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Effect of formulated feeds on the growth of Indian major carps in Cooch Behar District, West Bengal, India

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Abstract

This study was conducted in Cooch Behar District, West Bengal, India, to see how different formulated feeds affect the growth of Indian major carps — Catla catla, Labeo rohita, and Cirrhinus mrigala. The experiment was done over four years (2008–2012) in farmers' ponds using four types of feed made from fishmeal, soybean meal, silkworm pupae, and mustard oilcake. Treated ponds received artificial feed, while control ponds did not. The results showed that carps in treated ponds grew faster and became heavier than those in control ponds. Among the feeds, silkworm pupae-based feed (Feed C) gave the best growth results and lowest feed conversion ratio (FCR), meaning fish grew more with less feed. Mustard oilcake-based feed (Feed D) showed the least growth. The study proves that using properly formulated feed, especially with good protein and fat sources like silkworm pupae, can greatly improve fish farming outcomes.

Keywords
Carps, Feed, Silkworm, Growth, FCR

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1 Introduction

Most forms of traditional aquaculture rely largely on natural food sources that are by fertilization and water management in enclosed areas [1]. To certain extent, this practice is still followed in extensive and semi-intensive pond farming, but feed supplementation with complete artificial food is resorted for ensuring growth and production in intensive culture. Therefore, one of the reasons for the phenomenal growth of Indian Major Carps (IMCs) is the progressive intensification of many production systems. The key driver for intensification is the use of increasingly sophisticated complete feeds that meet nutritional requirements of target species [2]. So, the artificial feed has become the most important component of the culture system from the viewpoint of both fish production and cost. The artificial feed contains protein, lipid, carbohydrates, vitamins, and minerals.

Protein, the most expensive and wanton component in fish feeds is required by fish for maintenance and growth, though its requirement vary from species to species and cultured environment [3]. The average protein content in the feed for early culture of Indian Major Carps should be around

20% to 30%. The information on protein requirements is crucial in developing a cost-effective feed that can optimize growth and the feed efficiency is yet economically viable. Gradually, production increases manifold, using the technique of low-cost-high-yielding, with a revolution heralded in carp culture. IMCs are primarily cultured in polyculture system while, the study is primarily focused on the feed management and growth studies, reviews, guidelines and manuals on the use of feed [4]. Fish meal based feeds generally induce good growth, however, owing to the scarcity and escalating cost of fish meal, research on alternative protein sources is gaining importance [5]. To cut the culture expenditure, fish farmers often utilize locally available ingredients for feeding the fish. In Cooch Behar district, feeding of IMCs are largely on ad-hoc basis, and differ from one production centre to another. That is why; the formulation of a complete feed was felt necessary.

2 Materials and Methods

The experiments were conducted in four subdivisions of Cooch Behar District, West Bengal, India for four years from April 2008 to March 2012, at the farmers' ponds in four villages: Gitaldaha (ET_1), Kolakata (ET_2), Matalhat (ET_3), and Maruganj (ET_4) located in latitude 26° 12" N, longitude 89° 44" E, and altitude of 52 masl. The Indian major carps studied were *Catla catla*, *Labeo rohita* and *Cirrhinus mrigala*. There were a total of eight ponds selected at the four experimental sites (ET_1, ET_2, ET_3 and ET_4) and the results presented in this research were the comparison of the two ponds (one treated and one control) at each site. IA, IB, IC, and ID were treated ponds and IIA, IIB, IIC, and IID were control ponds at ET_1, ET_2, ET_3 and ET_4 respectively. The treated ponds were provided with artificial feed at the rate of 2 to 3% of the body weight of the carps and the control ponds without feed. However, both treated and control ponds were applied with cow dung manure at the rate of 7800 kg ha^{-1} $month^{-1}$.

From each of the eight ponds (four treated and four control), at the end of each month, for studying fish growth parameters, the length and weight of the three IMCs were taken from April, 2008 to March, 2012. For this, the carps were harvested in sufficient numbers and then returned to the same pond. Prior to harvesting the carps were starved for 24 hours to avoid stressful effects of netting and handling. The feed conversion ratio and absolute growth rate were calculated from the above observations.

