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Growth Performance of Different Dietary Sources on Experimental Larval Rearing of Amur Carp (*Cyprinus carpio hematopterus* Temminck & Schlegel, 1846)

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

In aquaculture practices, the mortality of larval fishes can be reduced by providing them with nutrient rich feeds. Nutritionally balanced fish diet can enhance the growth performance and survival of the fishes (Tom and Van-Nostrand, 1989. In the present study, the experimental fish Amur carp fries (initial weight of 0.03gm) were provided with different artificial feed (corn bran,

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wheat bran) and natural feed (Daphnia, Earthworm, Spirulina) as dietary sources to investigate the changes in various biological and chemical parameters such as growth performance, feed utilization and survival rate, length-weight correlation, condition factor and protein percentage in muscle. The experiment of the present study was conducted in the laboratory of Fish Biology and Fishery Science, Department of Zoology, Bhattadev University, Bajali, Assam, India for a period of 3 months (April, May and June, 2023) on 16 fries of Amur carp. The fish with average initial weight about 0.033g were stocked in two different aquarium tanks (136 litre capacity each) each containing 8 fishes. Various water quality parameters like water temperature, pH, dissolved oxygen, total alkalinity, total hardness and free CO_2 were monitored during the experimental study The present experimental study revealed that incorporating a mixed diet completes the nutrient requirement for Cyprinus carpio hematopterus fry rearing. The present study will benefit the aquaculturists by reducing the risk of mortality of larval rearing of fishes and increasing the total fish production. The results were expressed as mean ± SD and the data were analyzed using One- way ANOVA calculator including Turkey HSD.

Keywords: Amur carp; artificial feed; daphnia; earthworm; natural feed; spirulina

1. INTRODUCTION

Fish is highly nutritive and rich source of animal protein. Aquaculture has been a growing activity for the last twenty years worldwide. It has become necessary to increase fish production by developing effective technologies to ensure maximum output from minimum input and obtain maximum profit. For obtaining healthy fish production it is essential to provide nutritious food at the larval stages. Bhosale *et al*., [1]. Among the natural food sources, phytoplankton and zooplankton are of fundamental importance in fisheries. The quality of the plankton is important for the fish's health and yield. Larval rearing is one of the toughest task due to the high mortality rates during this rearing stage of fish larvae. Fish fry need a small sized feed which is easily digestible and serve as a protein-rich diet. In aquaculture using of microalgae as feed provide various nutrients such as proteins, vitamins, essential Poly-unsaturated Fatty Acids (PUFA) etc.

In India, Common Carp is an important aquaculture species which significantly enhances inland fish production. The Amur wild carp is an ancient form that originated from the Asian Carp Centre (Amur-China type of wild carp, *Cyprinus carpio hematopterus*) and reach to the water bodies of Western Asia. Over a period of hundreds of years, this carp got adapted to the local environmental conditions in the river Amur and adapted the river habitat. The fish revealed a good food conversion ratio (FCR). It is cultured with various enriched sources of nutrition, i.e. protein, fat, vitamins, minerals to obtain a healthy and nutritious fish food. The study aimed to investigate the effect of different feed sources i.e., artificial and natural on fish larval growth and several other physico-chemical parameters were recorded during the rearing of Amur carp fry.

2. MATERIALS AND METHODS

2.1 Fish Samples and the Aquarium

The species selected for the present experiment was Amur carp (*Cyprinus carpio hematopterus* Temminck & Schlegel, 1846). The salient features of Amur carp are fast growing, late maturing and not susceptible for diseases. Its body is slender and belly is smaller than existing stock. Initially 16 fries of Amur carp were brought from a local fish farm located in Nalbari district, Assam, India. Two aquaria (136 litre capacity each) were used for the experiment. Each tank was provided with a proper continuous aeration and internal filters. The fishes were kept in artificial light for 24 hours per day [2]. The tanks were cleaned once in a week by changing the water and removing remained particles from the system. Each tank was stocked with 8 fish fries with an average initial weight of 0.033 g. They were pre-acclimatized to laboratory conditions before releasing into the aquarium. In Tank-1, the fish were fed with Artificial feed (corn bran, wheat bran) whereas in Tank-2, the fish were fed with Natural feed (*Daphnia*, *Spirulina,* and Earthworm).

