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Full Length Research Paper

Effects of feed forms and feeding frequency on growth performance and nutrient utilization of *Clarias gariepinus* fingerlings

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A 12-week feeding experiment was conducted to determine the optimum feeding frequency and best feed form for the growth and nutrient utilization of African catfish *Clarias gariepinus*. Three replicate groups of fish (average weight of 3.05± 0.25 g) were fed at 5% body weight using either floating or sinking pellets at different feeding frequencies (three meals a day, two meals a day or one meal a day) in a 2 × 3 factorial experimental design. The mean weight gain and daily feed intake of the fish were not affected significantly by the feed forms; however the fish fed with floating pellets had a slight higher weight gain than those fed with the sinking pellets. The weight gain and daily feed intake of fish fed floating or sinking pellets twice a day and thrice a day were significantly higher than that of the fish fed once in a day ($p < 0.05$) . The feeding frequency did not have any effect on the feed efficiency and protein efficiency ratio in the fish fed with sinking pellet but these variables were significantly ($p < 0.05$) affected in the fish fed once in a day when compared with other feeding frequencies while using floating pellet. The feeding frequencies and feed forms had no significant effect on the protein content of the fish carcass. Significant differences ($p < 0.05$) were recorded in the lipid content of fish as feeding frequency increases. It is therefore concluded that any of these fish feed forms can be fed at twice or thrice per day effectively for optimum result in the growth of *C. gariepinus.*

Key words: African catfish (*Clarias gariepinus*), feed frequency, feed form, growth, nutrient utilization.

INTRODUCTION

As aquaculture is gaining attention all over the world as mean of improving world fish production which is currently on decline due to dwindling output from capture fishery (FAO, 2009), one problem facing fish culturists is the need to obtain a balance between rapid fish growth and optimum use of the supplied feed.

The optimal frequency for feeding fish species especially African catfish is yet to be clearly defined and this has led to uncertainty in the feeding routines used by many farmers. Both over- and underfeeding can be detrimental to the health of the fish and may cause a marked deterioration in water quality, reduced weight, poor food utilization, and increased susceptibility to infection (Priestley et al., 2006). This may also affect the specific growth rates and the efficiency of feed conversion as these have been observed to be directly related to feed ration and frequency (Dwyer et al., 2002). Therefore, it is important to be able to predict the most favorable feeding frequency relative to the species and size of fish. When fish are fed at suitable feeding frequency, growth and survival are expected to improve because this regulates their feed intake in relation to their energy demand (Schnaittacher et al., 2005). Time of feeding and feeding frequency had been reported to affect feed intake and growth performance in fishes (Ali et al., 2005).

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Table 1. Initial and final reading of the average values of water quality parameters.

Water quality parameters	Floating pellet			Sinking pellet			(initial)
	1×	2×	3×	1×	2×	3×	
Temperature (°C)	27.60	28.32	27.40	29.00	30.01	32.00	29.18
Dissolved oxygen (mg/l)	5.84	5.88	6.04	5.40	5.98	6.01	6.02
pH	7.43	7.11	7.24	7.36	7.10	7.26	7.11
NH_3 (mg/l)	52.08	50.12	49.25	75.41	52.16	50.23	50.21

1× = daily feeding once; 2× = daily feeding twice; 3×= daily feeding thrice.

The culture of *C. gariepinus* is becoming increasingly popular in Africa; this is due to the facts that this fish is widely accepted as food fish and its hardy nature makes its culture relatively easy (Adebayo and Fagbenro, 2004). To improve on the culture of this fish (*C. gariepinus*), there is need for more information on the management method in the area of feed forms and feeding frequency in order to produce fish within the shortest possible time and at minimum cost with good quality. This study aims to find the appropriate feeding frequency for optimum culture of *C. gariepinus* fish and to assess the impacts of feed types/forms on the growth quality of fish seed production.

MATERIALS AND METHODS

Experimental trial was conducted at the laboratory of Bowen University, Iwo, Nigeria. A total of 360 *C. gariepinus* fingerlings obtained from a reputable fish farm in Ibadan, Nigeria, weighing on average 3.05± 0.25 g, was divided equally into eighteen 30 L glass tanks: 20 fish were held in each tank. On the whole, there were three feeding frequencies (once meal per day- 9 h, two meals per day – 9 and 14 h and three meal per day – 9, 14 and 18 h) using two different feed forms (floating and sinking pellets), thus giving a total of 6 treatments in a 3 by 2 factorial experimental design.
The fingerlings were acclimatized for 2 weeks in a 300 L plastic container prior to the commencement of the experiment. The fish were starved for 24 h before the commencement of the growth studies.

Experimental procedure

A commercial floating pellet (CHI feed®) of 50% C. P. level was used for this experimental trial while 50% C. P. sinking pellet was formulated and prepared locally. The proximate analysis for these feeds is presented in Appendix 1.

