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Effect of different feeding rates on growth and survival of Indian major carp seed

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Abstract
Optimum feeding rate of Indian major carp, *Catla catla, Labeo rohita and Cirrhinus mrigala* fry was determined by feeding rice bran and mustard oil cake diet (RB+MOC) in 1:1 ratio at three feeding rates (T1-4%, T2-8% and T3-12% of body weight per day) for 60 days. Feeding trial was conducted in triplicate. Indian Major Carp fry (3.52-3.58cm, 0.52-0.57g) were randomly stocked at the rate of 20 fish per 500 litre capacity FRP tank. Total body length and body weight gain of fishes increased as feeding rates increased upto 12% body weight, but there is no significance difference ($P > 0.05$) has been observed between the total body length and body weight gain of fish fed on 8% of body weight (T2) and 12% of body weight (T3). The best specific growth rate (8.07±0.33 % per day) and survival (70±2.89 %) were evident at the ration size of 12% body weight, but there is no significant difference ($P > 0.05$) between 8% and 12 % ration size. Food conversion ratio (FCR) of 2.22 was significantly higher ($p<0.05$) in fish fed on ration size 12% of body weight whereas, the least value of 1.32 was obtained in fish fed on 8% of body weight daily. Water quality parameters such as water temperature, pH and dissolved oxygen recorded fortnightly and were found within the ranges for fish culture. Based on the above results, it is recommended that feeding rate 8% body weight per day would be optimal for the best growth performance of Indian Major Carp fry.

Keywords: Feeding rate, growth performance**,** indian major carp fry

Introduction
In India, culture of the Indian Major Carp; *Catla catla, Labeo rohita and Cirrhinus mrigala* has been directed toward intensification of production because they are the most important commercial fishes in India with maximum market demand and acceptability as food by the consumers due to their taste and flesh. They contribute over 90% of the total Indian aquaculture production [11].

Indian major carp fingerlings are in great demand all over the Indian sub-continent to serve as the stocking material for culturing table sized fish. Hence, fry rearing is one of the important phases and aims at obtaining high survival and growth for the production of fingerlings required for stocking. The success of any culture trial with fry depends largely on the presence of sufficient, preferred small food organisms the zooplankton [20]. Pond fertilization with organic and inorganic fertilizers is a very cheap and effective method of increasing primary productivity, but their excessive use deteriorates the water quality [13] and depletes the dissolved oxygen to a detrimental level. Pond farming at high intensity levels frequently limits the effects of fertilization [28]. Further, high stocking rates also lead to the reduction of standing crop of natural fish food organisms so; there is need of artificial feed to increase the aquaculture production.

During culture, supplementary feeding has become an integral means of achieving greater productivity. Supplementary feeding is the single most critical and expensive variable cost in intensive culture [10]. The economic success of production control in aquaculture depends to a large extent on reasonable feeding costs. One way of reducing feeding costs is to estimate the daily ration and formulate a feeding chart that will best suit local farming conditions.

A variety of ingredients of plants and animal origin has been screened for incorporation in supplementary feed for carps and used either singly or in combination [8]. For supplementary diet, the continued dependence on traditional feed ingredients such as rice bran, oil cakes and fish meal has led to increase in the prices of these components, which in turn determine the profitability of aquaculture enterprises [19]. Hence there is a need to find good quality, cheaper, and readily available alternative resources so as to substitute the costly ingredients in the

traditional supplementary diets [17]. Rice bran and mustard oil cake (MOC) is the cheapest and most commonly available feed ingredients [15]. For this reason, they are widely used as supplemental feed in extensive and semi-intensive aquaculture practices [5]. However, there is limited information on optimal feeding rate whether the rice bran and MOC used as feed for growing carps fry to fingerling.

Determining the optimum pattern of feed added to fish ponds is one of the most important tasks in pond management. Therefore, some concern should be paid to reduce this expense by feeding the correct amount at the right time to ensure maximum efficiency [21]. Meanwhile, realization of the optimum feeding regime for cultured fish would help to reduce feed wastes, costs and maximizing feed conversion efficiency [1, 6].

Determination of appropriate rations for cultured fish is important to achieving maximum productivity. Because feeding rate affects nutrient requirements in fish, such knowledge is regarded as a prerequisite for estimation of the amounts of nutrients they should receive [30]. The quantity and quality of feed consumed have a pronounced effect on growth rate, efficiency of feed utilization, and chemical composition [22]. When food intake levels are higher than the optimum, growth increase is negligible [31] whereas sub-optimum rations may result in reduced growth and increased size variation [16].

