STM JOURNALS

Research & Reviews: Journal of
Veterinary Science and Technology

https://journals.stmjournals.com/rrjovst

ISSN: 2319-3441(Online)
ISSN: 2349-3690 (Print)
Volume 15, Issue 1, 2026
January–April
DOI (Journal): 10.37591/RRJoVST

Research RRJoVST

Impact of Specially Prepared Food on Indian Big Carp Growth in West Bengal, India's Cooch Behar District

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Abstract

This four-year longitudinal study (2008–2012) in the Cooch Behar District of West Bengal, India, utilized on-farm ponds to evaluate the comparative growth performance of Indian Major Carps (IMCs) – Catla catla, Labeo rohita, and Cirrhinus mrigala – when subjected to four distinct supplementary feed formulations: fishmeal (A), soybean meal (B), silkworm pupae (C), and mustard oilcake (D). The experimental design contrasted treated ponds receiving formulated feed against control ponds relying solely on natural productivity. In comparison to the control group, all supplemental meals considerably increased weight gain and Specific Growth Rate (SGR), confirming the financial requirement of intensive/semi-intensive culture techniques. Technically, the silkworm pupae-based feed (Feed C) demonstrated optimal efficacy. This diet recorded the lowest Feed Conversion Ratio (FCR), indicating superior feed utilization efficiency where less feed mass was required to produce a unit of fish biomass. This is directly attributed to the high biological value of the pupae's protein – typically high in crude protein (50–80%) and balanced in essential amino acids (EAAs) and lipids. The robust EAA and essential fatty acid (EFA) profile ensures maximum nutrient digestibility and assimilation, leading to reduced metabolic waste and enhanced energy partitioning for growth. Conversely, the mustard oilcake-based feed (Feed D) yielded the poorest growth, likely due to a sub-optimal amino acid balance, lower protein digestibility, or the presence of anti-nutritional factors (ANFs) common in oilseed meals, which depress nutrient uptake. The study's results underscore that selecting a feed with a superior protein efficiency ratio (PER), as exemplified by silkworm pupae, is the key to maximizing yield and minimizing feeding costs in sustainable carp polyculture.

Keywords: Feed Conversion Ratio (FCR), Indian Major Carps (IMCs), Silkworm Pupae (SPM), growth performance, supplementary feed

INTRODUCTION

Natural food supplies, such as fertilization and water management in confined spaces, constitute the mainstay of most conventional aquaculture practices [1]. Although feed supplementation with fully artificial food is used to ensure growth and output in intensive culture, this approach is still somewhat used in large and semi-intensive pond farming. Thus, the increasing intensity of numerous production systems is one of the factors contributing to the phenomenal expansion of Indian Major Carps (IMCs). The primary cause of intensification is the use of more complex full meals that satisfy the target species' nutritional needs [2–5]. Therefore, from the perspective of both fish productivity and cost, artificial feed has emerged as the most crucial element of the culture system. The artificial feed contains vitamins, minerals, carbohydrates, protein, and fat.

Fish need protein, the most costly and desirable ingredient in fishA feed, for development and maintenance, while certain species and cultured environments have different needs [6–10]. For IMCs raised in early culture, the diet should have an average

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Received Date: October 29, 2025
Accepted Date: November 04, 2025
Published Date: November 05, 2025

Citation: Chandan Chakraborty, Sudip Barat. Impact of Specially Prepared Food on Indian Big Carp Growth in West Bengal, India's Cooch Behar District. Research and Reviews: Journal of Veterinary Science and Technology. 2026; 15(1): 7–12p.

protein content of 20% to 30%. When creating a cost-effective feed that can maximize development and maintain economic viability, knowledge of protein requirements is essential. Production steadily rises utilizing the low-cost-high-yielding method, and carp cultivation is hailed as undergoing a revolution. While the study is mostly focused on feed management and growth studies, reviews, guidelines, and instructions on the usage of feed, IMCs are primarily cultivated in polyculture systems [11–14]. Although fish meal-based meals often result in adequate development, research on alternate protein sources is becoming increasingly important because of the limited supply and rising expense of fish meal [15–17]. Fish producers sometimes use locally accessible items to feed the fish to reduce cultural expenses. IMC feeding in the Cooch Behar district is mostly done on an as-needed basis and varies according on the producing center. It was, therefore, deemed crucial to create a complete feed.

