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Optimizing Live feed and Weaning Strategies on Growth and Survival of *Mystus cavasius* Larvae in Captivity

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ABSTRACT

The study describes the performance of *Mystus cavasius* larvae by feeding live feeds and weaning time of larval feed during their rearing. The larvae of three days old were fed *Artemia nauplii*, tubifex worm and mixed plankton in triplicate tanks. Tubifex worms were identified as the most effective live feed among the three live feeds evaluated. It significantly ($P<0.05$) enhanced the larval growth (179 mg) and survival (97%) compared to *Artemia* nauplii and mixed plankton. The yolk sac absorbed larvae of 3 days old were also stocked in 12 tanks and were fed *Artemia naupli*. The live feed was withdrawn at the age of 10, 15 and 20 days and fed compound larval feed to know the best age for feeding the larvae with compound feed. A weaning age of 15 days post-hatching (dph) was optimal, facilitating the transition to formulated feed. It significantly enhanced the survival rate compared to the larvae fed with compound feed at the age of 10 dph. These findings may be a framework during large-scale seed production in hatchery. Hence the present study addresses the feeding management in larval rearing of this nutritionally significant species.

KEY WARDS: Catfish, Larval rearing, Live feed, *Mystus cavasius*

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INTRODUCTION

The drastic reduction of many fish species is encountered from the wild waters due to habitat loss, over fishing, pollution and other anthropogenic activities. The small indigenous fish (SIF) species are more affected (Lorenzen et al., 2016), which provides nutritional security to the rural population (Mohanty et al., 2013). *Mystus cavasius*, a near-threatened small indigenous catfish species is one among them (CAMP, 1998), which needs attention for aquaculture. This bagrid catfish is found in the water bodies of Indian sub-continent (Talwar and Jhingran, 1991; Roy and Hossain, 2006). It's delicious taste, fewer intramuscular bones and high nutritional content makes it popular among the consumers of the region (Mohanty et al., 2013; Banu et al., 2020). It is also valued in the ornamental fish trade due to its shiny coloration (Gupta and Banerjee, 2014).

Seed rearing of different stages is considered important in fish production system apart from captive breeding. Key considerations such as larval husbandry practices (Mollah, 1985; Sahoo et al., 2004; Pangni et al., 2008; Nwipie et al., 2015), larval feeding protocols (Verreth and Van Toneren, 1989; Hasim et al., 1992, Hung et al., 1999; Evangelista et al., 2005) and effective weaning strategies (Hung et al., 2002; Liu et al., 2012; Pradhan et al., 2014; Manya et al., 2018) have been identified as essential for the successful rearing of fish larvae. The initiation of larval rearing with live feed and weaning to compound feed thereafter, is a general protocol in larval rearing practice. The importance of live feed during initial feeding of larvae was also reported (Zheng et al., 2018; Radhakrishnan et al., 2020; Melaku et al., 2024). The successful larval rearing with live feed in many catfishes has been documented (Ronyai and Ruttkay, 1990; Hung et al., 1999; Sahoo et al., 2004; Sahoo et al., 2010), which provides energy for the growth and physiological function (Paliñska-¯arska et al., 2014; Radhakrishnan et al., 2020). Different live feeds are considered during larval rearing due to their nutrient profile, ability to remain alive in the rearing environment and, easy digestion and assimilation by the larvae (Damle and Chari, 2011). The use of live feed and weaning them to feed, play a significant role in determining growth and survival rates of larvae in a seed production system. Given these considerations, the present study evaluates the suitable live feed and weaning time during larval rearing of *M. cavasius* for the large-scale production of high-quality seeds.

MATERIALS AND METHODS

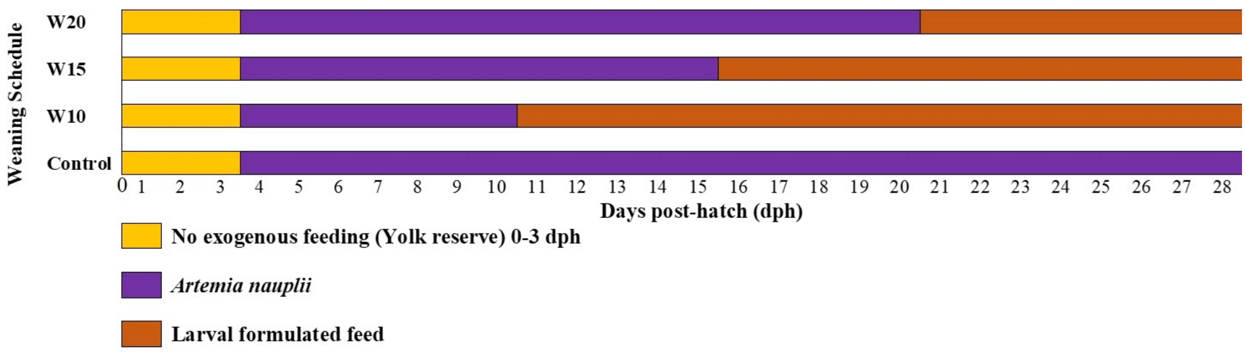
Experiment 1 – Effect of live feed type on growth and survival of *M. cavasius* larvae

