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Performance of Different Feeding Frequency on Growth Indices and Survival of Monosex Tilapia, *Oreochromis niloticus* (Teleostei: Cichlidae) Fry

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ABSTRACT
An experiment was conducted for twenty eight days to evaluate the efficacy of feeding frequency on growth performance and survival of monosex tilapia (*Oreochromis niloticus)* fry. A total of 13,500 fry of three-days-old (weight 0.018±0.04 g) were stocked in nine *hapa* (1×1×1 m^3) at the rate of 1500 fry/*hapa*. The *hapas* were divided into three treatments on the basis of feeding frequency viz. 3 (T_1), 4 (T_2) and 5 (T_3) times per day respectively, having three replications. Fry were fed with 17α-methyltestosterone (MT) hormone mixed feed initially at the rate of 25% of their body weight and the rate was gradually reduced by 10% up to the final week. The water quality parameters were monitored found to be within suitable range for proper growth of *O. niloticus.* After ending the trial period, significant variations (P<0.01) were observed in three treatments and T_3 showed the best performance in case of all parameters studied such as weight gain (WG), feed conversion ratio (FCR) and specific growth rate (SGR). The survival rates were estimated highest (95.66%) in T_3 compared to the rest two treatments (T_1 and T_2). The results revealed that feeding frequency had a positive effect on growth indices and the survival rate of *O. niloticus* fry.

Keywords: Feeding frequency, Monosex tilapia, Growth, Survival

1. Introduction
Nile tilapia, *Oreochromis niloticus* is likely to be the most important food fish and commonly cultured species in the 21st century throughout the world [19]. The use of the male monosex population is pre-requisite for commercial tilapia production as male tilapia grows approximately 30% more than females. Administration of androgen hormone (17α-methyl testosterone) is an effective and economically feasible method for obtaining all male tilapia populations [8].
Thus, it is important to consider the factors that influence its production such as feed type, ration size, various feeding frequencies and how they may influence on growth and feed utilization. Feeding frequency is important to ensure a maximal food conversion ratio and weight of cultured organisms [5]. Higher feeding frequencies decrease aggressive behavior may resulting the faster growth and uniformity in size. Moreover, feeding frequency can affect growth performance, survival, body composition [28] and water quality [27].
Furthermore, as we know the feed cost is one of the largest operational costs in the aquaculture industry [6]. An important approach for reducing feed costs in commercial aquaculture is to develop proper feed management, husbandry strategies [13] and efficient broadcasting of the predetermined ration to the culture system. Hence, the act of feeding may be pointed as one of the most vital element in the culture practice.
Several authors had already studied the influence of feeding frequency on growth performance for various species [10, 16]. However, the effect of feeding frequency on growth performance of monosex tilapia reared in *hapas* is yet quiet limited. Therefore, the present research work was carried out with an aim to find a suitable feeding frequency for optimal growth and survival during rearing of *O. niloticus* fry.

2. Materials and methods
2.1 Experimental design and rearing of *O. niloticus* Fry
This study was carried out in a private hatchery called "Reliance Aqua Farms", Trishal,

Mymensingh from 22 July to 18 August, 2013. A total of 13,500 hatchery produced fry having initial size (0.018±0.04 g) were distributed in nine experimental *hapas* (1×1×1 m^3) at a density of 1500 fry/*hapa*. All *hapas* were newly constructed before the start of the experiment and setup in a pond. *Hapas* were rectangular of synthetic netting of mesh size 1.5 mm closed from all sides except the top. The synthetic net was fitted with a bamboo pole by using rope and metallic wire. After that, *hapas* were divided into three treatments on the basis of feeding frequency, such as 3 (T_1), 4 (T_2) and 5 (T_3) times per day having three replications. Fry were provided hormone (17α-methyltestosterone) mixed formulated feed following the method of [7] for a period of 28 days. Then prepared diets were air dried at room temperature and stored for further application in a plastic container after sealing polythene bag. During the rearing period, in case of T_1 (8:00, 12:00 and 16:00 hours) feed was provided three times per day, T_2 Four times per day (8:00, 11:00, 14:00 and 17:00 hours) and T_3 Five times per day (8:00, 10:00, 12:00, 14:00 and 16:00 hours) initially 25% of their body weight and reduced gradually at the rate of 10% of their body weight up to the final week. Proximate composition of fry diet was determined following the standard methods as given by the Association of Official Analytical Chemists, [2]. During the experimental period, water temperature by using a Celsius thermometer, pH with a portable digital pH meter (MICRO-TEMP, pH 500) and dissolved oxygen (DO) by a digital DO meter (multi 340 i/set, DO-5509; Germany) were recorded as 26.5±1 ^oC, 7.5±0.2 and 6.8±0.4 ppm, respectively.