The feed to the target species should be nutritionally balanced, easily utilizable and also digestible [29]. Earlier studies show the rate of feeding alters nutrient intake and digestibility, as excess feeding may lead to leaching of nutrients and limited feeding may suppress growth due to starvation [14]. The present study will be carried out to determine the optimum feeding rate for Indian Major Carp seeds fed with mustard oil cake (MOC) and rice bran (RB) based feed, to optimize growth and their survival.

Material and Methods

General Description of Experiment

The present experiment was carried out for a period of 60 days starting from 15th September to 15th November, 2018 in the outdoor of the College of Fisheries, Kawardha, Chhattisgarh, India. There were three treatment groups, each with three replicates by using three sets of outdoor circular Fibre glass reinforced plastics (FRP) tanks (500 litre capacity). Three different feeding rates were used in this experiment to observe their effects on growth, and survival of Indian Major Carps; *Catla catla, Labeo rohita and cirrhinus mrigala* (fry to fingerling) using tradition feed (Mustard oil cake and Rice bran).

Experimental fish source

Approximately 320 of live fish fry of Indian Major Carps (IMC) weighed 0.5 gram (approximately) in weight and length of 3.5cm (approx.) were collected from the pond of Govt. Fish Farm Kostha bandha, Bodla, Kawardha (C.G), India. Fish seed were collected and acclimatized in three fresh water FRP tanks with water holding capacity 500 litres and maintained for 2 days till their use in the study.

Preparation of experimental tanks and stocking fry

The experiments were conducted in FRP tanks having an average depth of about 0.51 m. All the FRP tanks were thoroughly cleaned, disinfected using potassium permanganate ($KMnO_4$) solution at 0.5 ppm level and provide a 10 cm layer of soil into the bottom of the tank and filled with clear water and kept for maturation for 2 days before the stocking of fry. To begin the experiment, Known sizes of healthy induced bred fry of IMC were stocked at the rates of 20 numbers in per tank [4] in different species combinations and ratios.

Experimental design

The FRP tanks were divided into three treatments namely T1, T2 and T3, each having three replications. The stocking density of fry could be maintained at @ 20 numbers in each 500 litres capacity FRP tank and they will be fed with Farm made feed (Mustard oil cake + Rice bran) mixed in 1:1 ratio, twice a day. The experiment would consist of feeding of *C. catla, L. rohita and C. mrigala* fry with different feeding rates (T1:4%, T2:8%, T3:12% of body weight) in completely randomized design (CRD) for a period of 60 days. The 50% water exchange was done every 15 days to remove the excess feed remained at bottom.

Table 1: Experimental design

Treatments	Feeding rates (% per body weight)	Replication		
T1	4	T1R1	T1R2	T1R3
T2	8	T2R1	T2R2	T2R3
T3	12	T3R1	T3R2	T3R3

Growth performance

Sampling was done every fifteen days interval. Stocked fishes were sampled from each of the pond in the morning (from 08h to 09h) by using hand net. The length of the body of each fish sample were measured in centimetres (cm) while weight of the fish were measured in nearest gram (g) by using measuring scale and analytical balance (Contech CA-234) respectively. From each tank, fish was randomly collected and the following parameters were measured were analysed:

1. **Length gain (cm):** Length gain = Final total body length (cm) - Initial total body length (cm)
2. **Body weight gain (g):** Body weight gain = (Wt – W0) Where, W0 and Wt were live weight at the time of starting the experiment and at the end of the experiment for the duration of days for the size used.
3. **Specific growth rate:** SGR (% day-1) = [(In BW_f – In BW_i) /day on trial] ×100, Where, BW_i and BW_f were initial and final body weights of the fish, respectively.
4. **Survival (%)** = [Total number of fish harvested / Total number of fish stock]×100

Feed utilization performance

Feed conversion ratio (FCR) =Amount of dry feed intake (g)/fresh weight gain in fish (g).

Water quality parameters

The water quality parameters such as temperature, dissolved oxygen (DO) and pH were monitored fortnightly throughout the experimental period. Water temperature of the tanks was measured with the help of Celsius thermometer. Dissolved oxygen of the tank water was measured by using titrimetric method (Winkler's method) [3]. Electronic pH meter (Micro controller based pH meter, model CL-180) was used to measure the pH of water. All analysis was done in the Water Quality Laboratory of the College of Fisheries, Kawardha, Chhattisgarh, India.

