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Effects of Feed Types and Feeding Frequencies on Growth and Survival of *Clarias gariepinus* (Burchell 1822) Fry Under Laboratory Conditions

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Abstract

The effect of five diets containing different feed types - Shell-free artemia, diet 1; *Moina micrura*, diet 2; shell-free artemia & fish meal (72% CP), diet 3; *Moina micrura* & fish meal, diet 4; fish meal, diet 5 (control) fed 2 times, 4 times and 6 times daily each, on growth and survival of *Clarias gariepinus* larvae (2-3mg) were investigated for six weeks. Larvae were randomly distributed into 45 plastic tanks representing each diet treatment at 100 larvae per tank in a 3 by 5 factorial arrangement of a completely randomised design. Triplicate groups were fed treatment diets to satiation for four weeks. The highest growth values were obtained in larvae fed diet 3 six times daily daily ($p<0.05$) while survival rate was highest in larvae fed diet 1. It was concluded that *C. gariepinus* larvae should be fed first with shell-free artemia diet six times daily for one week, followed by a combined diet of shell-free artemia and fishmeal six times daily for the remaining part of rearing.

Key words:
Clarias gariepinus larvae, Larvae feed types, Feeding frequency

Introduction

There is a growing awareness of aquaculture in Nigeria, with many commercial fish farms currently in production but aquaculture expansion has been a slow process, as fish farmers have faced major constraints including lack of fish seed supply (George *et al*., 2010). The need for large quantity and good quality fish seed supply is necessary as high demand for fish seed in the growing aquaculture industry has stimulated the need for artificial propagation of culturable fish species. Among the culturable food fish in Nigeria, catfish species are the most common fish species. They are important to the growth of aquaculture industry in the country (Adewumi and Olaleye, 2011). However, in spite of the success in artificial propagation of the African catfish, the demand for fish seed still outstrips supply. Although the fertilized eggs hatch in most cases, the rate of mortality is high during the rearing stage. Giri *et al.,* (2003) reported that a successful larval rearing depends mainly on the availability of suitable diets that are readily consumed, efficiently digested and provides the required nutrients to support good growth and health. When suitable food is not immediately available to fish hatchlings, they become weak and this may lead to mortality. Live food such as Artemia, Daphnia, Rotifers and copepods are better 'first food' for fish fry (Pronob *et al*., 2012). Feeding frequency also has effect on growth and survival of fish (Aderolu *et al*., 2010), there is therefore the need to obtain a balance between rapid fish growth and optimum use of the supplied feed (Gokcek *et al*., 2008). This will improve growth and survival of fish and can reduce wastage of fish feed. Food of good quality, adequate size, fed at suitable feeding frequency will improve the growth and survival rate of fish fry. This study therefore, established the best feed type and feeding frequency for *C. gariepinus* fry in terms of growth performance and survival.

Materials and Methods

Experimental Procedure

A total of 4,500 larvae of *C. gariepinus* (2-3mg) were stocked in 40-litres capacity plastic tanks. Larvae were fed five different experimental diets [Shell-free artemia, diet 1; freshwater zooplankton (), diet 2; shell-free artemia and fish meal (72% CP), diet 3; freshwater zooplankton (*Moina micrura*) and fish meal (72% CP), diet 4; and fish meal (72% CP), diet 5] at three feeding frequencies [twice (2X); four times (4X); and six times (6X) daily] in a completely randomized design under 3x5 factorial arrangement. Each treatment was replicated thrice, and there were 100 fry per replicate. Larvae/fry were fed to satiation and feeds were administered in equal portions in line with feeding frequencies under each treatment.

Freshwater Zooplankton Culture Procedure

The freshwater zooplanktons (*Moina micrura*) used for the experiment were cultured in tanks at the Department of Aquaculture and Fisheries Management Fish Farm, University of Ibadan. The tanks were cleaned and half filled with fresh water from the well to a depth of 0.5m. The tanks were then fertilized using poultry dropping. The media were exposed to sunlight for two days for phytoplankton bloom, after which they were inoculated with freshwater zooplankton species from the wild. Five days after inoculation, harvesting commenced with the use of plankton harvesting scoop net, fitted with a clean transparent glass bottle to hold water and zooplankton. Harvested zooplanktons were properly rinsed with clean water before being used to feed the fry.

Water Quality

The water quality in each tank was maintained by replacing 80% of the water volume daily before the start of experimental feeding. The sample of water used was analysed for the following parameters: dissolved oxygen (DO), temperature and hydrogen ion concentration (pH). Daily temperature of the tank was measured in degree Celsius using Mercury-in-glass thermometer. Hydrogen ion concentration (pH) of the water media was determined daily using a pH meter calibrated from 1-14. The DO was determined using Winkler's method as described by Monica (2017).