2.2 Performance evaluation of *O. niloticus* fry

Periodic sampling of fry was done to assess the growth and health status of fry every after seven days. Fry were caught by using a scoop net with proper care and kept in a bowl with water. Weight was taken by digital electric balance (AND GULF, Dubai, U.A.E., model: GL-300). Then, fry were released in the respective *hapas*. Sampling was done early in the morning when the fish's stomach was about to empty, to avoid the biasness of weight due to the presence of excessive feed. Additionally, the mean weight gain (g), specific growth rate (SGR), feed conversion ratio (FCR) and survival of fry were recorded at the time of final harvesting and growth parameters were calculated as:

$$\text{Weight gain (g)} = \text{Mean final weight} - \text{Mean initial weight}$$

$$\%\ \text{Weight gain} = \frac{\text{Mean final weight} - \text{Mean initial weight}}{\text{Mean initial weight}} \times 100$$

$$\text{SGR (\%/day)} = \frac{\ln \text{final weight} - \ln \text{initial weight}}{\text{Number of experimental days}} \times 100 \quad [4]$$

$$\text{FCR} = \frac{\text{Feed fed (dry weight)}}{\text{Live weight gain}} \quad [9]$$

$$\text{Survival (\%)} = \text{No. of fish harvested/No. of fish stocked} \times 100$$

2.3 Statistical analysis

Data were analyzed by one-way analysis of variance (ANOVA) using the statistical software SPSS. Duncan Multiple Range Test (DMRT) was conducted to determine specific differences in treatment means. Differences were considered statistically significant at $P<0.01$.

3. Results

3.1 Composition analysis of diet

Proximate composition analysis of the test diet was made to verify the accuracy of the formulation. The protein content of the fry diet was 27.94 % and the overall results are shown in Table 1.

Table 1: Proximate composition of feed used in experiment.

Name of the major composition	Amount of composition (%)
Moisture	12.14
Protein	27.94
Crude fiber	5.23
Lipid	7.95
Ash	15.38
*NFE (Nitrogen free extract)	31.36

*NFE= 100% - (moisture + protein + lipid + Crude fiber +ash)

3.2 Effects of feeding frequency on growth and survival of *O. niloticus* fry

At the expiration of 28 days feeding trial, the mean final weight gain of the fry was recorded as 0.21±0.03 g, 0.26±0.07 g, and 0.36±0.12 g for T_1, T_2 and T_3 respectively. The growth indices of fry were varied significantly ($P<0.01$) among the different treated groups and the values for percent weight gain, SGR, FCR and survival during the study period are shown in Table 2. The uppermost performances were observed among all the parameters studied when fry received 5 meals per day (T_3) and was significantly different ($P<0.01$) from all other treatments (T_1 and T_2). In the current study, we found the values of FCR were decreasing in accordance with the increasing feeding frequencies and the best (lowest) FCR was recorded in T_3 (1.21 ±0.04).

Table 2: Growth performance (weight gain, percent weight gain, survival and specific growth rate) of *O. niloticus* fry during 28 days.