Statistical analysis

The data was analyzed statistically and interpreted by using Statistical Package for Social Sciences (SPSS, version 16.0) and Analysis of variance (one way - ANOVA) was performed to determine the differences between the mean values of different treatment. Differences in means were compared by Duncan's New Multiple Range test [12] at $P< 0.05$ level.

Results

Growth and survival

During the culture period, fishes exhibited consistent increase in mean length and weights during 60 days of experiment. The mean length of IMC fry were increased from 3.52 cm to 5.45 cm (T1), 3.57 cm to 6.33 cm (T2) and 3.58 cm to 7.01 cm (T3), whereas mean weight increased from 0.52 g to 2.75 g (T1), 0.55 g to 4.88 g (T2) and 0.57 g to 5.41 g (T3).

The growth performance of IMC during the experimental period is shown in Table 2. The mean length gain and weight gain was found to be increased significantly ($p<0.05$) with the increasing feeding rate up to 12% of body weight. The Initial mean length of carp seed for different treatment ranged between 3.52 cm to 3.58 cm whereas variations from 5.45 cm to 7.01 cm in the final mean length were observed. The highest mean length gain (3.42±0.25 cm) was observed in fish fed on diet 12% of body weight (T3) but there is no significance difference ($p>0.05$) has been observed in the length of fish fed on 8% body weight (T2) and 12% body weight (T3). The initial mean weight of carp seeds for different treatments ranged between 0.52g to 0.57g whereas variation from 2.75g to 5.41g in the final mean weight was observed. The highest mean weight gain (4.84±0.20 g) was observed in fish fed on diet 12% of body weight (T3), but no significant difference ($p>0.05$) were observed on 8% and 12% ration size.

Table 2: Growth performances of IMC fry fed with three different treatments

Parameters	Treatments		
	T1	T2	T3
Initial mean length (cm	3.52±0.06[a]	3.57±0.03[a]	3.58±0.03[a]
Mean Final length (cm)	5.45±0.18[a]	6.33±0.14[b]	7.01±0.28[b]
Mean Length gain (cm)	1.94±0.22[a]	2.76±0.16[b]	3.42±0.25[b]
Initial mean weight (g)	0.52±0.02[a]	0.55±0.04[a]	0.57±0.03[a]
Mean Final weight (g)	2.75±0.33[a]	4.88±0.13[b]	5.41±0.22[b]
Mean Weight gain (g)	2.23±0.34[a]	4.32±0.16[b]	4.84±0.20[b]
Specific growth rate (SGR) (% d^{-1})	3.72±0.57[a]	7.21±0.26[b]	8.07±0.33[b]
Survival (%)	50±2.89[a]	65±2.89[b]	70±2.89[b]
Feed conversion ratio (FCR)	1.42±0.01[b]	1.32±0.01[a]	2.22±0.01[c]

***Different upper-case letters in the same column denote significant differences according to *Duncan test ($p<0.05$).*

Overall survival (%) of the fish varied from about 50% to 70% in different treatment. There was significant difference ($p<0.05$) in overall survival (%) among the treatment (Table 2), 70% survival was found in T3 and the lowest was found in T1 (50±2.89%).

The specific growth rate (%/day) of the fish were recorded in ascending order from T1 (4%), T2 (8%) and T3 (12%), with their values 3.72±0.57, 7.21±0.26 and 8.07±0.33, respectively (Table 2). There is significant ($P>0.05$) difference among the treatment, the highest specific growth rate was (8.07±0.33) recorded in fish fed on diet 12% of body weight (T3) and the least (3.54±0.66) fed on diet 4% of body weight (T1), but SGR was not significant on 8% and 12% ration size.

Feed utilization

The feed utilization parameter such as apparent feed utilization parameters namely apparent feed conversion ratio (FCR) was evaluated for different treatment and is presented in Table 2. The apparent feed conversion ratio (FCR) showed significant variation ($P<0.05$) between different treatment. Good FCR value (1.32±0.01) was observed in T2.

Water quality parameter

The water quality parameters were recorded fortnightly. In general, the water quality parameters was within normal range and varied randomly without indicating any remarkable pattern during the whole duration of the experiment. The range values of different parameters of the water including water temperature (ºC), pH and dissolved oxygen (mg l^{-1}) are presented in the Table 1. The temperature during the whole experiment was in range of 28.2 ºC to 29.2 ºC. The pH during the experiment was ranged from 7.2 to 7.8. Dissolved oxygen was in the range of 4.06 - 6.6 mgL^{-1}.