Dechlorinated tap water was used to replace 80% of the water volume every four days before feeding. An aerator was used to aerate the glass tanks. The sample of water used was analysed with the aid of HACH Water Test kit for dissolved oxygen, temperature, ammonia level and hydrogen ion concentration (pH).

Measurement of weight and the survival of *C. gariepinus* fingerlings/juveniles

Weights of fingerlings were determined at the beginning of each treatment and subsequently at weekly intervals basis, the weights of the test fish in each treatment were also taken in order to determine the weight gain of the experimental fish per week. Two fish were taken randomly per treatment and weighed using Electronic digital weighing scale (ACCULAB model meter balance 2000).

The total weight gain was determined by finding the difference between the initial weight and final weight (g) of the experimental fish at the end of the experiment. Mean weight gain was estimated by dividing the total weight gain by the number of weeks of the experiment. Specific growth rate (SGR) was calculated from the logarithmic difference in final and initial weight of fish according to (Hogendon, 1980).

$$\% \text{ survival} = \frac{\text{Number of surviving fry}}{\text{Number of fry initially stocked}} \times 100$$

Statistical design and analysis

3 × 2 factorial experiment in complete randomized design (CRD) was used to analyze data for total weight gain, specific growth rate and survival rate of *C. gariepinus* . One-way analysis of variance (ANOVA) was used to determine whether there were significant differences in the variables measured among the experimental groups. When a difference was detected ($P<0.05$), Duncan multiple range test was applied while all data were analyzed with SPSS 13.

RESULTS

Water quality assessment

The results of the mean water quality parameters measured during the experimental period are summarized in Table 1.

Growth performance and survival of *C. gariepinus* fed floating and sinking pellet at different feeding frequencies

Table 2 shows the parameters observed and recorded for growth performance and survival rate of *C. gariepinus* fish fed floating and sinking pellets at different feeding frequencies.

Growth performances of floating and sinking pellets fed at different feeding frequencies

Mean weight gain

No statistically significant difference ($P<0.05$) was

Table 2. Growth performance and survival of *C. gariepinus* fish fed floating and sinking pellet once, twice and thrice/day.

	Floating pellet			Sinking pellet		
	1×	2×	3×	1×	2×	3×
Mean initial wt (g)	3.03± 0.05	3.10 ± 0.02	2.97 ± 0.57	3.15 ± 0.06	3.05 ± 0.41	3.00+_0.18
Mean final wt (g)	12.44 ± 2.01	12.27 ± 3.04	12.47 ± 2.31	12.04 ± 4.42	12.02 ± 0.36	11.96+_4.05
Mean wt. gain (g)	9.41 + 3.20 ^{a}	9.17 + 2.32 ^{a}	9.50 + 1.08 ^{a}	8.89 + 2.40 ^{a}	8.97 + 4.24 ^{a}	8.96+_2.09 ^{a}
SGR (%)	0.62 + 0.01^{c}	0.64 + 0.04^{c}	0.68 + 0.21^{c}	0.58 + 0.07^{c}	0.60+ 0.71^{c}	0.52+ 0.01^{b}
FCR	2.88+ 0.02 ^{a}	2.68+ 0.50 ^{b}	2.50+ 0.06 ^{b}	2.92+ 0.01 ^{a}	2.85+ 0.12 ^{a}	2.82+ 0.08 ^{a}
Survival (%)	95.00 + 3.41^{b}	98.0 + 1.81^{b}	95.5 + 1.81^{b}	85.0 + 3.22^{a}	98.0 + 1.24^{b}	98.0+_1.41^{b}

Mean values with different superscript along each row are significantly different from each other (P< 0.05).

Table 3. Proximate analysis of the fish fed floating and sinking pellets at different feeding frequencies

Parameter	Floating pellet			Sinking pellet		
	1×	2×	3×	1×	2×	3×
Crude protein (%)	16.53 + 0.08^{b}	16.97+ 0.25^{b}	17.27+ 0.17^{b}	15.77+ 0.13^{b}	16.20+ 0.11^{b}	16.63+0.08 ^{b}
Crude fat (%)	0.27 + 0.01^{a}	0.32 + 0.21^{a}	0.55 + 0.02^{c}	0.47 + 0.28^{b}	0.62 + 0.01^{c}	0.59 + 0.02^{c}
Crude fibre (%)	0.15 + 0.01^{a}	0.12 + 0.01^{a}	0.08 + 0.01^{a}	0.09 + 0.02^{a}	0.16 + 0.02^{a}	0.14 + 0.01^{a}
Ash (%)	3.71 + 0.04^{b}	3.31 + 0.42^{a}	3.55 + 0.02^{b}	3.59 + 0.03 ^{b}	3.51 + 0.03^{b}	3.39 + 0.03^{b}
Dry matter (%)	11.74+0.03^{a}	11.63+ 0.04^{a}	11.66 + 0.10^{a}	11.87+ 0.03^{a}	11.53+0.04^{a}	11.80 + 0.11^{a}

Mean values with different superscript along each row are significantly different from each other (P< 0.05)

observed among the mean weight gain obtained in fish fed floating pellet once (9.41±3.20 g), twice (9.17±2.32 g) and thrice (9.50±1.08 g). The same applied to the mean weight gain obtained in fish fed sinking pellet once (8.89±2.40 g), twice (8.97±4.24 g) and thrice (8.96±2.09 g). However, weight gain in fish fed floating pellet is higher than that of sinking pellet (Table 2).

