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**Manju Rani**
Department of Zoology and Aquaculture, CCS Haryana Agricultural University, Hisar, Haryana, India

**Surender Kumar**
Department of Zoology and Aquaculture, CCS Haryana Agricultural University, Hisar, Haryana, India

**RK Gupta**
Department of Zoology and Aquaculture, CCS Haryana Agricultural University, Hisar, Haryana, India

**NK Yadava**
Department of Zoology and Aquaculture, CCS Haryana Agricultural University, Hisar, Haryana, India

**Corresponding Author:**
**Manju Rani**
Department of Zoology and Aquaculture, CCS Haryana Agricultural University, Hisar, Haryana, India

# Effect of live and artificial feed on growth and survival of *Clarias batrachus* fry

**Manju Rani, Surender Kumar, RK Gupta and NK Yadava**

**Abstract**
The present study was designed to investigate the effect of live feed (plankton) and supplementary feed (soybean based) on the growth and survival of *Clarias batrachus* fry. A mass culture of planktons was maintained and used as live feed while the supplementary diet was fed at 5% body weight of fry. Results indicated significantly ($p< 0.05$) higher growth rate and gain in body weight in fry treated with plankton diet. The results are discussed in the light of available literature and it could be suggested that live feed can be effectively used for mass production of *Clarias* fry.

**Keywords:** Growth, aquaculture, plankton, artificial diet, *Clarias batrachus*

## 1. Introduction
Decline in capture fisheries has led to worldwide expansion of aquaculture to meet increasing human demand for fish. India is well known for carp aquaculture, related to an intensive research effort and then massive adoption by farmers. Carp culture remains a mainstay of Indian aquaculture followed by catfishes which are considered to be potential cultivable species. Among these, *Clarias batrachus* (Linnaeus, 1758) is a preferred medium-sized catfish for pond culture. *C. batrachus*, popularly called "magur" in India, is in high demand for its taste and therapeutic value. Magur fetch higher market price than carp and are sold fort US$ 4-8/kg in India. Being hardy, Magur is generally stocked 10 times higher density than carps. Their air-breathing nature makes them a good candidate for high-density culture (Sahoo *et al*., 2016) [1]. Quality culture of fish and fry largely depends on the type of feed being used. Of the feed ingredients, protein source is one of the expensive ingredients in the formulated feed. Fish meal is still an essential ingredient in the diets and it is also an expensive feed ingredient compared to other protein sources and thus represents a significant cost element in feed and production cost. This has necessitated the search of alternative sources available locally in the country. In this context, use of certain potential aquatic weeds offer excellent scope as the nutrient laden materials are naturally grown in the entire country without much agronomic care. Many plant proteins such as soybean, canola, guar, moong, sorghum etc. offer considerable promise in this regard owing to their low price and market availability. Their relative composition of protein, carbohydrate and oil are desirable as an alternative dietary protein and energy source for fish. However, most of them contain endogenous antinutrient factors (ANFs) which lead to digestive losses (Garg *et al*., 2002; Singh *et al*., 2004) [2, 3].
Many studies have focused on the fact that small live food such as planktonic Rotifera species are required for the development of fry production (Lim *et al*., 2003; Ogata and Kurokura, 2012) [4, 5]. However, several studies reported that fish fed solely on formulated diets, have poor percent survival and low growth rate (Finn and Kapoor, 2008) [6], whereas others researches insist that combination of live food and formulated diets in the early stage may provide higher growth rate and percent survival than live food (Puello-Cruz *et al*., 2010) [7]. In nature the early stages of fish and crustaceans feed on a broad spectrum of zoo and phytoplankton, providing a complete and balanced diet. The heterogenous size distribution of wild zooplankton makes it suitable for all target species. Zooplankton have been widely used for rearing fish larval stages, and most studies indicated that the fry performed better when fed live zooplankton than dry artificial diets (Dabrowski and Rusiecki, 1983; Sivakumar, 2005) [8, 9]. Availability of live food organisms in sufficient quantities is a major factor in the cultivation of early stages of shellfish and finfish. Only a few live feed organisms have been

used in hatcheries (Kahan, 1982) [10]. In aquaculture, an increasing demand exists for live zooplankton in spite of the availability of *Artemia* nauplii and rotifers (Pagano *et al*., 2000) [11]. The zooplankton forms ideal food usually in the larval stages of prawns and in early larval stages of fishes (Murugan and Moorthy, 1990) [12]. Being a natural food of fish and prawn larvae, zooplankton collected from natural resources are used as diet for the larvae of ornamental fish in many hatcheries (Altaff *et al*., 2002) [13]. Keeping this in view, the aim of the present study was to evaluate the effect of live and artificial feed on the growth and survival characteristics of fry of *C. batrachus.*

## 2. Material and methods

The present study was conducted in Fisheries laboratory and screen house belonging to the Department of Zoology and Aquaculture, CCS Haryana Agricultural University, Hisar.

