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Effect of different Dietary Sources on the Rearing of Amur Carp (*Cyprinus carpio haematopterus*)

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ABSTRACT: Different feeds were incorporated into the diet on the rearing of *Cyprinus carpio haematopterus* fry for three months as a suitable alternative to reduce the heavy mortality and in acceptability of food. It included T1 (live feed), T2 (live + formulated feed), T3 (formulated feed) and T0 (commercial feed) as a control treatment. 180 fry with initial weight (0.25 gm) and length (2.08 cm) were recorded and divided into 12 groups with 15 fries in each treatment tank. The study showed that all the growth parameters were found significantly ($p<0.05$) increasing throughout the experiment period. The growth of fish was observed at maximum in T2 treatment and the minimum in control treatment T0. The maximum weight and length were observed in T2 treatment *i.e.* (5.31±0.01) gm and (5.25 ±0.02) cm, and minimum weight and length were observed in control treatment T0 *i.e.* (3.37±0.04) gm and (3.10± 0.10) cm. The FCR of (1.30±0.05) was found best in treatment T2. Physico-chemical parameters (DO, pH, electrical conductivity, total alkalinity, total hardness, calcium, magnesium, chloride, and ammonia concentration) were monitored fortnightly throughout the experiment. Maximum survivability was observed of (86.67±3.84) % in treatment T2 and minimum survivability of (77.78±2.20) % and the highest mortality were observed in treatment T3. The experiment's result depicted that incorporating a mixed diet of T2 completes the nutrient requirement for the *Cyprinus carpio haematopterus* fry rearing. It showed that the diet containing both enriched live feed and formulated feed contains all essential nutrients and most acceptable feed at fry stage of fish gave the best results throughout the experiment.

Keywords: Live feed, fry, water quality, growth, rearing, FCR.

INTRODUCTION

Demand for fish is exceeding production, and per capita consumption is steadily increasing, providing excellent scope for expanding the production of the aquaculture sector as capture fisheries have almost reached their plateau. To contribute appreciably to world fisheries production, it has become necessary to increase fish production by developing effective technologies to ensure maximum output from minimum input and obtain maximum profit. To obtained healthy fish production, it is essential to provide nutritious food at the larval stages of cultured fish species. The fish food organisms in the aquatic environment are planktons, nekton, and benthos which play a vital role in the larval rearing of fish, particularly for exogenous feeding. Among the live fish food organisms, phytoplanktons and zooplanktons are of fundamental importance in fisheries. The quality and quantity of the plankton community are of significant importance, as the fish's health and yield depend entirely on its food intake. The diversity of phytoplankton to physicochemical parameters for the water quality status of a water body also shows a significant correlation with specific abiotic parameters such as water, temperature, phosphates, carbonates, and chlorides (Devi and Antal 2013; Bhuyan *et al.*, 2020). Larval rearing is one of the riskiest phases due to the high mortality risks during this rearing phase of larvae. When the fish eggs hatch, the larvae initially depend on yolk sac absorption for their nutrition and then prey on zooplankton as food. Larvae of fish and shellfish cannot feed on an artificial supplemental diet. Hence they need a small-sized live feed for their nutrition which is easily digestible and serve as a protein-rich diet for fish fry (Das *et al.*, 2012). Advances in live food enrichment techniques have helped boost the importance and potential of live food organisms in the rearing of fry. The successful hatchery production of fish fingerlings for stocking in the grow-out production system largely depends on the availability and nutrient value of suitable live food for feeding fish larvae, fry and fingerlings (Lim *et al.*, 2003). In addition to providing protein (essential amino acids) and energy, microalgae also provide other vital nutrients such as vitamins, essential polyunsaturated fatty acids (PUFA), pigments and sterols, which are transferred through the food chain and considered primary foods of fish larvae (Das *et al.,* 2012). The microalgae used in aquaculture hatcheries vary in size, nutritional value and growth (Helm *et al.*, 2004). Due to rapid growth and expansion, the sector could face constraints like-insufficient availability of natural food, limitation on broodstock availability, quality seed production, loss due to deficiency and diseases, less growth, low fecundity, the effect of synthetic drugs and weed fishes in fish culture systems which result in a significant bottleneck to production from the aquaculture sector. Strategies for preventing these problems include quality stocking material, water quality management, an adequate balanced diet and various additives to make the food acceptable.