Treatment	Replication	Weight gain (g)	Weight gain (%)	SGR (% day^{-1})	FCR	Survival (%)
T_1 (3 times per day)	R1	0.23	1288.88	9.39	1.67	81
	R2	0.19	1066.66	8.77	1.64	79
	R3	0.21	1177.77	9.09	1.64	81
	Mean	0.21±0.03^c	1177.77±34.28^c	9.08±0.13^c	1.65±0.09^c	80.33±2.49^c
T_2 (4 times per day)	R1	0.24	1344.44	9.54	1.48	85
	R2	0.26	1455.55	9.80	1.51	87
	R3	0.28	1566.66	10.05	1.54	89
	Mean	0.26±0.07^b	1455.55±39.67^b	9.79±0.17^b	1.51±0.08^b	89±2.68^b
T_3 (5 times per day)	R1	0.32	1788.88	10.49	1.22	93
	R2	0. 37	2066.66	10.98	1.19	93
	R3	0.39	2177.77	11.16	1.22	95
	Mean	0.36±0.12^a	2011.10±78.56^a	10.88±0.31^a	1.21 ±0.04^a	93.66±2.89^a
Mean values in the column with different superscripts are significantly different						

4. Discussion

Feeding frequency is one of the most important considerations in aquaculture practice that can affect overall growth, survival as well as habitat of fish. Again, the optimization of feeding frequency is considered as a significant factor as profit is the main motivating reason in fish culture. Proximate composition of the formulated diet was analyzed to verify the accuracy of the formulation. The protein content of the supplied diet was 27.94% that consistent with the findings of [20] who recommended that, the optimum protein requirement for growth of Nile tilapia is 25-35%.

Although, the amount of feed application was differ according to treatments, but same formulated diet was provided throughout the experimental period because the main purpose of this experiment was to evaluate the effectiveness of feeding frequency on growth performance of *O. niloticus* fry.

In our study, we found feeding frequency not only improved the growth indices, but also had a great impact on survival of *O. niloticus* fry. Fry that were fed at higher feeding frequencies (T_3) showed maximum performances in terms of weight gain, SGR and FCR. Our results are clearly supported by the findings of [16] who stated that, increasing the frequency of feeding in tilapia fry positively correlated with better fish growth performance. Again, [14] reported that weight gain, SGR and FCR of *O. mossambicus* fry are significantly affected by feeding frequency. High weight gain and specific growth rate at higher feeding frequencies have also been reported for red tilapia hybrid fry [22] and juvenile *O. nilo*ticus [18]. [21] suggested that the manual feeding frequency several times per day is the most appropriate for intensive grown tilapia. [24] also confirmed that weight gain of *O. niloticus* increased with increasing feeding frequency. Similar trends have also been observed for other fish species such as the red spotted grouper [11], hybrid sunfish [26], *Clarias gariepinus x Heterobranchus longifilis* hybrids [15], common carps [12] and in rainbow trout [25].

With regards to FCR, the lowest values (1.21) were recorded in *O. niloticus* fry fed with five times (T_3) per day followed by four (T_2) and thrice per (T_1) day respectively. This might indicate that *O. niloticus* fry fed more frequently and utilize the formulated diet efficiently than fish fed less frequently. According to [16], reducing feeding frequency to twice or thrice per day, considerably decrease growth and increase food conversion in Nile tilapia fry reared in earthen pond. Our data also concurrent with the results of [1] they recorded lowest FCR value (1.65) for monosex tilapia fry at higher feeding frequencies. Better FCR value at higher feeding frequencies were also reported for red hybrid tilapia fry [22]. The FCR values of the present study are lower than the FCR values reported by several biologists in case of different fishes. The causes might be due to the feed type, smaller ration size and proper utilization of diet. Therefore, daily feeding frequency is a useful tool particularly when the balance between maximum growth and optimal food conversion is aimed.

As we know, food availability and size variation are considered the primary causes of fish mortality. In our present work, poor survival of *O. niloticus* fry was observed in T_1 and the highest was found in T_3. [14, 23] reported a lower survival rate of *O. niloticus* fry for the lowest feeding frequency. Additionally [1] in an 40 days rearing period, obtained decidedly higher survival rates with monosex tilapia fry that were fed twice daily than with those that were fed once daily. The water quality parameters determined during the study period was within the acceptable range for tilapia culture [3, 17].

In fine, increased the no. of feeding frequency resulted in a better food accessibility, reduced feed competition to avoid stress of fry (that is the main factor for growth stunted) and leading to a better growth performance. A feeding frequency of 5 times a day compared to other treatments in this study is suggested to be optimum for achieving utmost growth, feed conversion efficiency and higher survival rates among *O. niloticus* fry.

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