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Development of an Efficient Fish Feed for *Catla catla* Post Larvae to Enhance the Survival Rates of Nursery Stages by Using Available Raw Materials

Rubasin Kattadige Nishadi HANSIKA[1], Manjula Prabath WITHANAGE[2], Mohamed Naleem Mohamed FOUZI[3*], Muneeb Muhamed MUNEEB[1], Mohamed RAHMATHULLAH[1]

[1] *Department of Biosystems Technology, Faculty of Technology, South Eastern University of Sri Lanka, University Park, Oluvil, #32360, Sri Lanka.*
[2] *Fish Nutrition Research, Development, and Training Section, Udawalawe, Sri Lanka.*
[3] *Department of Farm Animal Production and Health, Faculty of Veterinary Medicine and Animal Science, University of Peradeniya, 20400, Sri Lanka.*
** Corresponding author: M.N.M Fouzi e-mail: mnmf@vet.pdn.ac.lk*

RESEARCH ARTICLE

Abstract

This study aimed to identify a new feed for *Catla catla* post larvae. There is no suitable feed in Sri Lanka for post-larvae of Indian carp. A complete randomized design was used. Two feeds were formulated using different nutrient compositions with 32 % and 25 % of the fish meal separately. The formulated feeds were used as treatment one and treatment two. Commercial feed was used as the control. *Catla catla* post-larvae were stocked at a density of 300 post larvae per m^2 in nine cement tanks. Growth parameters were measured every two other days. Feeds were formulated according to the nutrient requirement of *Catla catla* post larvae. Water quality parameters were measured daily to maintain the water quality at the proper level. T-test preformed in Mini tab 16.0. Total body weight and length were significantly different ($p<0.05$). The survival percentage was higher in T1. Treatment feeds were not affected by the water quality parameters. *Catla catla* post-larvae show a maximum increase in length, survival percentage and weight in T1. It was concluded that T1 has a good combination of fish meal for *Catla catla* post-larvae. This study will help in future feed formulation for post-larvae feeds in developing nations.

Keywords: *Catla catla,* feeds, post larvae, fish length, fish weight.

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INTRODUCTION

In Sri Lanka, the inland fisheries sector contributes around 0.2% to the Gross Domestic Production (GDP), showing a 70% growth in inland fishing contribution (Edirisinghe *et al*., 2018). Further, it accounts for about 20% of the total fish production in the country. The sector provides direct and indirect employment to a considerable number of people. Moreover, fish products are an important source of animal protein and around 70% of Sri Lankans consume fish and related products to fulfill their protein requirement (Jayasekara, 2022). Inland fish production mainly consists of capture base fishing activities and is mainly dependent on exotic species such as Tilapia SPP, Indian carp, and Chinese carp (James et al., 2006). However, the sustainability of aquaculture production depends on proper feeding and farm management (Adikari et al., 2017). Fish feeding has become one of the critical management practices today, as it accounts for 50-60% of the total production cost (Davis and Hardy, 2022). In Sri Lanka, there is no available feed form for the post-larvae-to-fry stage of Indian carp (Giri et al., 2019). Some farmers use their ingredients in developing fish feed, without taking into account the presence of nutrients in the raw materials and the necessary nutrition of the fish. Thus, those feeds do not contain the required amount of nutrients and it is impossible to achieve a higher growth rate of post larvae under local conditions. In feed ingredients, the protein source is one of the expensive ingredients in formulated feed (Thirumalaisamy et al., 2016). Among several protein sources; fish meal is still an important ingredient in animal feeds and also an expensive feed ingredient compared to other protein sources (Onsongo et al., 2018). Feeding is an important part of fish care. Natural feed, supplementary feed, and complete feed are the three types of feed used in fish ponds (Craig et al., 2017). Natural feed is found naturally in the pond. This can include detritus, bacteria, plankton warms, insects, aquatic plants, and fish. Additional feeds are feeds that are regularly distributed to fish ponds. These feeds usually consist of locally available inexpensive materials such as terrestrial plants, kitchen waste, or agricultural products. Complete feeds can also be distributed regularly. They are made from a mixture of carefully distributed ingredients to provide all the nutrients for the fish to grow properly (Craig et al., 2017). These feeds are relatively difficult to make on the farm and are usually relatively expensive to purchase. The proper nutritional feeds in animal production are vital to good economical production of a healthy and nutrition-rich product; in aquaculture, nutrition is crucial (Daniel, 2016). Fish nutrition has increased dramatically in recent years with the development of recent balanced commercial diets that produce ideal fish growth and health. The dietary content of the feed depends on the species of fish and the life stage of the fish (Kwasek et al., 2020).