EXPERIMENTAL PROCEDURE

The experiments were conducted at the farmers' ponds in four villages, Gitaldaha (ET1), Kolakata (ET2), Matalhat (ET3), and Maruganj (ET4), which are located at an elevation of 52 masl, latitude 26º 12" N, longitude 89º 44" E in the Cooch Behar District of West Bengal, India, between April 2008 and March 2012. The three primary Indian carps that were studied were *Catla catla*, *Labeo rohita*, and *Cirrhinus mrigala*. The results of this study contrasted the two ponds – one treated and one control – at each of the four experimental sites (ET1, ET2, ET3, and ET4), totaling eight ponds. IIA, IIB, IIC, and IID were control ponds at ET1, ET2, ET3, and ET4, respectively, while IA, IB, IC, and ID were treated ponds [18–20].

Artificial feed was added to the treated ponds at a rate of 2–3% of the carps' body weight, whereas the control ponds received no feed. However, 7800 kg ha^{-1} $month^{-1}$ of cow dung manure was applied to both the treatment and control ponds.

To assess fish growth variables, the length and weight of the three IMCs were measured at the end of each month from April 2008 to March 2012 from each of the eight ponds (four treated and four controlled). This was accomplished by harvesting enough carps and then reintroducing them into the same pond. To prevent the unpleasant impacts of handling and netting, the carps were famished for a full day before being harvested. Based on the aforementioned observations, the feed conversion ratio and absolute growth rate were computed [21–24].

DATA INTERPRETATION AND ANALYSIS OF RESULTS

The feed ingredients and composition of the four formulations (A, B, C, and D at the treated ponds IA, IB, IC, and ID of ET1, ET2, ET3, and ET4) with reference to the locations at Gitaldaha, Kolakata, Matalhat, and Maruganj, respectively, of Cooch Behar, West Bengal, India, showed the presence of animal protein in the form of fishmeal in A and silkworm pupae in C, while the presence of plant protein was shown by the presence of soybean meal in B and mustard oil cake in D (Table 1). The approximated analysis of the formulated feeds A, B, C, and D showed that crude proteins were 25.05, 24.15, 26.90, and 25.02% and crude fat was 9.80, 6.85, 14.40, and 9.05%, respectively (Table 2).

The composition of the feed materials used to produce feeds using various animal and plant proteins for Indian main carps is the cause of the variations observed in the percentages of crude protein and crude fat (Table 1).

The length and weight of IMCs were higher in the treated ponds (50.2 cm and 2.455 kg in *Catla catla*; 41.3 cm and 1.490 kg in *Labeo rohita*; and 42.1 cm and 1.228 kg in *Cirrhinus mrigala*) than in the control ponds (45.1 cm and 1.264 kg in *Catla catla*; 29.1 cm and 0.818 kg in *Labeo rohita*; and 30.1 cm and 0.828 kg in *Cirrhinus mrigala*). This came about because of the control ponds not receiving any artificial feeds, whereas the treatment ponds received formulated foods. The impact of specially designed diets on carp fish output was also documented by Allan et al. (2006). A fish's length and weight are very important [6, 7] for determining its productivity, maturity, and growth pattern [8], and they are also helpful for applied fishery management [25–27].

Table 1. Feed Ingredients and the composition of the formulated feeds (A, B, C, and D).