2.2 Water Quality Parameters

Water analysis was carried out twice in every month and certain parameters were recorded i.e. water temperature, pH, dissolved oxygen, total

alkalinity, total hardness, and free CO_2. For the analysis of water quality, water samples were collected from each tank from a surface depth of 10 cm. Temperature and DO were recorded by using a Thermometer and Winkler's Method, respectively. pH was measured by using pH meter. Alkalinity and hardness were estimated by Titrimetric Method. Free CO_2 was analyzed using phenolphthalein indicator and titrating the sample against sodium hydroxide.

2.3 Growth Performance

The following parameters were assessed to evaluate the growth performance of the experimental fishes,

Weight gain (g/fish) = Mean of weight (g) at the end of the experimental period – weight (g) at the beginning of the experimental period (Schmalhusen, 1926).

Daily weight gain (DWG) (g/day) = Weight Gain / experimental period (Schmalhusen, 1926).

Relative growth rate (RGR) = Weight Gain / Initial weight x 100 (Brown, 1957).

Specific growth rate (SGR) = ([ln final body weight–ln initial body weight] /experimental period) X100 Lagler, [3].

2.4 Feed Utilization and Survival Rate

Feed conversion ratio (FCR) =Total feed fed (g) / total wet weight gain (g) (Uten, 1978).

Feed efficiency ratio (FER) = Total weight gain (g) / Total feed fed (g) (Uten, 1978).

Survival rate (%) =No. of fish at the end / No. of fish at the beginning x 100.

2.5 Biological Parameters

Length-weight correlation was determined by calculating the value of correlation coefficient (r).

The Fulton's Condition factor for each fish was calculated using the cube law.

Condition factor, K = Fish weight × 100/ total length^3 Lagler, [3].

2.6 Estimation of Muscle Protein

At the end of the experimental period, the percentage of protein in the fish muscle was calculated by using Lowry's method of protein estimation.

2.7 Statistical Analysis

The results were expressed as mean ± SD and the data were analyzed using One- way ANOVA calculator including Turkey HSD.

3. RESULTS

3.1 Water Quality Parameters

Results of water quality monitoring in both treatments showed that the water quality parameters important for Amur carp rearing (water temperature, pH, dissolved oxygen, total alkalinity, total hardness, and free CO_2) were within their recommended optimal ranges. Occasionally temperature, dissolved oxygen, pH, and transparency had undesirable values that affected the overall environmental conditions in treatment tanks. No major differences between treatments were found comparing average measured parameter values in dissolved oxygen, total hardness, and total alkalinity during the investigation period. The average water quality parameters monitored during April, May and June months of the experimental period are shown below.

3.2 Growth Performance

During the experimental study, the growth performance indicator of the fishes were examined in both the tanks i.e. Tank 1 and Tank 2 (Table 2). Significantly higher final weight gain, daily weight gain, relative growth rate and specific growth rate were found in the fishes of Tank 2 which were fed with natural feed.

3.3 Feed Utilization and Survival Rate

During the whole experiment, the fishes of each Tank were fed 150g of supplements for 3 months. The amount of feed given to experimental fish per week is given in Table 3. The FCR and FER on feed utilization by the experimental fishes was calculated (Table 4). Significantly higher FCR and FER values were obtained in the tank 2 containing natural feed.

3.4 Survival Rates

In the present study, the survival rates of rearing fish of both the tanks were 100%. Initially, 16

fries of Amur Carp (*Cyprinus carpio hematopterus*) were kept for the experiment dividing in two treatment groups each tank having 8 fries. At the end of the experimental period, all the fries were found survived.

3.5 Biological Parameters

3.5.1 Correlation studies

The correlation studies of experimental fish are discussed below.

During the experimental study, total body length and total body weight of the fishes from both the tanks (Tank 1 and Tank 2) were examined (Table 5 and Table 6). The results points to a significantly higher body lengths and weight in the fishes fed on natural feed of the Tank 1.