The larvae of 3 dph (2.70 mg) were stocked at 5 larvae L^{-1} in triplicate FRP tanks (50 L) to evaluate the growth performance of *M. cavasius* larvae under different live feed based rearing conditions. The study was conducted for 21 days and the *Artemia* nauplii, tubifex and mixed plankton were fed to larvae as per the treatment condition for the entire study period. The sieved mixed zooplankton collected from the nursery pond was fed to larvae, which were dominated by copepods. *Artemia* cysts (OSI red ring, USA) were hatched in salt water (30 ppt). The live tubifex was collected from Ornamental fish unit of the Institute. The collected tubifex were chopped into smaller pieces with the help of scissors before feeding the larvae. All the live feeds were fed *ad libitum* level. The larval tanks were cleaned regularly and 30-40% water exchanged daily and continuous aeration was provided to maintain the water quality to an optimum condition. The larvae in each tank were counted at the end of the experimental period to know the survival rate. Twenty-five fish from each tank were sampled individually to measure the final length and weight through measuring board and electronic balance respectively.

Experiment 2 – Effect of weaning age on growth and survival of M. cavasius larvae

For the weaning experiment, hatchlings of 4 dph (2.85 mg) were used. Healthy larvae were stocked into 12 FRP tanks (50 L; 5 larvae L^{-1}) under a completely randomised design and maintained in four experimental treatment groups in triplicates for a period of four weeks. *M. cavasius* larvae were subjected to four feeding schedules and the weaning was studied at different days of post-hatch such as 0 (C), 10 (W10), 15 (W15) and 20 (W20) dph and feeding of *Artemia* nauplii alone was the control (C) treatment (Fig 1). The experimental tanks were cleaned daily and maintained as described in the previous experiments. After four weeks of experimental study, the larval growth performances and survival rate of different treatment groups were recorded as described in the earlier experiment.

Fig 1. Figure showing the feeding protocol of *M. cavasius* larvae during entire rearing period



Formulation and preparation of larval feed

The experimental feed for *M. cavasius* larvae was formulated (Table 1) and prepared for the weaning study. All the feed ingredients were purchased from the local market at Bhubaneswar, Odisha, India. The feed ingredients were weighed as per the formulation and mixed well with the required volume of water to prepare the feed dough. The dough without the addition of vitamin and mineral mix, fish oil, sunflower oil and carboxy methyl cellulose (CMC) was steam-cooked in a pressure cooker for 25 minutes and cooled at room temperature. The oils, vitamin mineral mixture, CMC were added and mixed uniformly. The feed dough was pelletised through hand pelletiser and the feed pellets were dried at 40 ºC, which were grounded and sieved to obtain particle size of less than 300 microns for feeding *M. cavasius* larvae. Weaning diet were prepared with 30 % inclusion of fish meal and 3% oil sources (fish oil and sunflower oil) and the diet had 37.20 % crude protein and 6.9 % crude lipid. The larvae were fed thrice daily to satiation level in all the experimental groups.

Table 1. Ingredient composition and proximate analyses of the *M. cavasius* larval weaning diet (% of dry matter basis)

Ingredients (%)	Weaning diet
Fish Meal	30.00
Soya flour	30.00
Groundnut oil cake	20.00
Maize	5.00
Wheat flour	6.00
De-oiled rice bran	3.00
Vitamin and Mineral mix	2.00
Fish oil	1.50
Sunflower oil	1.50
CMC binder	1.00
Proximate composition	
Crude protein (% dry matter, DM)	37.20
Crude lipid (% DM)	6.90
Ash (% DM)	5.80
Moisture (%)	8.85

Vitamin and Mineral mix: Each 1kg contains Vitamin A-5000 IU; Vitamin D3-1000 IU; Vitamin B1-10 mg; Vitamin B2-10 mg; Vitamin B6-5 mg; Vitamin B12-15 mcg; Vitamin B3-75 mcg; Vitamin B5-10 mcg; Vitamin C-150 mg; Vitamin E-25 mg; Vitamin H-5mg; Vitamin B9-5mg; Ca-225 mg; Co-20 mg; Mn-60 mg; Fe-30 mg; Cu-2 mg; Zn-2 mg; K-20 mg; Mg-2 mg; Choline Chloride-50 mg.

