized for one week in glass tanks, Dissolved oxygen content was increased by aeration using Cosmo model 8000 and 12000 Air pumps. Changing of water and cleaning of the tank was done every two days while, faeces and any unwanted food were siphoned from the tanks daily. Dead fish were removed, counted and the number recorded.

Experimental fish and rearing conditions: Two hundred and 50 juveniles of *C. gariepinus* (weight range = 8.4±0.004-9.0±0.004 g, mean weight (8.6±0.004 g were purchased from Nigerian Institute for Oceanography and Marine Research (NIOMR) Lagos. Experimental fish were fed with COPPEN 45% crude protein diet (2 mm size) for one week while, being acclimatized. They were randomly distributed into experimental tanks (120×60×80 cm) at the rate of 30 fish per tank. Dead fish were removed from the tank daily and the number recorded. Five fish were selected from each tank on weekly intervals and their length and weight measured. Average and total weight per tank were computed in order to monitor their growth and also to adjust the feed ration in each feeding frequency. Average water temperature was 26.5±0.2°C, dissolved oxygen ranged between 5.5±0.20 and 6.2±0.20 mg L^{-1}. The pH varied between 6.45 and 7.42, salinity 0.25 and 0.26 ppt during the study.

Experimental design: Four feeding frequencies were applicable in the experiment 2 tanks for each feeding frequency i.e., 2 replications for each treatment. They are once daily, twice daily, thrice daily and four times daily.

Chemical analysis: Proximate analysis of the fish carcass was carried out before and after the experiment. Dry weight was determined after drying at 105°C until a constant weight was obtained. Ash content was determined in a muffle furnace at 500°C for 15 h. Crude protein was analysed by the kjeldal method. Table 1 shows the proximate analysis.

Formation of nutrient parameters: The weekly weight recorded and feed supplied were used to compute the utilization parameters as follows.

Feed Intake (FI): This is the amount of feed given or supplied during the experimental period.

Food Conversion Ratio (FCR): This is a numerical value used to measure the gross utilization of food for growth in fish and other animals (Teugels, 1982, 1984). It is also, a measure of the efficiency or suitability of a feed. This ratio shows the amount of feed required to achieve a unit weight increase in the product. It was calculated by the equation (Cherches *et al*., 1984).

$$FCR = \frac{\text{Diet fed (g)}}{\text{Weight gained}} \text{ or } \frac{\text{Feed supplied}}{\text{Weight gained}}$$

Gross Food Conversion Efficiency (GFCE) (%): This is the reciprocal of Food Conversion Ratio (FCR) or the percentage of the reciprocal of FCR.

$$GFCE = \frac{1}{\text{Food conversion ratio}} \times 100$$

Protein Intakes (PI): This is the product of food supplied and the percentage of crude protein present in the feed (Teugels, 1982, 1984).
Mathematically,

$$\text{Protein intake} = \text{Food supplied} \times \text{Crude protein (\%)}$$

Protein Efficiency Ratio (PER): Protein Efficiency Ratio was described as live weight gram per gram of protein fed.

$$PER = \frac{\text{Increase in the weight of fish produced (wet weight)}}{\text{Percentage crude protein of feed (g) (dry weight)}}$$

Productive Protein Value (PPV): This was the different between the final body protein and the initial body protein per unit of protein intake.

Table 1:Mean proximate fish carcass composition before and after feeding frequency trial

Sample code	Sample weight (g $fish^{-1}$)	Dry weight (g $fish^{-1}$)	Moisture content (g $fish^{-1}$)	Dry weight (g $fish^{-1}$)	Moisture amount (%)	Crude protein (%)	Ash content (%)	Crude fish (%)	Lipids (%)
FFA	54.83	13.26	41.52	24.17	75.83	27.53	12.22	0.029	10.94
FFB	62.52	15.43	47.09	24.59	75.41	27.35	11.86	0.032	12.38
FFC	158.34	39.38	118.97	24.56	75.44	28.90	9.24	0.044	29.93
FFD	171.01	41.63	129.39	24.14	78.85	28.71	10.11	0.041	34.23
Initial value	8.60	2.09	6.51	24.30	75.70	26.22	6.35	0.020	8.95