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 haematopterus*) and spread to the water bodies of Western Asia. Depending upon its habitat, the density of common carp is an essential factor that significantly affects the aquatic ecosystem (Rahman, 2015). It has a good food conversion ratio (FCR) and natural feed selection capacity. This stock is used because breeders need to follow proper genetic management protocols such as maintaining adequate population size, breeding practices (single pair mating) and brood stock replacement strategies. It is essential to minimize the inbreeding rate and maintain consistency in its performance (Basavaraju and Reddy 2013). The fish is cultured with various enriched sources of nutrition, *i.e.* vitamins, protein, fat, minerals, PUFA, HUFA to obtain healthy and nutritious food. In the present study, the effect of different dietary sources on the growth and survival of fish and several physico-chemical parameters were monitored and managed during the rearing of Amur Carp fry.

MATERIAL AND METHODS

Site of experiment and source of Fry. The experimental fry was obtained from the farmer of village Dabra (Hisar, Haryana) and kept for acclimation for seven days in freshwater culture in April month of 2021. After that, fry was divided into three groups with three replicates of each and fed on different diets. The 40% protein level commercial feed was taken as a control treatment (T0), and the first group was fed live feeds consisting of enriched zooplanktons (T1). The second experimental group was fed on both live feed + formulated feed (T2). The third group was fed on formulated feed (T3) prepared using locally available ingredients (De-oiled rice bran, Groundnut oil cake, Wheat flour, Soyabean meal, Vitamin and mineral mixture).

Study of Experiment. Several growth parameters were calculated, and sampling of length, weight, survivability, mortality and FCR was done fortnightly. During the experiment, all water quality parameters were calculated using the standard method of the American Public Health Association (APHA) (Rice *et al.,* 2012).

Preparation of diet

Methodology for feed formulation. The fish diet was formulated using the Pearson square method at 40% protein and was fed for the whole experimental period. The feeding frequency was three times per day @ 8-10% of biomass for the first month, followed by 6-8% and 4-6% biomass during the second and third months, respectively.

Methodology of plankton culture. Planktons were enriched water which contained all the essential nutrients that were prepared by fermentation method. The fermentation process was allowed to undergo anaerobically for other days. 42 hours after the setup, plankton was collected using plankton net from the earthen ponds of the organic farm, CCS HAU Hisar. The fermented water was inoculated with a wide variety of plankton. The planktons were harvested seven days after the density was higher than100 numbers/ml and repeated every 3-4 days. Harvesting was done through a filter cloth of 80µ mesh size. In this investigation, three replicates were maintained for each treatment. The quantitative analysis of plankton was done by the drop count method.

Experimental design. A complete randomized design (CRD) was followed for the experimental tanks. The experiment was designed with one control (triplicate) and three treatments with triplicate for each treatment. Before stocking, the tubs were dewatered, treated with salt water for disinfection, and dried. 180 fry seeds were transferred in 80 liter capacity of tubs 15 fish fry in each tub. Aeration for each tub was provided with the aerator connected to the common aerator pump.

Statistical Analysis. The different growth performance parameters, physico-chemical parameters and survivability were statistically analysed using ANOVA method. The results of statistics were interpreted as required.

RESULT AND DISCUSSION

Mass culture of live feed. For Seven days the culture of zooplanktons was conducted in the College of fisheries science. The zooplanktons were collected from the nearby productive fish pond and were enriched with fermented water for mass culture of live feed for the rearing of fish fries. During the mass culture of zooplanktons *Daphnia* followed by *Moina* and *Trinema* were found higher than other species (Table 1).

Growth Parameters. All growth parameters were measured fortnightly, maximum growth was observed in treatment T2, and a minimum increase was observed in the control treatment (T0). The common carp fry grows more in length and weight when fed on a live feed nutrition source than artificial feed (Elkic *et al*., 2014). The average body weight of Amur carp was found to be higher in the supplemented treatment group T2 (5.31±0.01) gm followed by T1 (4.25±0.03) gm and T3 (4.20±0.02) gm. The minimum average weight was observed in the control group. A similar trend was observed for average body length, *i.e.* T2 >T1>T3 and the minimum average length was observed in the control group T0. The total length gain at the end of the experiment was found to be highest (5.25 ±0.02) cm T2, followed by (4.20± 0.11) cm in T1, (4.10± 0.05) cm in T3 and least total length (3.10 ± 0.10) cm was observed in the control treatment T0.

Table 1: Mass culture of zooplanktons for feeding Amur carp in treatment 1.