Analysis of feed proximate composition

The proximate composition of larval diet was analysed (Table 1) according to the standard procedures (AOAC, 1995). Moisture content (%) of the diet was determined by drying the feed in a hot air oven at 105º C overnight. The crude protein was determined by Kjeldahl method (nitrogen×6.25) using the Kjeldahl distillation systems (Vapodest; Gerhardt Analytical System, Germany). The crude lipid content of the diet was estimated by solvent extraction method (SOCS plus, SCS 08 AS, PELICAN Instruments, India). Total ash (TA) content of the diet was calculated by using muffle furnace at 550º C for a period of 6 h.

Statistical analysis

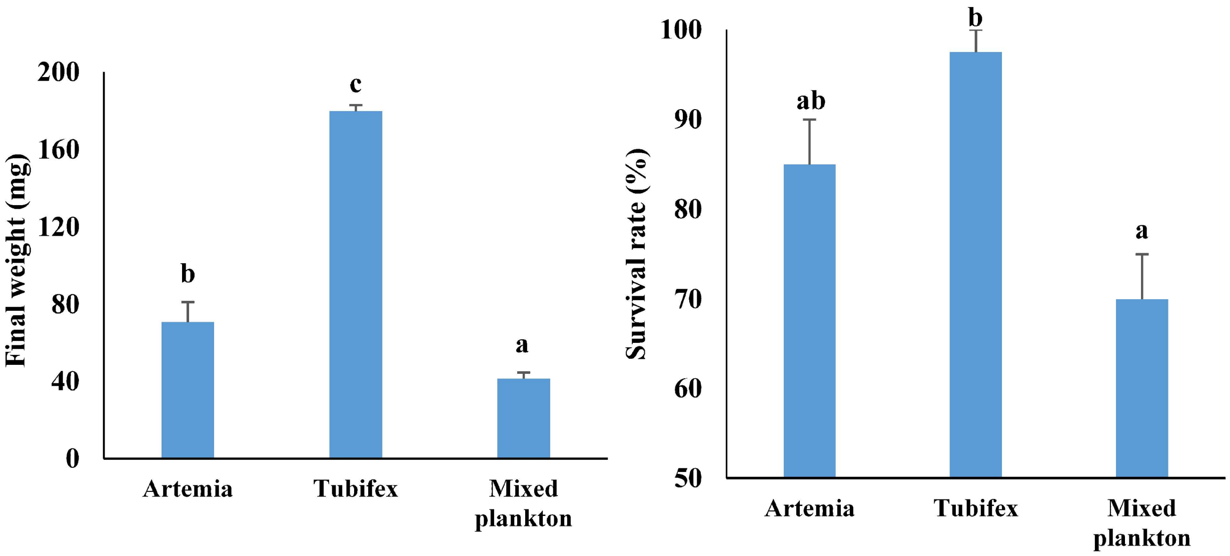
All the data were expressed in mean ± standard error (SE). The data variables were checked for normality using the Kolmogorov-Smirnoff method and tested for homogeneity of variance using Levene's test. The data did not follow a normal distribution and expressed in percentage, were arcsine transformed. Using IBM-SPSS software version 24, the data of different parameters was analysed for any significant difference using one-way analysis of variance (ANOVA) followed by Turkey's HSD test. The values were considered significant at $P<0.05$.

RESULTS AND DISCUSSION

Feeding the larvae with a suitable diet is the foremost step for the successful operation of a hatchery. Live feeds are considered most suitable during the initial feeding most of the fish species due to many advantages such as highly digestible, nutritious and will not deteriorate the water quality (Kumar et al., 2022). In the present experiment, significantly ($P<0.05$) higher growth (179 mg) and survival (97%) were observed in *M. cavasius* larvae fed with tubifex compared to *Artemia* and mixed plankton (Figure 2). The growth (70 mg) was reduced significantly in the larvae fed with *Artemia* nauplii, but the survival rate was unaffected. The present result suggests that tubifex is the most suitable live food for *M. cavasius* larvae during initial feeding for enhanced growth, which agrees to the previous works published for other catfish species such as *C. macrocephalus* (Evangelista et al., 2005), *Pangasius bocourti* (Hung et al., 2002) and *Silurus glanis* (Ronyai and Ruttkay, 1990). This is possibly due to the higher fatty acid, amino acid and having more chemoattractant properties in tubifex as also reported earlier (Hashim et al., 1992; Tamaru et al., 1997).