Table 3: Ranges of different physical and chemical parameters of water for the different treatment during the culture period

Treatments	Parameters		
	T1	T2	T3
Temperature (ºC)	28.2-29.2	28.2-28.9	28.3-29.0
Water pH	7.3-7.8	7.4-7.7	7.2-7.8
DO (mg l^{-1})	4.6-6.6	4.06-6.2	4.8-6.3

Discussion

Growth and survival

Information on optimum feeding rate is a prerequisite to determining the nutrient requirement and production. Growth rate and feeding rate interact to determine FCR and are used to estimate the daily ration for a particular fish stock [18]. Fish loses their weight when their nutrient intake rate falls below that required for daily maintenance [18]. As food availability increases, the quantity consumed by the fish will also increase, giving a linear increase in specific growth rate (SGR %) up to the point of maximum voluntary food intake. If fish are fed above their appetite, then the extra food will be wasted and an artificially high FCR will result. So, high FCR can result from both over- and under-feeding. Excessive feeding does not necessarily result in higher growth. Beyond a certain level, excessive feeding has no influence on the growth and result in poor growth [9].

Significant variation ($p<0.05$) in growth was observed between the treatments (Table 2). Our results indicated that total body length and body weight gain of fishes significantly increased as increasing the feeding rate of fish up to 12% body weight. But there is no significant difference ($p>0.05$)

has been observed between total body length and body weight gain of fish fed on 8% body weight (T2) and 12% body weight (T3). This indicates that feeding of fishes with 8% body weight per day results in maximum utilization of food for growth. The best specific growth rate (8.07±0.33 % per day) and survival (70±2.89 %) were evident at the ration size of 12% body weight, but there is no significance difference (P > 0.05) between 8% and 12 % ration size. These results are in accordance with the work of Seenappa and Devaraj (1991) [26] who concluded that the total weight gain (%), daily rate of growth mg/g live fish/day, specific growth rates (%/day) were least in Catla fry fed at 4% body weight and were maximum in fry fed at 14% body weight, but 10, 12 and 14% was statistically similar (p>0.05), indicating that 10% ration would be optimal for Catla fry. In the result of Ahmed (2007) [2], it was found that the highest weight gain, best feed conversion ratio (FCR), best specific growth rate (SGR %), and highest protein efficiency ratio (PER) in *Labeo rohita* were evident for rations of 6–8% body weight. In the work of Khan (2004) [18] it was concluded that feeding of *C. mrigala* in the range of 4–6% body weight per day results in maximum utilization of food for growth. Our results were matches with these findings.

Food conversion ratio (FCR) of 2.22 was significantly higher (p<0.05) in fish fed on ration size 12% of body weight whereas, the least value of 1.30 was obtained in fish fed on 8% of body weight daily. Poor FCR at higher ration levels can be the result of loss of nutrients and wastage of food, as fish took longer time to consume food and reach satiation [32]. Khan *et al*. (2004) [18] revealed that poor growth and FCR in *C. mrigala* fed at 2% body weight per day suggests that this ration size approximates only the maintenance requirement of nutrients, wherein the major portion of ingested nutrients is utilized to maintain life and a smaller portion available for growth. In the study of Seenappa and Devaraj (1991) [26] it was found that the FCR value was least in fish fed at lower level (4%). The value increased with increasing ration size except at 8% and was high (4.2) for fish fed at 14% body weight. FCR values did not differ significantly between fish fed for 6, 8, 10 and 12% rations. Our results were matches to these findings.

Water quality parameters

Fish production is dependent on the optimum physical, chemical and biological qualities of water to most the extent [7]. Water quality determines to a great extend the success or failure of a fish culture operation [23]. The water quality parameters in all the tanks during the experimental period of 60 days were within the acceptable ranges. The water quality parameters of the experimental tanks are showed in Table 3. The water parameters in experimental tanks during the culture period were recorded fortnightly. There were no drastic changes in temperature, pH and dissolved oxygen. The temperature was in the range 28.2-29.2 ^{0}C during the whole experimental period. The water temperature in fish tank has a great impact on growth rate, feed consumption and other metabolic functions [25]. For instance, pH ranges 7.2-7.8 (acceptable range: 6.5-8.5) as reported by Saha (2010) [24]. The dissolved oxygen concentration of tank water remained in a suitable range of 4.6-6.6 mgl^{-1} which is well within the optimum in all the treatment [27].

Conclusion

The present study suggests that a ration level of 8% body weight would be optimal for carp seed whether the mustard oil cake and Rice bran (1:1 ratio) used as feed for growing carps fry to fingerling. The results of the present study could help fish feed farmers to get maximum yield in a minimum period of time for the carps fed with cheap and proper feed.

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