### 2.1 Mass culture of zooplanktons

Zooplanktons were cultured in glass aquaria of 100L capacity, in replicates of three, in the screen house. The aquaria were filled with water and a mixture of manure (cattle manure: mustard oil cake: poultry cake in ratio 1:1:1) was added at 200g/ aquarium (Garg, 1999) [14] and allowed to grow. The plankton samples were collected after 10 days from nearby fish pond and inoculated in these aquaria to start the culture. The culture was maintained for a period of 20 days and was then studied to identify the plankton population. The population of zooplanktons and phytoplanktons was then subsequently tracked for a period of 30 days at a regular interval of 5 days. The planktons from these aquaria were used as live feed for the fry. To calculate plankton density, water samples were collected by filtering 10L of water through plankton net of 125µm mesh size and concentrated to 40 ml in plastic bottles. Plankton abundance was expressed as organisms per liter. The organisms were counted in Sedgwick rafter cell.

### 2.2 Collection of fish fry and experimental design

*C. batrachus* fry needed for the current experiment were procured from CIFE centre Lahli, Rohtak. Before commencing the experiment fry were acclimatized for a period of 10 days in glass aquaria (60×30×30 cm) under laboratory conditions where the temperature was maintained at 25±1°C lighting schedule of LD 12:12. The aquarium water was renewed daily with fresh water adjusted to 25°C. Fry with body weight ranging between 0.70g to 0.76g were randomly distributed as 20 fry per aquarium with three replicates of each dietary treatment (T1 as live feed and T2 as supplementary feed). The plankton culture was used as live feed while fish meal and processed soybean was used as supplementary feed. The experiment was carried out for a duration of 45 days and the fry were fed twice daily at 9 a.m. and 3 p.m., respectively @5% body weight. Their growth was monitored fortnightly (interval of 15 days) in terms of weight gain and length gain and feeding rate was also adjusted accordingly. Fish fry were exposed to their respective diet for 4 hours during each feeding. The uneaten feed was siphoned out.

### 2.3 Estimation of growth parameters

At the beginning and end of the experiment, the length and weight of each fish were recorded and processed for subsequent analysis according to AOAC (1995) [15].

$$\text{Survival percentage} = \frac{(\text{Pre- treatment count} - \text{Average number of live fry after treatment})}{\text{Pre- treatment count}} \times 100$$

Live weight gain = Final weight – Initial weight ($W_2 - W_1$)

$$\text{SGR (\% body weight gain/day)} = \frac{\text{Log}_n \text{ Final fish weight} - \text{Log}_n \text{ Initial fish weight}}{\text{Time interval (t)}} \times 100$$

Live length gain = Final length ($L_2 - L_1$)

$$\text{SGR* (\% body length gain/day)} = \frac{\text{Log}_n \text{ Final fish length} - \text{Log}_n \text{ Initial fish length}}{\text{Time interval (t)}} \times 100$$

The data obtained was statistically analyzed by ANOVA, following group means also compared by student 't' test.

### 2.4 Water quality analysis

During experimental period, water temperature and pH were recorded daily using respective digital meters and other physico-chemical parameters such as dissolved oxygen, alkalinity, total hardness, free $CO_2$, electrical conductivity, ammonia nitrogen and orthophosphate were analyzed following the procedures of APHA (1998) [16].

## 3. Results and Discussion

The results of the present study have been presented in Tables 1-4. The planktons in mass culture were identified (both zooplankton and phytoplankton) and their population count was performed as shown in Tables 1 and 2. Among zooplanktons we observed protozoans, rotifers, crustaceans, copepods and ostracods in the culture. However, crustaceans dominated the population with 28 percent, followed by protozoans (27%) and copepods (19%). Also, *Trinema sp.* was found to dominate the zooplankton population followed by *Daphnia sp.* The number of phytoplanktons was found to be higher than zooplanktons. Phytoplanktons belonging to Chlorophyceae dominated the culture with 68.36 percent population and *Microspora sp*. being abundant of all. The water quality analysis was also performed over the experimental period of 45 days and physico-chemical characteristics so recorded have been presented in Table 3. The parameters such as temperature, dissolved oxygen, pH, alkalinity, hardness, carbon dioxide, electrical conductivity, nitrate, phosphate etc. did not show wide variations in both the treatments. Water quality should be maintained at

optimum levels for the normal development of fish fry.