The feeding of larvae with tubifex often reduces the energy cost during feeding, which promotes growth as also reported in *Cyprinus carpio* (James et al., 1993). However, the feeding of *Artemia nauplii* may be the second best option during larval rearing of this catfish if tubifex is not available plenty.

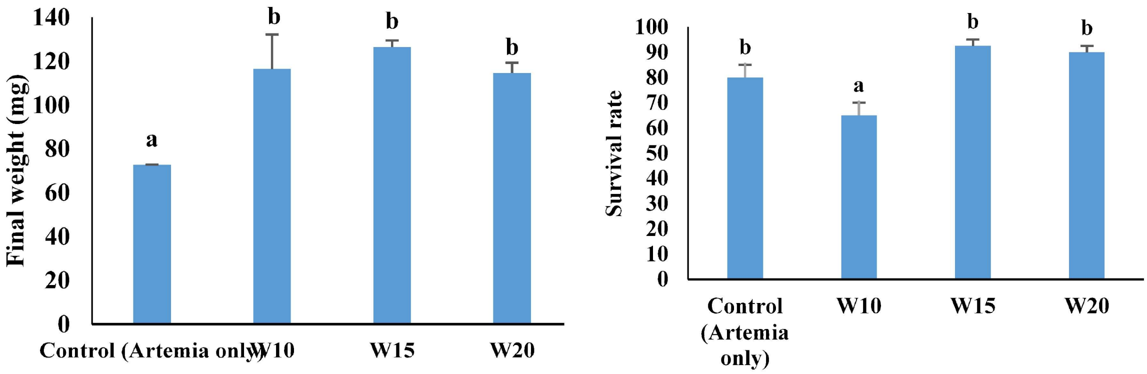
Fig 2. Final body weight and survival rate of *M. cavasius* larvae weaned on different age for 21days rearing period



Different super scripts on the column are significantly (P<0.05) different from each other

The requirement of live feed in fish larvae culture is unavoidable during initial feeding. Their production and maintenance are often laborious and cost-intensive, accounting for more than 50% of the total operation cost of a hatchery (Drossou et al., 2006). Hence, the larvae must be weaned at the earliest possible age with compound feed for the best growth and survival. In the present study, the final weight and survival rate of *M. cavasius* larvae weaned at different age have shown significant differences among the treatments. The final body weight of larvae was increased significantly in all the treatment groups (10, 15 and 20 dph) than the control (Figure 3). However, the percent survival (65%) was drastically reduced among the larvae weaned at 10 dph, which indicates that the *M. cavasius* larvae require live food until 15 dph. Thereafter the weaning of larvae with formulated feed can be feasible, which resulted higher growth (126 mg) and survival rate (92%). The higher larval mortality was observed during weaning at 10 dph, which might be due to lack of ontogenical development of the digestive system in the larvae. The catfish larvae do not pose a functional stomach and rely solely on intestinal digestion at the initial feeding. Previous studies also reported the early weaning leads to higher mortality of fish larvae due to small mouth size, inadequate development of digestive tract and insufficient production of digestive enzymes (Engrola et al., 2010; Pradhan et al., 2014). The formulated feeds cannot be digested compared to live food organisms due to low moisture concentration (<10%) than in live feed (>90%). It is assumed to be supplying their endogenous digestive enzymes as exo-enzyme to the larvae and facilitate easy digestion in the alkaline pH of the intestine as reported in *Channa striata* (Kumar et al., 2022). The optimal weaning age of different catfishes (Verreth and Van Tongeren, 1989; Fermin and Bolivar, 1996; Hung et al., 2002; Pradhan et al., 2014) and other fishes (Liu et al., 2012; Hien et al., 2017; Minya et al., 2018) varies from few days to weeks. This variation of time in different fishes could be due to the completion of digestive ontogenic development in different times. The present finding indicates that completion of digestive ontogeny and the onset of the functional stomach is relatively leisurely developed in *M. cavasius* larvae compared to other catfish species as mentioned above.

Fig 3. Final body weight and survival rate of *M. cavasius* larvae weaned on different age for 28 days rearing period.



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CONCLUSION

The study reflects a comprehensive protocol for feeding the *M. cavasius*, larvae with live feed and the feasibility of using compound feed during its larval rearing. The feeding of chironomid larvae remains best among the live feeds tried. *Artemia nauplii* may be the other option during larval rearing of this catfish in case of non-availability of chironomid larvae. These larvae may be reared with live feed till 15 days after which they may be shifted to compound feed for higher growth and survival during the large-scale larval rearing of *M. cavasius*.

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