Catla catla is also known as the major South Indian carp and economically important freshwater fish in the carp family Cyprinidae. As Catla catla is rich in protein, they have great commercial value (Das et al., 2016). It is native to rivers and lakes in North India, Bangladesh, Myanmar, Nepal, and Pakistan. It reaches up to 182 cm in length and 38.6 kg in weight (Sarder et al., 2011). Under normal conditions, *Catla catla* grows to 1-1.2 kg in the first year, compared to 700-800 g and 600-700 g for Rohu and Mrigal, respectively (Arya et al., 2019). *Catla catla* fish are surface and mid-water feeders. They naturally grow in wild waters where the temperature ranges between 25 ^{0}C and 32 ^{0}C (Kadhar et al., 2014). Since a riverine environment is required, natural breeding does not occur within ponds, even though the species attains maturity (Pradhan et al., 2015); thus hormonal induction is required. Among the three Indian major carp, *Catla catla* is the most difficult to breed as it requires precise environmental conditions for spawning (Gurung, 2022). It attains sexual maturity in two years. Hormonal stimulation for induced breeding often gives poor results in *Catla catla*, compared to other major Indian carp (Thirumalaisamy et al., 2016). This poor breeding response, coupled with a relatively shorter spawning season, results in inadequate production of hatchery-reared seed, which often fails to cover the entire needs of the farmers (Valenti et al., 2021). Survival rates typically range from 30 to 40 percent; however, survival often remains low due to improper management. Also catla's survival rate in nursery ponds is generally lower than that of Rohu and Mrigal. The dietary requirement of *Catla catla* post larvae is 45% crude protein 8-10% crude lipids and 26% carbohydrates (Paul and Giri, 2015). The proposed fish feed for Catla catla post larvae is to accomplish their nutrient requirement and to increase the survival rates by using available raw materials. *Catla catla* is an exotic fish species that was imported to Sri Lanka from India. They have a low survival rate in Sri Lankan aquatic ecosystems (Epa, 2014). Because a river environment is required, natural breeding does not occur within ponds, even when the species is gaining maturity; so hormonal induction is necessary (Athukorala, 2008). The lack of commercial feed, forcing farmers to use the feed produced by them is another limiting factor for fish growth and survival (Hasan and Halwart, 2009). This results in less weight gain and animal safety due to insufficient availability of nutrients in the feed. Carbohydrates is a significant, less expensive, and rapid source of energy for carp spawn, fry, and fingerling to achieve optimal growth. Protein is the most important component of a fish's diet since it promotes growth and is a major component of body tissues (Hassan, 2016). Fish have a higher protein need than mammals since protein is a structural element and the most essential source of growth and development of the body. Protein and lipids are the main sources of metabolic energy followed by carbohydrates in fish (Sandre et al., 2017). The energy level in carp diets is usually maintained at 3.5–4 kcal / g. Under conditions where energy intake is insufficient, fish first get energy from protein at the expense of muscle growth (Barfuss et al., 1988). Lipids are the richest energy component of feed and act as an insulator and regulate body temperature. Lipids are almost completely digestible by fish and seem to be favored over carbohydrates as an energy source (Bell and Koppe, 2010). Dietary lipids, besides providing energy, serve as sources of essential fatty acids. Dietary lipids influence the flesh quality of fish (Espe, 2014). Vitamins are also essential for optimum growth and physiological functions of fish but are required in small quantities as compared to energy and protein (Khalili Tilami and Sampels, 2018). Despite the current body of knowledge concerning catla nutrition requirements, there are no specific commercial feeds for this species (Giri et al., 2019). A good fish feed should contain higher levels of crude protein, fat, and fibre content when forming feeds for Catla post larvae. So it is necessary to produce an efficient feed for *Catla catla* post larvae according to their nutrient requirement.