Growth Measurement

The weight measurement of larvae/fry in each treatment was taken on a weekly basis. The fry in each tank were bulk-weighed using a sensitive weighing balance calibrated to a minimum of 0.00g to a maximum of 100g. Feed rations were adjusted for the next week based on the new weights taken. The following parameters of growth were measured. The total weight gain was determined from the difference between the initial weight (W1, g) and final weight (W2, g) of the experimental fish at beginning (T1) and the end (T2) of the experiment. The mean weight gain was expressed as the difference between the mean final and initial weights.

Specific Growth Rate (SGR) was calculated from the logarithmic difference in final and initial weight of fry

$$SGR\ (\%) = \frac{\ln W2 - \ln W1}{T2 - T1} \times 100$$

Where W2 = Final weight of fry, W1 = Initial weight of fry; T1 and T2 are experimental period (days) at the beginning (day 0) and end (day 42).

ln = Natural logarithm,

The percentage survival rate of fry was determined by manually counting the fry that survived in each tank, and dividing the number by the total number of fry stocked and expressed as:

$$\text{Survival rate (\%)} = \frac{\text{Number of surviving fry}}{\text{Number of fry initially stocked}} \times 100$$

Freshwater Zooplankton Identification

Identification of freshwater zooplankton used for the study was done in the Laboratory of Department of Zoology, University of Ibadan.

Statistical Design and Analysis

All data were analysed using the two way analysis of variance (ANOVA) method while standard error (SE) was used to estimate the probability of deviation from means at P-level of significance. The significant mean differences were separated using the L.S.D method as described by Adesoye (2004). Correlation analysis was also carried out on feeding frequency, weight gain, specific growth rate and survival of *Clarias gariepinus* fry in all diets.

Results

The results of water quality parameters measured during the experimental period are presented in Table 1.The total weight gain and SGR were significantly higher (P<0.05) in fry fed with diet 3, this was followed by fry fed diet 1, while fry fed with diet 5 (fish meal) had the least weight gain and SGR (Table 2). Survival was significantly higher (P<0.05) in fry fed with diet 1, this was followed by fry fed with diet 3. Survival rate was low in fry fed with diet 2 (freshwater zooplankton), diet 4 (freshwater zooplankton and fish meal), and diet 5 (fish meal) (Table 2). The result of weekly mean weight gain of *C. gariepinus* fry fed different diets (Fig. 1) indicated that in the first and second week of the experiment, there were no significant differences in mean weight gain of fry fed with diet 1 and fry fed with diet 3. From the third week to the last week, fry fed diet 3 had significantly higher mean weight gain (P<0.05).

The result of total weight gain, SGR and survival rate of *C. gariepinus* fry fed at different feeding frequencies (Table 4) indicated that weight gain, SGR and survival were higher in fry fed six times daily while fry fed twice daily had the least. Although there was no significant difference in SGR and survival of fry fed six times and four times daily.

The result of the mean weight gain, SGR and survival rate of *C. gariepinus* fry fed different diets at different feeding frequencies (Tables 4 & 5) indicated that mean weight gain was significantly higher (P<0.05) in fry fed 6 times daily with diet 3, while fry fed twice daily with diet 5 had the least mean weight gain. There was no significant difference (P>0.05) in SGR of fry fed four times daily and fry fed six times daily with diet 3. For fry fed with diet 1, SGR was significantly higher (P<0.05) in fry fed six times daily, compared to fry fed twice and four times daily. Fry fed twice daily with diet 5 had the lowest SGR (P>0.05).

Table 1: Average values of water quality of fry fed experimental diets at different frequency

Water quality	**Diet 1**			**Diet 2**			**Diet 3**			**Diet 4**			**Diet 5**		
Parameters	**2X**	**4X**	**6X**	**2X**	**4X**	**6X**	**2X**	**4X**	**6X**	**2X**	**4X**	**6X**	**2X**	**4X**	**6X**
Temperature (0C)	26.90	27.05	27.00	27.02	27.03	27.01	27.05	27.03	27.05	27.00	27.01	27.01	27.01	27.02	27.04
Dissolved Oxygen (mg L-1)	6.05	6.07	5.90	6.09	6.04	6.07	5.83	5.92	6.02	6.04	6.00	6.01	6.00	6.01	6.01
pH	7.24	7.31	7.41	7.24	7.19	7.29	7.19	7.25	7.30	7.25	7.30	7.38	7.21	7.28	7.34

Abbreviations: 2x=2 times daily feeding, 4x = 4 times daily feeding, 6x = 6 times daily feeding

Table 2: Total Weight Gain, Specific Growth Rate (SGR) and Survival of *C. gariepinus* Fry fed with different diets