FFA: Feeding frequency at one time daily, FFB: Feeding frequency at two times daily, FFC: Feeding frequency at three times daily, FFD: Feeding frequency at four times daily

Mathematically,

$$PPV = \frac{BF\text{-}Bi}{PI}$$

Where:

PPV = Production Protein Value
BF = Final body protein
Bi = Initial body protein
PI = Protein Intake

RESULTS

Proximate composition of experimental fish: The proximate composition of the fish carcass before and after the feeding trials is shown in Table 1. The mean crude protein value was lowest 27.35% based on dry weight in the feeding frequency at twice daily while the mean highest value of 28.90% based on dry weight was recorded for the feeding frequency of three times daily. The initial mean crude protein value was 26.22% (Table 1). The lowest mean value for ash content (9.24%) was recorded for the thrice daily feeding frequency while, the highest value of 12.22% was recorded at once daily feeding frequency with the initial mean value of 6.35%. The initial mean crude fibre content was about 0.020% while, the mean values at the end of the trial ranged from 0.029-0.044% for the various feeding frequencies. The initial mean values for dry weight of fish and dry weight percentage before and after were 2.09 g and 24.30%, respectively while dry weight for the different feeding frequencies were 13.26-41.63 g at the end of the trial.

Nutrient utilization parameters: The mean nutrient utilization of the fish on the four different feeding frequencies are shown in Table 2 and 3 shows prediction equation between weight gained and nutrient utilization.

Feed Intake (FI): There was an increasing trend in the total feed intake FFA (472.33 g) <FFB (557.12 g) <FFD (794.71 g) <FFC (857.92 g) (Table 4). The feed intake of all the groups in the daily feeding frequencies do not display any significant differences ($p>0.05$) in terms of daily feed intake and mean weekly feed intake. The feed intake in thrice daily feeding frequency was the highest in all the feeding frequencies.

Food Conversion Ratio (FCR): The food conversion ratios for fish samples in each feeding frequency are shown in Table 2. The highest FCR of 4.76 was recorded for fish fed

Table 2: Mean nutrient utilization of *C. gariepinus* juveniles fed at four different feeding frequency

	Feeding frequencies			
Nutrient parameters	FFA	FFB	FFC	FFD
Total food intake (g fish^{-1})	472.32	557.11	857.91	794.70
Food conversion ratio	5.55	6.25	5.54	4.76
Gross food conversion efficiency	0.18	0.16	0.19	0.21
Total protein intake	212.52	244.92	386.02	357.62
Protein efficiency ratio	0.47	0.38	0.4200	0.4100
Productive protein value	0.0019	0.0020	0.0039	0.0042
Survival rate	91.67%	95%	97%	100%

Table 3: Predication Equation Between Weight gain and nutrient utilization indices

Y	X	Prediction equation	r	r^2	Remark
MWG	FI	Y = 0.55 + 0.184x	0.64	0.41	NS
MWG	PI	Y = 0.52 + 0.40x	0.64	0.41	NS
MWG	FCR	Y = 32.38-14.79x	0.82	0.67	NS
MWG	PER	Y = 155.44-63.00x	-0.26	0.068	NS

MWG = Mean Weight Gain, FCR = Food Conversion Ratio, PI = Protein Intake, PER = Protein Efficiency Ratio, FI = Food Intake, r = Correlation Co-efficient, r^2 = Co-efficient of determination, ns = not significant at $p<0.05$

Table 4: Mean weekly feed intake

	Weeks										
Feeding Frequency	1	2	3	4	5	6	7	8	9	10	Total
FFAI	13.50	18.72	26.82	31.00	41.72	40.59	38.27	55.86	64.48	141.36	472.33
FFAII	13.50	18.72	26.82	31.00	41.72	40.59	38.27	55.86	64.48	141.36	472.33
FFBI	13.50	18.72	29.10	28.96	54.93	48.98	54.11	89.79	93.57	125.45	557.12
FFBII	13.50	18.72	29.10	28.96	54.93	48.98	54.11	89.79	93.57	125.45	557.12
FFCI	13.50	18.72	28.35	32.20	57.26	65.79	69.48	168.22	173.37	231.02	857.92
FFCII	13.50	18.72	28.35	32.20	57.26	65.79	69.48	168.22	173.37	231.02	857.92
FFDI	13.50	18.72	23.22	33.40	60.00	62.58	64.06	122.57	179.16	217.49	794.71
FFDII	13.50	18.72	23.22	33.40	60.00	62.58	64.06	122.57	179.16	217.49	794.71