3.5.2 Condition factor

The relationship of length-weight estimates condition factor (K) of the fish species and fish biomass through the length frequency (Fishbase, 2013). The information on condition factor can be vital to culture system management because they provide the producer with information of the specific condition under which organisms are developing (Araneda *et al*. 2008). The condition factor (K) of all the individual fish species estimated are given below:

3.5.3 Muscle protein

In the present study, the fishes were fed with various natural and artificial feed supplements to examine the protein contents in the fish muscle. At the end of the experimental period, one fish was randomly selected from each treatment groups (Tank-1 and Tank-2) for muscle analysis. The head, viscera, bones, fins, scales, and tails of these fish were removed. Muscle tissue was examined for protein content using Lowry's method and the amount of protein estimated are presented below.

Table 1. Table shows the values of water quality parameters during the experimental period

Parameters	Tank 1				Tank 2			
	April	May	June	Mean±SD	April	May	June	Mean±SD
Water Temperature(^{o}c)	24.2	25.4	28.1	25.9±1.99[a]	24.8	26.6	28.5	26.63±1.85[a]
pH	7.8	7.7	7.6	7.7±0.1[b]	7.4	7.5	7.2	7.3±0.1[b]
Dissolved Oxygen(mg/ml)	3.6	3.8	4	3.8±0.2[b]	3.4	3.3	3.6	3.4±0.1[b]
Total Alkalinity(mg/ml)	151	152	154	152.3±1.52[b]	153	154	156	154.3±1.52[b]
Total Hardness(mg/ml)	159	158	157	158±1[b]	138	140	138	138±3.0[b]
Free CO_2(mg/ml)	Nil	Nil	Nil		Nil	Nil	Nil	

[a] Indicates that the result isnot significant at p<0.05, [b] Indicates that the result is significant at p<0.05

Table 2. Effect of different feed supplements on growth performance in amur carp (Cyprinus carpio hematopterus)

Treatment groups	Mean initial weight (g)	Mean final weight(g)	Weight gain (g)	Daily weight gain(g/day)	Relative growth rate	Specific growth rate
Tank 1 (Artificial feed)	0.033[a]	1.02[b]	0.987[b]	0.01[b]	0.299[b]	3.81[b]
Tank 2 (Natural feed)	0.033[a]	1.37[b]	1.33[b]	0.014[b]	0.4[b]	4.11[b]

[a] Indicates that the result isnot significant at p<0.05, [b] Indicates that the result is significant at p<0.05

Table 3. The amount of feed given to experimental fish

Month	April	May	June
Feed (g)	40	50	60

Total feed fed per tank = 150 g (in 90 days)
Total wet weight gain in, Tank 1= 8.19 g
Tank 2= 10.99 g

Table-4: Effect of different feed supplements on utilization of feed for amur carp *(Cyprinus carpio hematopterus)*

Treatments	Feed conversion ratio	Feed efficiency ratio
Tank 1	18.31[b]	0.054[b]
Tank 2	13.64[b]	0.073[b]

[b] *Indicates that the result is significant at p<0.05*

Table 5. Tank-1 (Fish on Artificial feed)

Body Weight (g)	1.87[b]	1.24[b]	1.25[b]	1.16[b]	0.58[b]	0.59[b]	0.63[b]	0.87[b]
Body Length (cm)	3.5[b]	3.4[b]	3.4[b]	3.2[b]	2.6[b]	2.7[b]	2.7[b]	2.8[b]

Correlation coefficient, r = 0.9
[b] *Indicates that the result is significant at p<0.05*

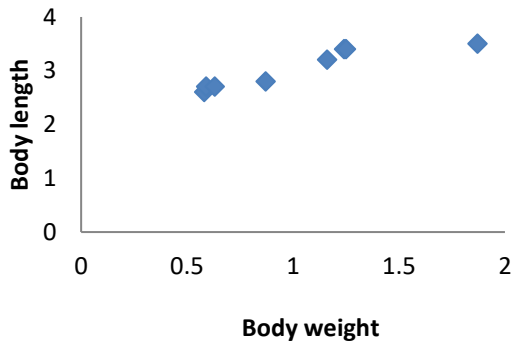

Fig. 1. Correlation between body length and body weight of experimental fish in Tank-1