3 Results and Discussions

The feed ingredients and composition of the four formulated (A, B, C, and D at the treated ponds IA, IB, IC, and ID of ET_1, ET_2, ET_3, and ET_4 referring to the locations at Gitaldaha, Kolakata, Matalhat, and Maruganj respectively of Cooch Behar, West Bengal, India) have shown the presence of animal protein of fishmeal in A and silkworm pupae in C whereas it showed the presence of plant protein of soybean meal in B and of mustard oilcake in D (Table 1). The poximated analysis of the formulated feeds A, B, C, and D exhibited crude proteins 25.05, 24.15, 26.90, and 25.02% and crude fat 9.80, 6.85, 14.40, and 9.05% respectively (Table 2). The differences seen in the crude protein and crude fat percentage is due to composition of the feed ingredients while formulating feeds taking different animal and plant proteins for the Indian major carps.

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	**D** at 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 wastes (unused breads)	-	45	-	-
Soybean meal	-	20	-	-
Silkworm pupae	-	-	50	-

The length and weight of IMCs were higher in 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 was due to formulated feeds provided in the treated ponds and no artificial feeds supplied in the control ponds. Allan *et al.* (2006) also reported the role of formulated diets on the production of carp fish.

Length and weight of a fish is of quite significance [6, 7] to know the production, maturity, and pattern of growth [8] and is equally useful in applied fishery management [9]. The length and weight of IMCs were highest in feed C (50.2 cm and 2.455 kg

in *Catla catla*), higher in feed A (44.1 cm and 1.525 kg in *Catla catla*), low in feed B (44.2 cm and 1.048 kg in *Cirrhinus mrigala*), and lowest in feed D (29.6 cm and 0.333 kg in *Cirrhinus mrigala*). This was due to silkworm pupae feed in C, fishmeal feed in A, soybean meal with B, and mustard oilcake in feed D. This is because of required quantity of amino acids and lipids present in the artificial feeds [10]. This is also due to the total protein intake available for the IMCs. The growth in length and weight with feed C was highest due to the presence of silkworm pupae and comprising 26.90% crude protein and 14.40% crude fat whereas it was lowest with the feed D due to the presence of mustard oilcake and comprising nearly resembling 25.02% crude protein but only 9.05% crude fat.

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

The length and weight of *Catla catla* was highest (50.2 cm and 2.455 kg), *Labeo rohita* low (41.3 cm and 1.490 kg), and *Cirrhinus mrigala* lowest (42.1 cm and 1.228 kg) in both treated and control ponds. This was due to their feeding habits. This was also due to the size (length and weight) and condition of the fingerlings stocked and availability and consumption of natural feed (phytoplanktons, zooplanktons, and zoobenthos) and artificial feed. Length and weight, of the free swimming fries, fries and fingerlings, in the present research, resembled as per described by Le Cren (1951) and explained by Woynarovich [11].

The length and weight relationship of *Catla catla*, *Labeo rohita*, and *Cirhhinus mrigala* was seen in both treated and control ponds (correlation analyses in ANOVA and regression analyses in ANOVA; $P < 0.01$). However, the length and weight relationship of *Catla catla*, *Labeo rohita*, and *Cirhhinus mrigala* in both treated and control ponds of the first year doesn't differ with second year, third year, and fourth year (one-way ANOVA, t-test).