Diets	**Weight Gain (g)**	**SGR (%)**	**Survival (%)**
I (Shell-free Artemia)	0.476^{c}	12.035^{d}	70^{c}
11 (Freshwater Zooplankton)	0.045^{a}	6.873^{b}	6^{a}
111 (Shell-free Artemia and fish meal)	0.876^{d}	13.662^{e}	39^{b}
1V (Freshwater zooplankton and fish meal)	0.191^{b}	10.403^{c}	10^{a}
V (Fish meal)	0.038^{a}	6.170^{a}	4^{a}

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

Table 3: Total Weight Gain, Specific Growth Rate (SGR) and Survival of *C. gariepinus* Fry Fed at Different Feeding Frequencies

Feeding Frequency	**Weight Gain (g)**	**SGR (%)**	**Survival (%)**
A (2 Times Daily)	0.283^{a}	9.544^{a}	21^{a}
B (4 Times Daily)	0.320^{a}	9.954^{b}	27^{b}
C (6 Times Daily)	0.371^{b}	9.987^{b}	28^{b}

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

Table 4: Mean Weight Gain of *C. gariepinus* Fry Fed with Different Diets at Different Feeding Frequencies

Diets	**Daily Feeding Frequency**		
	2 x Daily	**4 x Daily**	**6 x Daily**
(i) Shell-free processed Artemia	0.1478^{c}	0.1733^{d}	0.2122^{e}
(ii) Freshwater Zooplankton	0.0253^{a}	0.0381^{a}	0.0258^{a}
(iii) Shell -free processed artemia + fish meal of 72% CP	0.2788^{f}	0.3054^{g}	0.3593^{h}
(iv) Freshwater zooplankton + fish meal of 72% CP	0.0619^{b}	0.0656^{b}	0.0719^{b}
(v) Fish meal of 72% CP	0.0183^{a}	0.0229^{a}	0.0257^{a}

Mean values with different superscript were significantly different from each other (P<0.05)

Table 5: Correlation matrix of Feeding Frequency, Weight Gain (WG), Specific Growth Rate (SGR) and Survival of *C. gariepinus* Fry Fed with Experimental Diets

Parameters	Feeding frequency (Daily)	WG (g)	SGR (% day^{-1})	Survival rate (%)
Feeding Frequency	1.00			
WG	0.11	1.00		
SGR	0.06	0.91*	1.00	
Survival rate (%)	0.09	0.67*	0.71*	1.00

*Significantly correlated at p-level (0.05) of significance

Discussion

The significantly higher weight gain and specific growth rate observed in fry fed combined diet of shell-free artemia and fish meal (diet 3), could be related to differences in dietary lipid content, amino-acid composition or digestibility of shell-free artemia and fishmeal. This result aligned with the findings of Armando *et al.,* (2007) and Pektam and Moodie (2000) that mixed diet of shell free artemia which produced the best weight gain in catfish fry. The poor growth performance and survival of fry fed diet 2 (freshwater zooplankton) indicated that the freshwater zooplankton were not well accepted and ingested. This might be as a result of increase in the size of the zooplankton in the culture media, which became too large for the larvae to eat. Uneaten freshwater zooplanktons were observed in the culture media. This result is in agreement with the observation of Rottman *et al*., (2003) who reported that moina grows at a rapid rate, becoming too dense and large to be eaten by fry. Additionally, their "hopping" movements could potentially harm fry in aquaria.

The high survival rate and also good growth performance observed in fry fed diet 1 (shell-free artemia) might be as a result of high acceptance level of the feed by the experimental fry because of the feed particulate size and the fact that it had balanced nutrient composition (Olurin *et al.,* 2010). Also shell-free artemia has a high floating capacity and sinks slowly to the bottom of culture media, which might have contributed to its acceptability. Similar result was observed by Olurin and Oluwo (2010) when shell-free artemia was fed to catfish (*C. garipinus*) fry. Fry fed diet 5 (fish meal) had low growth performance and survival rate. Although the fry were able to ingest the diet, their growth was inferior as compared to fry fed diets 1 and 3. This might be as a result of the inability of larvae/fry to easily digest and absorb fishmeal. Also the powdery nature of fishmeal allows it to quickly dissolve in water thereby making the nutrient unavailable for the fry.

Increase in growth performance as a result of increased daily feeding frequency can be attributed to the fact that catfish require adequate food survive, grow and to maintain their high metabolic requirement. The result is in line with Asuwaju *et al*., (2014) that reported significant increase in growth and survival of catfish fed five times daily when compared to those fed three times and once daily. Lower growth and survival observed in fry fed twice daily might be as a result of reduced nutrient intake. This study equally revealed that proper feeding frequency for maximum growth performance might be a function of diet type.

Conclusion

In conclusion, the results of this study suggested that, at the start of exogenous feeding, *C. gariepinus* larvae should be fed with shell-free artemia diet six times daily for one week, after which a combined diet of shell-free artemia and fishmeal should be fed to fry at feeding frequency of six times daily until fingerling stage is attained. These feeding procedures will ensure maximum growth performance and high survival of *C. gariepinus* fry.

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