MATERIALS AND METHODS

Location

The Aquaculture Development Centre at Muruthawela, located in the Hambantota District of Sri Lanka, commenced operations in 2018. It is positioned approximately 240 kilometers from Colombo, near the Muruthawela reservoir. The size of this centre covers 10.2 hectares. The facility includes breeding and rearing facilities specifically designed for Tilapia, Indian Carp, and Chinese Carp.

Experimental design

Studies were designed in the Aquaculture Development Center, Muruthawela. Six cemented tanks were used whose size was 3 m x 3 m x 0.3 m (L*W*H). Two treatments were tested with the control feed, where three replicates were maintained in every treatment. 03 tanks were used as a control tank with T1 and another 03 tanks were used as a control tank with T2. Before stocking, all tanks were disinfected with 20 ppm bleaching powder and cleansed with new water. To remove all disinfectant chlorine, ponds were left 24 hours before filling. Water up to 30 cm was held in all ponds throughout the experiment.

Fish stocking

Random samples of 2700 (300 PL per 1 m^2) post-larvae of *Catla catla* which size is 6 mm in length from a single batch were counted and kept inside the hatchery of the Aquaculture Development Center, Muruthawela for acclimatization before introducing into experimental tanks. After an hour of acclimatization period, post-larvae were stocked in experimental tanks with 2700 fish in each tank.

Table 1. Dietary requirements of *Catla catla*

Nutrient requirement (% DM)	Larvae	Fry
Crude protein	45	35-45
Crude fat	8-10	8-10
Carbohydrate	26	22-26

Note: Source: National Aquatic Resources and Research and Development Agency

Feeding

Soya milk was used in all experiment tanks during the first week with the rate of prepared milk of one kilogram of soya seeds per hundred thousand post larvae. The second and third weeks of the experiment were fed with formulating two feeds for treatments one and two and commercial carp fish feed powder form for control. Feeding rates for the second week and third week were 800 g / 100,000 post-larvae and 1200 g / 100,000 post-larvae respectively. The experiment period was 21 days. Experimental feeds were formulated according to the dietary requirement of the fish (Table 1) by using a fish meal, rice bran, maize, vitamin and mineral mixture, and fish oils (Table 2). Two experimental feeds were formulated by changing the available raw materials to fulfill the nutritional requirement of the Catla catla post larvae (Figures 1 and 2).

Table 2. Composition of treatment feeds

Ingredients	Treatments feed (%)	
	T1	T2
Fish meal (Imported)	32	25
Soya bean meal	20	30
Corn	8	8
Rice bran	8.4	5.4
Wheat	15	15
Fish oil	5	5
Vitamin & mineral	1	1
Fish meal (Prepared in Sri Lanka)	10	10
Methionine	0.3	0.3
Lysine	0.3	0.3

Preparation of feeds

During the present study, feed ingredients were collected and ground using a grinding machine. All the feed ingredients were measured according to the feed formulation and mixed well by adding a little bit of water. Then the feed mixture was put into the feed pelletizer and feed pellets were made. Pallets were steamed for about 2 minutes and removed from the steamer. Feed pallets were dried using a drier for about 24 hours or more according to the amount of feeds. After drying, the pallets were ground till the pellets got a powdery structure.

Figure 1. T1 fodder

Figure 2. T2 fodder

Measuring growth parameters

Every second day, the total length (cm) and body weight (g) of random fish samples from each tank were measured by using a ruler and chemical balance respectively, and were brought into the fish and released in the same experimental tanks. Water quality parameters were also measured and kept at a standard level by using a digital pH meter, oxygen meter and water quality testing kit. Total fish were harvested separately in each pond. A Fry net was used to harvest fish with a mesh size of 2 mm. A counting cup was used to count fish. Survival percentage was measured by the following equations in three weeks (Rahman and Arifuzzaman, 2021).

$$Survival\ (\%) = \frac{Number\ of\ Fishes\ Survived\ at\ the\ End\ of\ the\ Experiment}{Number\ of\ Fishes\ Stocked\ at\ the\ Start\ of\ the\ Experiment} \times 100$$

Data analysis

Statistical analysis was done using Mini tab 16.0. The effect of testing feeds on fish's parameters was analyzed by using a Students' T-test at the significant level of p=0.05.