The growth response of experimental fry subjected to different dietary treatments (live feed and supplementary feed) has been shown in Table 4. Live feed proved to enhance the survival percentage of fry (95%) against artificial feed (91%). A significant increase in weight (2.24±0.3 g) and length (2.09±0.4 cm) and high SGR was recorded in fry fed on planktons in contrast to those fed on supplementary food. Feeding is responsible for providing nutrition to the fish and thus constitutes a major factor in intensive rearing of fish fry and fingerlings. Fish and prawn larvae have been reported to prefer live feed over formulated feed in various studies (Murugesan *et al.*, 2010; Bakhtiyar *et al.*, 2011) [17,18]. Kadhar *et al.* (2014) [19] studied the effect of live feed on survival and growth of fry of *Catla catla* and reported that fish fry fed with cyclopods showed significantly ($P< 0.001$) better growth (26.03 ± 1.88 mm, weight 61.07 ± 3.53mg) than those fed with artificial and mixed diets. Sivakumar (2005) [9] highlighted that zooplanktons have been widely used for rearing fish larval stages also indicating that the fry performed better when fed live zooplankton than dry artificial diets. Artificial diet has been stated to perform poorly in larviculture due to poor digestibility and deficiency of growth factors (Lauff and Hofer, 1984) [20]. It has been well established that one of the limiting factors in nutrition of early stages of fishes is the level of n-3 HUFA. Hence certain feeds containing HUFAs (especially DHA, 22:6 n-3 and EPA 20:5 n-3) can be valuable as food sources for enrichment (Singh *et al.*, 2012) [21]. Copepods and cladocerans among zooplanktons have been emphasized as live food by many authors (Sujatha, 2000; Safiullah, 2001) [22,23]. Nutritional quality of Copepods is reported to have high protein content and a good amino acid profile. Holm and Moller (1984) [24] observed faster growth rate in Common carp and Atlantic salmon when fed on zooplankton than those fed on formulated diets. The growth of zooplankton in nature may depend on the quality of the food available as the phytoplankton community keeps changing. According to Rutkowska and Pijnowska (1999) [25], phytoplanktons may stimulate zooplankton development by production of vitamin E ($\alpha$-tocopherol) and releasing odour into water. Some hatcheries that are located close to the sea, rivers or large water bodies can make use of this natural food source. The harvested wild zooplankton can be fed to the cultured species as a sole food source, or supplement. The poor survival and storage possibilities, however, considerably restrict their use as a fresh diet. A possible solution to this problem is deep freezing the food.

**Table 1:** Zooplankton species identified and their population in live feed treatment

| Zooplankton sp. | Number of Zooplanktons/ ml water sample | | | | | |
|---|---|---|---|---|---|---|
| | Day 5 | Day 10 | Day 15 | Day 20 | Day 25 | Day 30 |
| **Protozoa** | | | | | | |
| *Trinema* | 2 | 8 | 14 | 16 | 12 | 15 |
| *Paramoecium* | 2 | 6 | 8 | 9 | 11 | 12 |
| Total protozoans | 4 | 14 | 22 | 25 | 23 | 27 (27%) |
| **Rotifera** | | | | | | |
| *Branchinous sp.* | 1 | 3 | 4 | 5 | 6 | 7 |
| *Rotaria* | 1 | 4 | 2 | 4 | 7 | 9 |
| Total rotifers | 2 | 7 | 6 | 9 | 13 | 16 (16%) |
| **Crustacea** | | | | | | |
| *Daphnia sp.* | 3 | 6 | 8 | 9 | 11 | 12 |
| *Moina sp.* | 2 | 4 | 5 | 7 | 8 | 10 |
| *Ceriodaphnia* | 1 | 2 | 3 | 5 | 6 | 6 |
| Total crustaceans | 6 | 12 | 16 | 21 | 25 | 28 (28%) |
| **Copepoda** | | | | | | |
| *Cyclops sp.* | 1 | 3 | 4 | 6 | 7 | 9 |
| *Diaptomus sp.* | 0 | 2 | 3 | 5 | 7 | 10 |
| Total copepods | 1 | 5 | 7 | 11 | 14 | 19 (19%) |
| **Ostracoda** | | | | | | |
| *Cypris* | 0 | 1 | 2 | 7 | 10 | 10 |
| Total ostracods | 0 | 1 | 2 | 7 | 10 | 10 (10%) |
| Total zooplanktons | 13 | 39 | 53 | 73 | 85 | 100 |