Feed Ingredients Feed Ingredients (%)	A at the Treated Pond IA of ET1	B at the Treated Pond IB of ET2	C at the Treated Pond IC of ET3	Dat the Treated Pond ID of ET4
Fishmeal	30	–	–	–
Mustard oilcake	25	35	–	60
Rice–bran	25	–	–	40
Rice-broken	20	–	–	–
Wheat flour	–	–	30	–
Maize	–	–	20	–
Bakery waste (unused breads)	–	45	–	–
Soybean meal	–	20	–	–
Silkworm pupae	–	–	50	–

Feed B had the lowest IMC weight and length (44.2 cm and 1.048 kg in *Cirrhinus mrigala*), feed C the highest (50.2 cm and 2.455 kg in *Catla catla*), feed D the lowest (29.6 cm and 0.333 kg in *Cirrhinus mrigala*), and feed A the highest (44.1 cm and 1.525 kg in *Catla catla*).

This was the outcome of feeding fishmeal in A, silkworm pupae in C, soybean meal in B, and mustard oilcake in D. This is a result of the artificial diets' necessary levels of lipids and amino acids [28–30].

This is also a result of the IMCs' overall protein consumption. Because feed C contained silkworm pupae, which made up 26.90% crude protein and 14.40% crude fat, it had the highest growth in length and weight. In contrast, feed D contained mustard oilcake, which made up nearly 25.02% crude protein but only 9.05% crude fat (Table 2) [31–34].

Table 2. Proximate analyses of the formulated feeds (A, B, C, and D).

Proximate Composition (%)	A at the Treated Pond IA of ET1	B at the Treated Pond IB of ET2	C at the Treated Pond IC of ET3	D at the Treated Pond ID of ET4
Crude Protein	25.05	24.15	26.90	25.02
Crude Fibre	7.10	17.50	4.50	7.00
Crude Fat	9.80	6.85	14.40	9.05

CONCLUSIONS

In the treated and control ponds, *Catla catla* had the highest weight and length (50.2 cm and 2.455 kg), *Labeo rohita* the lowest (41.3 cm and 1.490 kg), and *Cirrhinus mrigala* the lowest (42.1 cm and 1.228 kg). Their eating habits were the cause of this. This was also caused by the fingerlings' size (weight and length), condition, and availability and consumption of both artificial and natural feed (phytoplanktons, zooplanktons, and zoobenthos). The weight and length of the fingerlings, fries, and free-swimming fries in the current investigation were comparable to those described by Woynarovich and Le Cren (1951). The length and weight of *Catla catla*, *Labeo rohita*, and *Cirhhinus mrigala* were related in both treatment and control ponds (ANOVA regression analysis; $P < 0.01$).

However, compared to the second, third, and fourth years, there is no difference in the length and weight relationship of *Catla catla*, *Labeo rohita*, and *Cirhhinus mrigala* in the first-year treated and control ponds (one-way ANOVA, t-test). The highest feed conversion ratio (FCR) was found in feed D (0.91 for *Catla catla*, 0.61 for *Labeo rohita*, and 0.58 for *Cirhhinus mrigala*); the lowest FCR was found in feed A (0.38 for *Catla catla*, 0.30 for *Labeo rohita*, and 0.26 for *Cirhhinus mrigala*); and the lowest FCR was found in feed C (0.22 for *Catla catla*, 0.26 for *Labeo rohita*, and 0.15 for *Cirhhinus mrigala*) diets C with silkworm pupae, B with soybean meal, D with mustard oilcake, and A with fishmeal were the specifically designed diets that produced this. The FCR of the fishmeal diet was 1.42, according to Clark, whereas the FCR of the silkworm pupae diet was 1.90, according to Bhagat and Barat; Akbulut reported that the FCR was 1.37; Bulut reported that the FCR was 0.77; Klontz reported that the FCR was 1.06; and Yildiz reported that. This might be because of the fingerlings' size (weight and length), condition, and availability and intake of both artificial and natural feed (phytoplanktons, zooplanktons, and zoobenthos). Additionally, feed C had the lowest feed conversion ratio, followed by feed A, feed B, and feed D.