RESULTS AND DISCUSSIONS

Nutrient composition of experimental feeds

The crude protein content of the experimental feeds was nearly 41 % (Table 03). Crude fat content, fibre content and ash content of feeds were more or less similar.

Table 3. Nutrient composition of formulated feeds

Nutrient composition	Treatment Feeds	
	T1	T2
Crude protein %	41.00	40.41
Crude fat %	10.00	9.79
Crude fiber %	2.28	2.26
Ash %	10.58	9.75

Growth parameters

The body weight and body length obtained by the fish varied significantly across treatments (p <0.05). At the end of the study period, the mean body weight and length achieved by the fish varied between 0.014 -0.313 g (Figure 3) and 0.83–3.56 cm (Figure 4). Weight and body length were significantly greater (p <0.05) in post-larvae fed with T1.

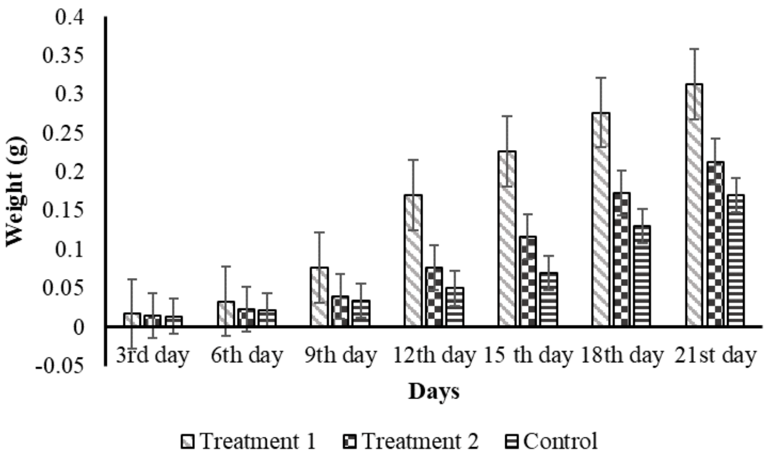

Figure 3. Mean weight relationship between treatments

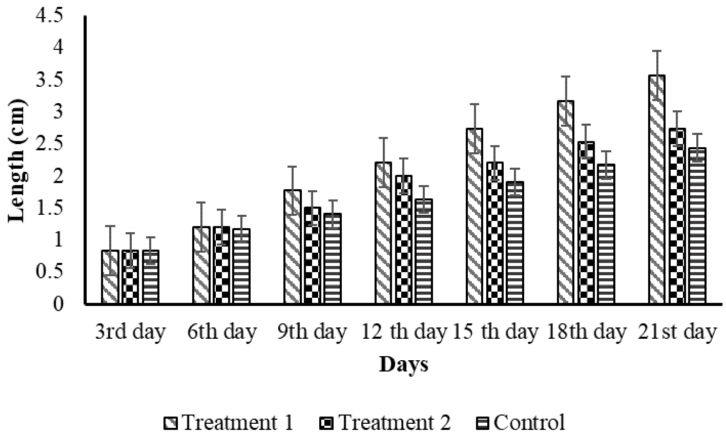

Figure 4. Mean length relationship among treatments

Survival percentage

The survival percentage of fry varied from 47.19 -58.00 %. A numerically low survival percentage was found in control and a high survival rate was found in T1 at 3rd week (Figure 5).