Zooplanktons	Number of zooplanktons observed (per ml) in days						
	1	2	3	4	5	6	7
Protozoa							
Chlorogonium	5	7	8	8	10	11	11
Trinema	4	7	5	6	6	10	13
Rotifera							
Rotaria	9	9	10	10	11	11	12
Keratella	6	8	9	10	10	12	11
Brachionus	8	10	11	12	13	13	13
Cladocera							
Daphnia	10	11	12	14	15	13	17
Moina	7	10	11	12	10	12	13
Copepods							
Eucyclops	3	6	6	8	9	9	10
Cyclops	5	7	8	10	10	10	11
Total Zooplanktons	**52**	**68**	**72**	**82**	**84**	**91**	**100**

The lowest FCR (1.3±0.05) was observed in T2 and highest in control (1.7±0.05) at the termination of the experiment. Overall, maximum survivability of (86.67±3.84) % was observed in T2 and a minimum of (77±2.20) % in T3 treatment. Several factors, like nutrient content in enriched feed and food acceptability, are responsible for better FCR and feed utilization capacity of Amur carp (Rahman *et al.*, 2006). The result on growth performance and digestibility have shown the suitability of live feed with formulated feed as better feed compared to a single dietary source for rearing Amur Carp (*C. carpio haematopterus*) fry. Zakaria *et al*. (2007) shows zooplanktons are considered biological indicators of organic pollution as they live in an organically rich environment so it is essential to maintain the level of organic matter in the form of food wastes in the rearing tank. At larval stages, food values of zooplankton were found to be more acceptable, productive and economical than conventional and commercial pellet feed (Rajanna and Shivananda 2021). The phytoplankton-zooplankton interface is the crucial point where the animals at the trophic level create a food web and adapt to the changing environment that changes the property of ecosystems, such as primary productivity and nutrient recycling (Elser *et al*., 1990). Our results support the use of live food for the early life stages of Amur carp fry. The poor quality of supplementary feed was observed in the commercial feed due to less acceptability of feed at the early phases of its life cycle. The Amur carp has greater practical significance in low-input aquaculture systems due to better growth performance than the existing strain (Verma and Mandal 2018). The maximum growth was observed in treatment T2, where the fry was fed with both live and formulated feed. As the live feed is easily acceptable for the fry stage, its nutritional requirement of fish was compensated by formulated feed as it contains a good amount of dietary components. In the initial phase of the experiment, the growth was slower in the control treatment due to inaccessibility to the adaptation of feed type. Later on, the advanced fry stage showed acceptance of commercial feed.

Physicochemical parameters of water in different treatment. Results of water quality monitoring in different treatments showed that the water quality parameters important for Amur carp rearing (dissolved oxygen, pH, electrical conductivity, total hardness, calcium concentration, and total ammonia) 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 statistical differences between treatments were found comparing average measured parameter values in dissolved oxygen, total hardness, carbonate, chloride, magnesium and calcium during the investigation period. The average water quality parameters monitored during the experiment are shown (Table 2). The productivity of a water body depends upon the physico-chemical characteristics (Garg *et al*., 2002). The positive effect of fish growth on water quality is that they stabilize the food web and maintain steady production and at the same time negative effect is that when there is an increase in biomass then the net production factor decreases (Chand *et al*., 2006; Ombe *et al*., 2006). Excessive water exchange increases the production cost, and it itself may act as stressor as the fish has to repeatedly adjust its body physiology with the new environment (Das *et al*. 2021). In unmanaged ponds, fish growth/yield and dissolved oxygen were low and ammonia, chlorides, calcium, total hardness, magnesium, phosphates and biochemical oxygen demand were higher when compared against managed ponds (Singh *et al.*, 2016). So, the only way to minimise organic matters and ammonia that are primarily responsible for heavy fish mortality is to keep the rearing clean and use of siphoning pipe to remove food and excreatory wastes. When the carp larvae were fed exogenously with zooplankton, it supported higher production through the maintenance of better water quality, higher survival rates, and a greater abundance of zooplankton in the system (Jha *et al.*, 2008).

Table 2: Water quality parameters monitored during the experiment.

Parameter	Control (T0)	Live feed (T1)	Live + Formulated feed (T2)	Formulated feed (T3)
Water Temperature ºC	27.17±0.08	27.23±0.03	27.20±0.10	27.27±0.03
pH	7.23±0.08	7.70±0.26	7.43±0.24	7.93±0.08
Electrical Conductivity µS/cm	562.67±8.37	410.00±10.58	452.67±9.91	564.00±9.24
Dissolved oxygen mg/l	5.3±0.44	5.5±0.50	6.3±0.60	6.1±0.23
Total ammonia mg/l	0.20±0.05	0.18±0.12	0.30±0.08	0.45±0.05
Carbonate Alkalinity mg/l	11.7±1.66	8.3±4.41	8.3±4.41	11.7±1.66
Bicarbonate Alkalinity mg/l	138.33±7.27	166.67±6.67	171.67±9.28	188.33±7.27
Total alkalinity mg/l	150.00±5.77	175.00±2.89	180.00±5.77	200.00±5.77
Chloride mg/l	4.33±0.24	4.56±0.26	5.00±0.11	6.76±0.14
Total Hardness mg/l	166.67±6.66	216.67±8.81	203.33±8.81	160.00±5.77
Calcium mg/l	36.66±0.33	38.00±1.73	36.33±1.76	35.66±1.20
Magnesium mg/l	32.53±2.39	43.59±7.33	37.49±4.52	28.71±2.93