Specific growth rate

The result for specific growth rate (SGR) of *C. gariepinus* fry fed floating and sinking diets at different feeding frequency is shown in Table 2. Fry fed sinking pellet thrice had the lowest SGR (0.52±0.01%) while fry fed floating pellet once and twice had the highest SGR. There was no significant difference in the SGR of fry fed twice with either floating (0.64±0.04%) or sinking pellet (0.60±0.71%)

Percentage survival

Fry fed sinking pellet once recorded the lowest percentage survival (85%) while there was no significant difference in the rest.

Proximate analyses of carcass fish fed the 2 feed types

The result of the proximate analyses of the carcass of fish fed floating and sinking pellet at different feeding frequencies is shown in Table 3.

A significant difference (P < 0.05) in crude protein level was obtained in fish fed floating pellet once (16.53 ± 0.08%) when compared with fish fed sinking pellet once (15.77±0.13%) while no significant difference was observed in fish fed floating/sinking pellets twice and thrice. Significant difference (P < 0.05) was also recorded in the percentage fat and ash content obtained from the carcass of the fish fed floating and sinking pellets. No significant difference was observed in the percentage fibre content of the fish fed different feed types.

DISCUSSION

At the end of the experiment, no significant difference was observed in weight gain in fish fed floating and sinking pellet once, twice and thrice. This shows that feeding frequency does not have any significant correlation with feed types (floating and sinking pellet). Booth et al. (2008) corroborated this that different feeding regime does not have a significant effect on weight gain. Wang et al. (2007) noted at the end of his feeding trial that there was no significant difference in body composition among fish fed at different feeding frequencies. However, the higher weight gain recorded for fish fed with floating pellet against the ones fed with sinking pellet may be attributed to the nature of the feed types. Floating pellet float on water and does not disintegrate easily like sinking pellet vis-à-vis their availability to the fish in water.

Sinking pellets does not float on water and it disintegrates easily thereby becoming unavailable to the fish. The wastage, (unavailable sinking pellet) may have resulted to the lower weight gain recorded. Also, the lowest specific growth rate observed in fry fed sinking pellet once may be attributed to the crumbling nature of the feed types.

Fry fed sinking pellet once had the lowest percentage survival (85%). This may be attributed to the release of ammonia from unconsumed feed, thereby polluting the water since the primary nitrogenous waste produced by fish from protein digestion is ammonia (Durborow et al., 1997).

The mean ammonia level obtained from tanks with fry fed once with sinking pellet (75.41mg/L) was significantly higher than the recommended water quality level for warm water fishes (0.05 ppm nitrogen) which is equivalent to 50 mg/L NH_3 (Ayodele and Ajani, 1998). This may be attributed to the disintegration of unconsumed feed since all the ration meant for the day is been given once to the fish.

Sadek et al. (2004) also recorded a higher SGR in Sea Bream (Sparus aurata) fed extruded floating pellets in ponds against only inorganic fertilizer, compressed sinking pellets, and extruded semi-sinking pellets. The significant difference in crude protein level, obtained in fish fed floating/sinking pellet once could be attributed to the instability of the sinking pellet for more than an hour in water before disintegrating (Cruz and Ridha, 2001). Sinking pellet fed once per day stands this risk thereby reducing the available nutrients to the fish.

The significant difference recorded in the percentage fat and ash content obtained from the carcass of the fish fed the different feed types may be due to losses due to volatisation or some interaction between constituents (Michael et al., 1995).

Conclusion

There was no significant difference in weight gain in fish fed floating and sinking pellet of the same crude protein level (50% C. P.) although fish fed floating pellet exhibited higher weight gain. Also, no significant difference was observed among the fish fed at different feeding frequencies at 5% body weight (once, twice, thrice/day). A significant difference was obtained in fish fed floating and sinking pellet once and this is due to the crumbling nature of the sinking pellet within a short time.

It was also revealed from this experiment that floating pellet can be fed at the three feeding frequencies effectively for optimum result while the best feeding frequency for sinking pellet in order to obtain optimum result is twice and thrice per day.

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APPENDIX 1

Proximate analysis of floating and sinking pellets

Protein: 50%+_0.67;
Moisture: 9.08+_1.52;
Fat: 15%+_2.10;
Fibre: 0.8%+_1.82;
Carbohydrate: 44.46+_0.52;
Ash: 6.4%+_0.88;
Lysine: 4.1%+_0.06;
P: 2.9%+_0.11;
Ca: 2.8%+_1.00;
Zn: 3.04+_0.76;
Fe: 10.20+_1.42;
Mn: 7.08+_0.61.