**Table 2:** Phytoplankton species identified and their population in live feed treatment

| Phytoplankton sp. | Number of Phytoplanktons/ ml water sample | | | | | |
|---|---|---|---|---|---|---|
| | Day 5 | Day 10 | Day 15 | Day 20 | Day 25 | Day 30 |
| **Bacillariophyceae** | | | | | | |
| *Diatoma sp.* | 0 | 4 | 7 | 9 | 5 | 12 |
| *Navicula sp.* | 4 | 9 | 15 | 11 | 14 | 21 |
| Total | 4 | 13 | 22 | 20 | 19 | 33 (8.84%) |
| **Chlorophyceae** | | | | | | |
| *Chlorella sp.* | 10 | 18 | 15 | 21 | 25 | 34 |
| *Ankistrodesmus sp.* | 0 | 0 | 2 | 5 | 3 | 8 |
| *Chlorococcum sp.* | 12 | 29 | 43 | 50 | 46 | 49 |
| *Euastrum sp.* | 3 | 8 | 5 | 9 | 12 | 17 |
| *Tetrastrum sp.* | 0 | 0 | 0 | 1 | 4 | 7 |
| *Cosmarium sp.* | 2 | 4 | 7 | 12 | 16 | 20 |
| *Ulothrix sp.* | 9 | 15 | 12 | 1 | 20 | 18 |
| *Pediastrum sp.* | 15 | 20 | 36 | 48 | 65 | 39 |

| | | | | | | |
|---|---|---|---|---|---|---|
| *Microspora sp.* | 10 | 19 | 25 | 34 | 49 | 51 |
| Total | 61 | 113 | 145 | 197 | 240 | 255 (68.36%) |
| **Cyanophyceae** | | | | | | |
| *Anabaena sp.* | 8 | 12 | 20 | 36 | 39 | 45 |
| *Oscillatoria sp.* | 6 | 10 | 17 | 28 | 34 | 40 |
| Total | 14 | 22 | 37 | 64 | 73 | 85 (22.78%) |
| Total phytoplanktons | 79 | 148 | 204 | 281 | 332 | 373 |

**Table 3:** Physico-chemical characteristics of water recorded over the experimental period

| Water Parameters | T1 (Live feed) | T2 (Artificial feed) |
|---|---|---|
| Temperature ($^0$C) | 26.0-30.0 | 26.5-30.0 |
| Dissolved oxygen (mg/L) | 5.2-6.3 | 5.4-6.4 |
| pH | 7.6-7.9 | 7.8-8.0 |
| Alkalinity (mg/L) | 245-285 | 249-283 |
| Total hardness (mg/L) | 205-230 | 210-232 |
| Free $CO_2$ (mg/L) | 15.6-17.1 | 15.2-16.8 |
| Electrical conductivity (µ mhos/cm) | 0.49-0.52 | 0.50-0.51 |
| Ammonia Nitrogen (mg/L) | 0.172-0.250 | 0.170-0.244 |
| Orthophosphate (mg/L) | 0.215-0.276 | 0.211-0.268 |

**Table 4:** Survival percentage and growth performance of *C. batrachus* fry subjected to treatments

| Treatments | Stocking density | Survival % age | Initial weight (g) | Initial length (cm) | Final weight (g) | Final length (cm) | Weight gain (g) | Length gain (cm) | SGR * (g/ day) | SGR** (cm/day) |
|---|---|---|---|---|---|---|---|---|---|---|
| T1 (Live Feed) | 20 | 95% | 0.71±0.5 | 0.91±0.6 | 2.95±0.2 | 3.00±0.2 | 2.24±0.3 | 2.09±0.4 | 1.37±0.3 | 1.15±0.5 |
| T2(Supplementary Feed) | 20 | 91% | 0.75±0.7 | 0.94±0.4 | 2.75±0.5 | 2.79±0.6 | 2.00±0.5 | 1.65±0.5 | 1.25±0.5 | 1.04±0.3 |

* Specific growth ratio (by weight)
** Specific growth ratio (by length)

## 4. Conclusion

A major factor in the cultivation of early stages of fish is the availability of live food organisms in sufficient quantity. Artificial diet, also known as supplement feed, has been widely used in aquaculture because of ease in availability and low storage maintenance. The present experiment was thus designed to study whether live feed is better over artificial feed. The results indicated significant effect of live feed on the growth and survival of *C. batrachus* fry as compared to artificial feed. Thus, it can be concluded that live feed is better suited than artificial feed for sustainable and economically viable fish culture.

## 5. Conflict of interests

The authors declare that there is no conflict of interests regarding the publication of this paper.

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