Table 6. Tank-2 (Fish on Natural feed)

Body Weight (g)	1.89[b]	1.73[b]	1.53[b]	1.46[b]	0.93[b]	0.97[b]	1.12	1.36[b]
Body Length (cm)	3.6[b]	3.5[b]	3.4[b]	3.4[b]	3.2[b]	3.2[b]	3.2	3.3[b]

Correlation coefficient, r = 1
[b] *Indicates that the result is significant at p<0.05*

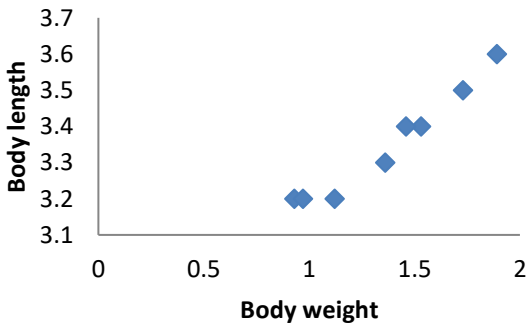

Fig. 2. Correlation between body length and body weight of experimental fish in Tank-2

Table 7. Condition factor for Tank-1

Sl No	Length (L) (cm)	Weight (g)	L^3	K
1	3.5	1.87	42.87	4.36
2	3.4	1.24	39.3	3.15
3	3.4	1.25	39.3	3.18
4	2.6	0.58	17.57	3.3
5	2.8	0.87	21.95	3.96
6	2.7	0.63	19.68	3.2
7	2.7	0.59	19.68	2.99
8	3.2	1.16	32.76	3.54

Table 8. Condition factor for Tank-2

Sl No	Length (L) (cm)	Weight (g)	L^3	K
1	3.5	1.73	42.87	4.03
2	3.4	1.53	39.3	3.89
3	3.2	1.12	32.76	3.41
4	3.6	1.89	46.65	4.05
5	3.2	0.97	32.76	2.96
6	3.3	1.36	35.93	3.78
7	3.2	0.93	32.76	2.83
8	3.4	1.46	39.3	3.71

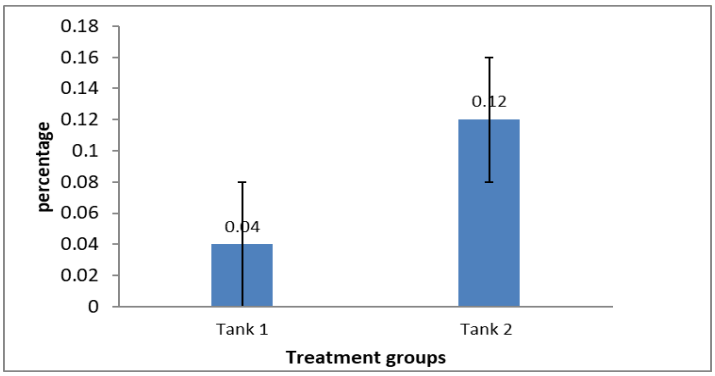

Fig. 3. The estimated percentage of protein from both the treatment groups

In Tank-1, the concentration of protein calculated from the fish muscle of Tank-1 which was kept in artificial diet is 0.45 mg/ml i.e. 0.04%. The estimated protein percentage is quite low as the experimental fish were very young. In Tank-2, the concentration of protein calculated from the fish muscle of Tank-2 which was provided with natural diet is 1.26 mg/ml i.e. 0.12%. The estimated protein percentage is slightly higher as compared to the protein content in Tank-1.