FFAI: Feeding frequency at one time daily replication I, FFAII: Feeding frequency at one time daily replication II, FFBI: Feeding frequency at two times daily replication I, FFBII: Feeding frequency at two times daily replication II, FFCI: Feeding frequency at three times daily replication I, FFCII: Feeding frequency at three times daily replication II, FFDI: Feeding frequency at four times daily replication I, FFDII: Feeding frequency at four times daily replication II

four times daily and the lowest mean value of 6.25 for those feed twice daily. There were no significant difference at $p<0.05$ and $p<0.01$ in the food conversion ratios between treatments.

Protein Intakes (PI): The lowest mean value of 212.54 g was recorded for once daily feeding while the highest mean value of 386.06 g was recorded for those feed on three times daily. There was no significance difference at $p<0.05$ and $p<0.01$ for the treatment.

Protein Efficiency Ratio (PER): The mean protein efficiency ratio of fish fed the different feeding frequencies ranged from 0.38-0.47. The least value was recorded for fish on feeding frequency of twice daily while the highest value was recorded for fish on feed frequency of once daily. There were no significance difference ($p<0.05$ and $p<0.01$) in the between.

Productive Protein Value (PPV): The least mean productive protein value of 0.0019 was recorded for fish fed once daily while, the highest mean value of 0.0042 was recorded for those fed four times daily.

DISCUSSION

The proximate composition of the fish carcass showed an increase in the values of crude protein, crude lipid, ash content, crude fibre and dry weight at the end of the experiment over the initial fish samples. The increase in the crude protein and of all the fish samples might be indicative of the adequacy of the high crude protein level of the feed used and protein intake by the fish. This means that the experimental fish converted and utilized the protein from the feed into their body protein. Garling and Wilson (1976) reported that dietary protein intake resulted in an increase in the fish intake protein level. Several investigations have reported the option protein requirements suitable for culture of some catfishes. Faturoti *et al.* (1986) recommended 40% crude protein as option for growth and nutrient utilization in *C. gariepinus* and Fagbenro *et al.* (1992) reported 40% for the culture of a closely related species, *H. indorsatis*. Crude protein values of 37, 35 and 30% were reported as adequate for 3 other species *C Ishreinsis, C. buthopogon* and *C. batrachus*, respectively (Fagbenro *et al.*, 1992; Ugwu, 1984; Chuapoehuk, 1987). Therefore, the crude protein of the diet used for this study was within the suitable range for *C. gariepinus*.

Food conversion ratio was best in four times daily feeding frequency because it had the lowest food conversion ratio, value. Twice daily feeding frequency with the highest food conversion ratio value was the poorest in food conversion and this may have been responsible for the poorest growth recorded for this frequency. Protein intake, which was highest in three times daily feeding frequency may have also contributed to the best growth recorded for this frequency.

The productive protein value expresses the protein retention of fish. Nose (1963) reported the use of productive protein value for the study of nutrient utilization with good results. In the present study, fish in 3 and 4 times daily feeding which had the highest growth and best food conversion had the least protein retention.

This research study has shown that all the different feeding frequencies experimented upon can be used to feed *C. gariepinus* juvenile. However, once and twice daily feeding frequencies might result in wastage of feed hence uneconomical. The fish samples on 3 times daily feeding frequency generally performed best followed by those on 4 times daily feeding frequency.

CONCLUSION

This shows that several feeding frequencies are better than few feeding frequencies. Therefore, it can be recommended that the feeding of *C. gariepinus* juveniles be done three times daily for optimum growth.

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