The feed conversion ratio (FCR) of the feed D was highest (0.91 for *Catla catla*, 0.61 for *Labeo rohita*, and 0.58 for *Cirhhinus mrigala*); feed B higher (0.73 for *Catla catla*, 0.73 for *Labeo rohita*, and 0.53 for *Cirhhinus mrigala*); feed A low (0.38 for *Catla catla*, 0.30 for *Labeo rohita*, and 0.26 for *Cirhhinus mrigala*); and feed C lowest (0.22 for *Catla catla*, 0.26 for *Labeo rohita*, and 0.15 for *Cirhhinus mrigala*). This was due to formulated feeds: feed D with mustard oilcake, feed A with fishmeal, feed B with soybean meal, and feed C with silkworm pupae. According to Bhagat and Barat [12], the FCR of the silkworm pupae diet was 1.90; [13], the FCR in the fishmeal diet was 1.52; according to Clark [14], the FCR in the fishmeal diet was 1.42; according to Akbulut [15], the FCR was 1.37; according to Bulut [16], the FCR was 0.77; according to Klontz [17], the FCR was 1.06; and according to Yildiz [18], the FCR was 1.2 ± 0.0. This might be due to the size (length and weight) and condition of the fingerlings stocked and availability and consumption of natural feed (phytoplanktons, zooplanktons, and zoobenthos) and artificial feed. Further, the feed conversion ratio due to the feed C was least; feed A lower, feed B low, and the feed D highest. The feed conversion ratio with feed C was least due to the presence of silkworm pupae and comprising 26.90% crude protein and 14.40% crude fat whereas it was highest with the feed D due to the presence of mustard oilcake and comprising nearly resembling 25.02% crude protein but only 9.05% crude fat.

The feed conversion ratio of the formulated feed A differs with B, C, and D (one-way ANOVA; $P < 0.01$). However, the feed conversion ratio of the formulated feed A of the first year doesn't differ with second year, third year, and fourth year (one-way ANOVA, t-test).

The absolute growth rate was higher (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*) in treated ponds 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 was due to formulated feeds provided in the treated ponds and no artificial feeds supplied in the control ponds.

The absolute growth rate of IMCs were highest in feed C (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*), higher in feed A (4.55 g day^{-1} for *Catla catla*, 2.80 g day^{-1} for *Labeo rohita*, and 2.59 g day^{-1} for *Cirhhinus mrigala*), low in 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*), and lowest 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*). This was due to silkworm pupae feed in C, fishmeal feed in A, soybean meal with B, and mustard oilcake in feed D. The absolute growth rate with feed C was highest due to the presence of silkworm pupae and comprising 26.90% crude protein and 14.40% crude fat whereas it was lowest with the

feed D due to the presence of mustard oilcake and comprising nearly resembling 25.02% crude protein but only 9.05% crude fat. According to Bhagat and Barat [19], the absolute growth was highest in silkworm pupae feed.

The absolute growth rate of IMCs were 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*), higher in IIA (2.69 g day^{-1} for *Catla catla*, 1.97 g day^{-1} for *Labeo rohita*, and 1.46 g day^{-1} for *Cirhhinus mrigala*), low 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*), and lowest in IID (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 was due to variations in the abundance of the natural feed in the control ponds.

The absolute growth rate of the IMCs due to the formulated feed A differs with B, C, and D (one-way ANOVA; $P < 0.01$). However, the absolute growth rate of the IMCs due to the formulated feed A of the first year doesn't differ with second year, third year, and fourth year (one-way ANOVA, t-test).

The absolute growth rate of the IMCs in IIA differs with IIB, IIC, and IID (one-way ANOVA; $P < 0.01$). However, the absolute growth rate of the IMCs in IIA, IIB, IIC, and IID of the first year doesn't differ with second year, third year, and fourth year (one-way ANOVA, t-test).

The feed formulation with silkworm pupae feed had exhibited superiority over all other feed formulations against all feed efficiency indicators however; results of growth of different stages of IMCs were comparable with that of other feeds. Silkworm pupae as feeds for fingerlings of common carp and IMCs had also proven its suitability as substitute of protein and fat of oil cake and rice bran (Chakrabarthy *et al.*, 1973). Common carp fed with increasing level of silkworm pupae revealed progressive growth with highest growth of 30% (Cheng *et al.*, 2003) in comparison to diet containing 30% of fishmeal [20]. Silkworm pupae, although low cost ingredient, has more protein and lipid than shrimp meals (Bhuiyan *et al.*, 1989) and rich in amino acid profile than fishmeal (Solomon and Yusufu, 2005).

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