4. DISCUSSION AND CONCLUSION

The present experimental study showed that the diet containing both natural and artificial feed contains all essential nutrients which gave the best results throughout the experiment. The physico- chemical parameters of the water tank were investigated with a view to optimize the conditions for proper growth of the fishes. The results of the parameters of water were within their optimal recommended ranges suitable range for rearing of Amur Carp. Similar water quality results were also obtained by Shahi *et al.,* [4] on rearing of Amur carp. It has been revealed that good fish management relates to the proper understanding of the physical, chemical and biological characteristics of the aquatic habitat which determine the quality of fish and the problems to be encountered [5]. The results of the growth performance are shown in Table 3. Inclusion of Daphnia, Spirulina and earthworm in

the fish diet changed the growth performance and the daily and final weight gain, and specific and relative growth rate revealed an increase in their value in comparison to the artificial feed. Graaf *et al.,* [6] reported that the success of the culture methods applied depend on various factors under a certain condition such as feed quality, stocking density, genetic variation, environmental condition, feeding rate and feeding frequency. The increase in the protein percentage of fish muscle is in accordance with the report of Zhou *et al.,* [7] that nutrition is a very significant inward factor in fish, as the foremost determination of fish feeding is to satisfy the protein, energy requirements of the fish and reflecting its growth. The study of Length-Weight relationship are used for estimating the weight to corresponding to a given length (omiero and Braga, [8] Froese *et al*., [9] and give information on the condition and growth patterns of fishes Bagenal and Tesch, [10]. The condition factor 'K' is a useful index for monitoring the age and growth of the fishes Anene, [11]. In the present experimental study, higher condition factor 'K' values were recorded in both the tanks (Tank 1 and Tank 2) indicating that the fishes were sufficiently fed and had favourable conditions for the growth. Similar results were obtained on studies done by Nikos, [12] and Blackwell *et al*., [13]. Here, the individual fish species condition is determined based on the analysis of length weight data reflecting the overall growth of the fishes Bolger and Connolly, [14] therefore the results of the present study are in accordance with the previous findings.

Natural feed especially the planktonic feeds are the potential fish food that should be used in larval rearing. Planktonic feed incorporation in the initial life stages of fish enhanced the gut flora and digestibility also the FCR of fish fry. The earthworms contain almost similar nutritional values to that of the fish meal, and thus it would be a potential source of animal protein in supplementing fish meal Bhuvanwshwaran *et al.,* [15]. Due to higher risk of mortality in the larval stage, proper care, nutrition and maintenance protocols were followed throughout the culture period. Natural feed supplement utilization caused a reduction in costs of feed conversion ratio which has a substantial role in determining the costs of aquaculture; dietary natural feed escalates the feed efficiency ratio and declines the feed conversion ratio. In accordance with the findings of chemical composition, various statements were acquired wherein natural feed supplements significantly affect the protein ratio.

However, the present study will benefit the aquaculturists by reducing the risk of mortality at larval rearing stage and increasing the output of total fish production. From the findings of the present study, it can be concluded that if Amur carp is cultured on a large scale, a high profit will be obtained, significantly augmenting monospecies rearing and production. Equally important is that fish growth performance and growth patterns is significant after exposing to natural feed indicating an isometric growth.

Fig. 4. Tank-1 with artificial feed supplements

Fig. 5. Tank-2 with Natural feed supplements

Fig. 6. Fry of experimental fish (Amur carp)

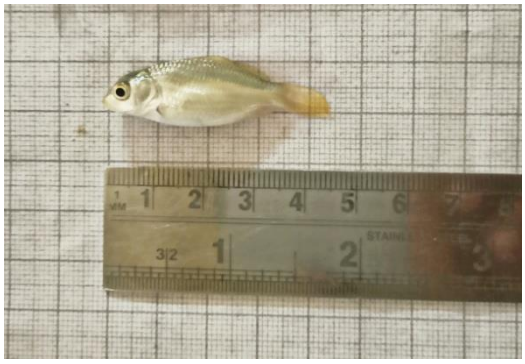

Fig. 7. Fingerling of experimental fish (Amur carp)

5. DISCLAIMER

This is a working paper and hence it represents research in progress. This paper represents the opinion of authors and is the product of professional research. Any errors are the fault of the authors. Also the research was not funded by the producing company rather it was funded by personal efforts of the authors.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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