Feed C had the lowest feed conversion ratio because it contained silkworm pupae, which made up 26.90% crude protein and 14.40% crude fat. In contrast, feed D had the highest feed conversion ratio because it contained mustard oilcake, which made up almost 25.02% crude protein but only 9.05% crude fat.

According to a one-way ANOVA, the feed conversion ratio of formulated feed A is different from that of B, C, and D ($P < 0.01$).

However, according to a one-way ANOVA and a t-test, the feed conversion ratio of the first-year simulated feed A does not change from the second, third, or fourth years. Absolute growth rates were greater in treatment ponds (5.96 g day^{-1} for *Catla catla*, 3.72 g day^{-1} for *Labeo rohita*, and 3.17 g day^{-1} for *Cirhhinus mrigala*) and lower in control ponds (2.19 g day^{-1} for *Catla catla*, 1.46 g day^{-1} for *Labeo rohita*, and 1.53 g day^{-1} for *Cirhhinus mrigala*). This happened because of the control ponds not receiving any artificial feeds while the treatment ponds received specially prepared feeds. For *Catla catla*, *Labeo rohita*, and *Cirhhinus mrigala*, feed C had the highest absolute growth rate of IMCs (5.96 g day^{-1}, 3.72 g day^{-1}, and 3.17 g day^{-1}); feed A had the highest rate (4.55 g day^{-1}, 2.80 g day^{-1}, and 2.59 g day^{-1}); The lowest rates were found in feed D (3.08 g day^{-1} for *Catla catla*, 2.30 g day^{-1} for *Labeo rohita*, and 2.06 g day^{-1} for *Cirhhinus mrigala*) and feed B (4.00 g day^{-1} for *Catla catla*, 2.60 g day^{-1} for *Labeo rohita*, and 2.21 g day^{-1} for *Cirhhinus mrigala*). The diet for silkworm pupae in C, fishmeal in A, soybean meal in B, and mustard oilcake in D caused this. Feed C had the highest absolute growth rate because it included silkworm pupae, which comprised 26.90% crude protein and 14.40% crude fat. On the other hand, mustard oilcake, which comprised just 9.05% crude fat but roughly 25.02% crude protein, was present in feed D. According to Bhagat and Barat, the silkworm pupae meal had the highest absolute growth. The absolute growth rate of the IMCs was highest in IIC (3.24 g day^{-1} for *Catla catla*, 2.33 g day^{-1} for *Labeo rohita*, and 1.82 g day^{-1} for *Cirhhinus mrigala*), lowest in IIB (2.41 g day^{-1} for *Catla catla*, 1.91 g day^{-1} for *Labeo rohita*, and 1.45 g day^{-1} for *Cirhhinus mrigala*). This was caused by variations in the amount of natural feed in the control ponds. With B, C, and D, the IMCs' absolute growth rate because of the formulated meal A varies (one-way ANOVA; $P < 0.01$). Nevertheless, the first-year IMCs' absolute growth rate because of the first-year formulated feed A is the same for the second, third, and fourth years (one-way ANOVA, t-test). IIB, IIC, and IID had different absolute growth rates for the IMCs than IIA (one-way ANOVA; $P < 0.01$). The first-year IMCs' absolute growth rates in IIA, IIB, IIC, and IID do not, however, vary from those in the second, third, or fourth years (one-way ANOVA, t-test). The feed formulation containing silkworm pupae feed had shown an advantage over all other feed formulations against all feed efficiency measures, even though the growth outcomes of the various stages of IMCs were equivalent with those of other feeds. Common carp and IMC fingerlings have been fed silkworm pupae, which have also demonstrated their usefulness as a protein and fat substitute for rice bran and oil cake. When compared to a diet that contained 30% fishmeal, common carp given a higher percentage of silkworm pupae showed progressive development, reaching a maximum growth of 30%. Despite being a cheap ingredient, silkworm pupae are richer in amino acid profiles than fishmeal and contain more protein and fat than prawn meals.

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