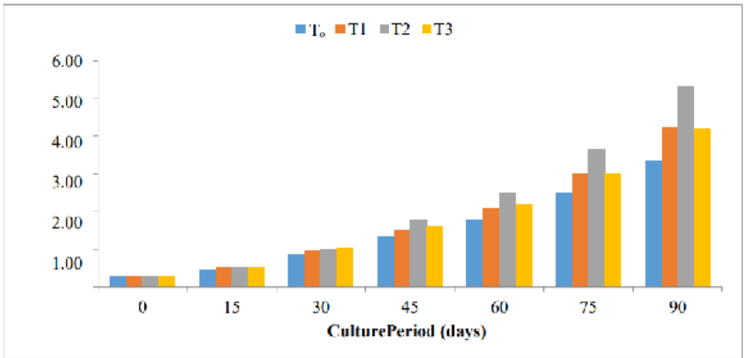

Fig. 1. Variation in weight gain (gm) of Amur carp in different treatments.

Fig. 2. Variation in FCR of Amur carp in different treatments.

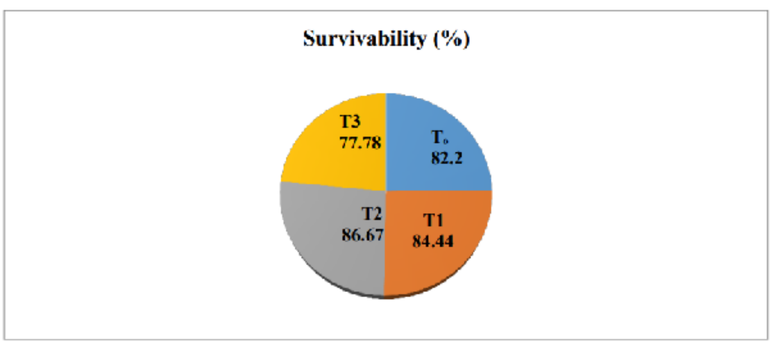

Fig. 3. Variation in Survivability (%) of Amur carp in different treatments.

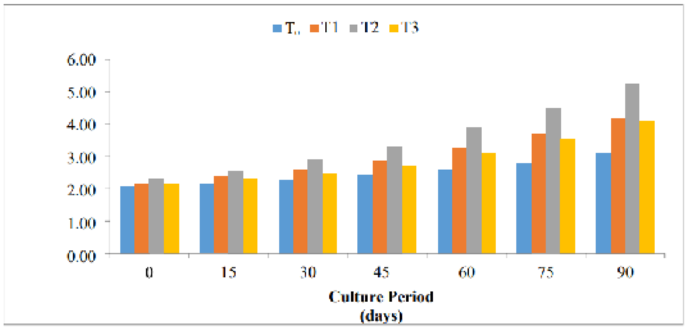

Fig. 4. Variation in length (cm) gain of Amur carp in different treatments.

CONCLUSION AND FUTURE SCOPE

The present study showed that the diet containing both enriched live feed and formulated feed contains all essential nutrients and most acceptable feed at fry stage of fish gave the best results throughout the experiment. Zooplanktons such as rotifers, cladocerans, and copepods are the potential fish food organisms that should be used in larval rearing. The live feed incorporation in the initial life stages of fish enhances gut flora and enhance digestibility and FCR of fish fry. Due to the higher risk of mortality in the larval stage, proper care, nutrition, and maintenance protocols should be followed throughout the culture period. Moreover, the water quality parameters should be maintained as the slight environmental stress may risk a large number of fry. Based on investigated findings of the present study, it concluded that if Amur carp is cultured on a large scale, a high profit will be obtained, significantly augmenting monospecies rearing and production. The present study will benefit aquaculturists by reducing the risk of mortality at larval rearing stage and increasing output of total fish production. In this way, food crisis can be combat and food security may be ensured through high-potential food sources across the globe.

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Conflict of Interest. None.

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