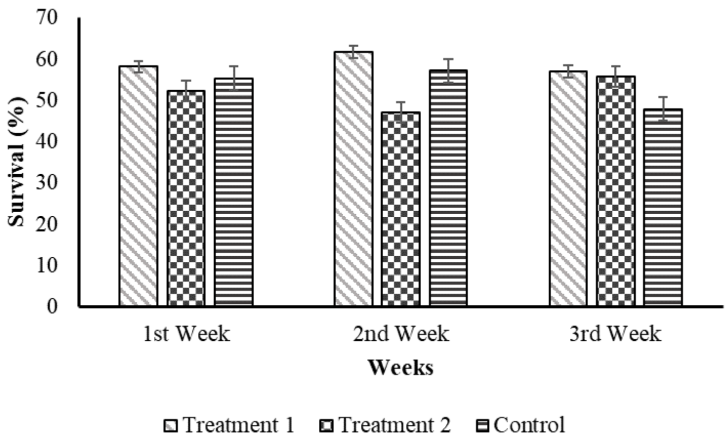

Figure 5. Survival rate among treatments

Initially, post-larvae exhibited reluctance towards the newly introduced feeds, which consisted of a blend of soya bean milk. The fish did not immediately embrace the feeds, even when presented in a mixture. It took approximately two to three days for the post-larvae to become accustomed to the novel feeds. Notably, T1 and T2 feeds faced resistance and were not readily embraced by the post-larvae in the initial week of the experiment. However, after the 1st week, the fry became familiar with the experimental feeds and it was observed that they actively fed with the entire experimental period. Fish feed's perception depends on availability, appearance (Roch et al., 2020), particle size (Hutchings, 2011), and taste (Kasapis, 2009). Commercial feeds typically contain high-quality fish meals and have a relatively good smell, which attracts post larvae to the feed. It can also be a reason for immediate acceptance of commercial feeds than other formulated feeds. The formulated feed is in the powdery form. The generated feed powder is more suitable because the post-larvae have a small gap in the mouth. During the 1st week, the satisfaction of T1 and T2 feeds was moderate. However, after the 1st week, most fish were fed on T1 and T2 feeds. According to Kasumyan (2019), studies, the degree of hardness in feed can have a substantial impact on whether an individual decides to consume or deny a grasped, exceptionally palatable feed item.

The temperature whole experiment period was maintained at a standard level because ammonia toxicity grows with increasing temperature and decreasing dissolved oxygen capacity in water (Haerudin et al., 2016). The optimal pH range for freshwater fish is 6.5-9.0 (Parra and Baldisserotto, 2019). The pH range was optimal in the current study. Ammonia concentrations were maintained in all experimental tanks from 0.15 mg /l to 0.30 mg/l; because It is important to regularly monitor the ammonia levels in fish ponds to prevent both chronic and acute harmful effects. Monitor the level closely to ensure it remains below 0.2 mg/l. It is crucial to maintain the pH values effectively to prevent any adverse synergistic effects when ammonia is present in the pond (Haerudin et al., 2016).

Dissolved oxygen level ranges from 4-9 mg/l with the treatment feeds during the experimental period. According to the findings, Decreased oxygen levels significantly impact various physiological processes in fish, leading to reduced eating, growth, food conversion ratio, and increased gill ventilation rate (Braun et al., 2006). In rearing fish post-larvae, feeding is the major factor since fish obtain their entire nutrition requirement through the food consumed. In the present study, experimental feeds were formulated with different nutrient compositions. Dietary protein plays a major role in fish growth. T1 shows some significant enhancement in the growth of Catla post-larvae when compared with other treatments. Catla post-larvae shows a maximum increase in length and weight observed in T1 and the survival percentage was also high in three weeks for T1 tanks.

CONCLUSION

This research effectively identified a potentially beneficial novel feed formulation for *Catla catla* post-larvae, thereby filling a significant void in the aquaculture sector of Sri Lanka. In comparison to treatments and the control, treatment one (T1) exhibited superior results in terms of total body weight, length, and survival percentage due to its distinct nutrient composition and especially in environments with limited resources. Through its contribution to the improvement of aquaculture methodologies in developing countries, this research establishes a fundamental basis for bolstering food security and economic well-being in the area.

Author Contributions: M.M.M.M. and F.M.N.M. conceived designed and supervised the whole research. W.P.M. and H.R.K.N. collected the data, N.R.M. performed the data analysis and wrote the paper and final corrections were made by M.M.M.M. and F.M.N.M.

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Conflicts of Interest

The authors declare that they do not have any conflict of interest.

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