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Original Article

# Variations in growth performance of Catla (*Cattla cattla*), Rohu (*Labeo rohita*) and Mrigal (*Cirhinus mrigala*) fed with varying levels of fishmeal based diets in intensive farming

## Variações no desempenho de crescimento de Catla (*Cattla cattla*), Rohu (*Labeo rohita*) e Mrigal (*Cirhinus mrigala*) alimentados com níveis variados de dietas à base de farinha de peixe em pecuária intensiva

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**Abstract**

A one year feeding trial was conducted on carps i.e. Catla (*Cattla cattla),* Mrigal *(Cirhinus mrigala)* and Rohu *(Labeo rohita)* to find out appropriate level of fishmeal in diet and their effects on growth, survival and biomass in intensive polyculture. Three different inclusions of fishmeal were used in experimental diets (25%, 35% and 45%). Highest average daily growth was observed by 25% fish meal diet (2.18g, 2.19g and 2.34g for catla, rohu and mrigal respectively), whereas 35% fish meal based diet was next by showing 1.63g average daily growth for catla, 1.73g for rohu and 1.67g for mrigal. Mean values of monthly weight again and average daily growth showed significant differences among treatments. Growth was found to be higher in *C. mrigala* in case of 25% and 45% and *L. rohita* in case of 35% fish meal. Minimum FCR was obtained by 25% FM based diets as 3.53±0.41 followed by 45% (3.82±0.33) and 35% (4.05±0.45). The findings of this research trial determine the optimum dietary level of fishmeal and its effectiveness as an important ingredient in diets of Indian major carps. It is proved that a feed by the combination of animal and plant protein is much preferable by carps as compare to a feed with higher concentration of fish meal.

**Keywords:** fishmeal, carps, fish farming, polyculture, protein.

**Resumo**

Um teste de alimentação de um ano foi realizado em carpas, ou seja, Catla (*Cattla cattla),* Mrigal (*Cirhinus mrigala*) e Rohu (*Labeo rohita*) para descobrir o nível adequado de farinha de peixe na dieta e seus efeitos no crescimento, sobrevivência e biomassa em policultura intensiva. Três diferentes inclusões de farinha de peixe foram utilizadas nas dietas experimentais (25%, 35% e 45%). O maior crescimento médio diário foi observado pela dieta com 25% de farinha de peixe (2,18g, 2,19g e 2,34g para catla, rohu e mrigal, respectivamente), enquanto a dieta à base de farinha de peixe de 35% foi a próxima, mostrando um crescimento médio diário de 1,63g para catla, 1,73g para rohu e 1,67g para mrigal. Os valores médios de peso mensal novamente e crescimento médio diário apresentaram diferenças significativas entre os tratamentos. O crescimento foi maior *em C. mrigala* no caso de 25% e 45% e *L. Rohita*, no caso de 35% de farinha de peixe. A TCA mínima foi obtida por dietas à base de 25% FM como 3,53 ± 0,41 seguido por 45% (3,82 ± 0,33) e 35% (4,05 ± 0,45). Os resultados desta pesquisa determinam o nível ideal de farinha de peixe e sua eficácia como um ingrediente importante nas dietas das principais carpas indianas. Assim, demonstrando que uma ração com combinação de proteína animal e vegetal é preferível para as carpas do que uma ração com maior concentração de farinha de peixe.

**Palavras-chave:** farinha de peixe, carpas, piscicultura, policultura, proteína.

## 1. Introduction

In the preceding fifteen years, production of cultured fishery has more than twice, worldwide. In order to sustain the existing level of per capita consumption, worldwide aquaculture industry will have to attain 80 million tones by 2050 (Tacon et al., 2006). Aquaculture is a dynamic approach to make a considerable input to this growing demand of aquatic food in the world (Naylor et al., 2000).

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A successful fish culture depends on well management of feed. Fish require sufficient nutrition to obtain optimal growth. In intensive fish culture, fish density completely relays on artificial feed (Jhingran, 1991).The quality of feed has a prominent impact on growth, feed conversion ratio and proximate profile of fish (Jena et al., 1998; Hassan et al., 1996).

Almost 67% of total freshwater fish yield contributed by Indian major carps *Catla catla, Labeo rohita and Cirrhinus mrigala* (FAO, 2001) and with a highest demand and acceptability, are the main commercial fishes of Pakistan. Although carp farming is extensively practiced in Asia, the non- accessibility of appropriate and reasonably priced compound feed to fulfill the dietary requirements of the species still remains a chief limitation (Guo et al., 2013).

By addition of fishmeal in diets, feed efficiency is enhanced through improved feed palatability, better nutrient uptake, enhanced digestion and assimilation. High-quality fishmeal supplies a balanced quantity of all essential amino acids, fatty acids and phospholipids vital for best development and optimal growth (Lie, 2001). Inclusion rates of fishmeal have been comprehensively reduced in fish and crustacean diets to decrease the cost of feed, over the past decade (New and Wijkström, 2002).

Rajbanshi et al. (1989), Alam et al. (1996), Hassan et al. (1996), Cho et al. (2001), Khan et al. (2004), Ali and Salim (2004), Biswas et al. (2006), Abidi and Khan (2007), Bashir et al. (2010) and Guo et al. (2013) have been previously worked out on feeding of carps. The aim of present study was to determine the optimum fish meal requirement of carps Catla, Rohu and Mori in intensive farming and to compare the effects of varying level of fish meal on growth through evaluation of feed conversion ratio (FCR),specific growth rate (SGR), and proximate composition of fish flesh. This work has been quite useful to convey comprehensive information for the progression of polyculture of carps.

## 2. Materials and Methods

### *2.1. Experimental design and feed formulation*

All trials were carried out in triplicates to minimize chances of errors. The fingerlings of *Cirhinus mrigala, Labeo rohita* and *Catla catla* were reared into raceways with the dimension 22′×50′ (W×L) for a period of one year in a proportion of 34:33:33 fish/ raceway correspondingly by following Wahab et al. (2002). The initial weights and lengths were recorded as 31.70 ± 4.40g/176.18 ± 3.83mm for *Catla catla,* 28.20 ± 9.30g/167.1 ± 13.9mm for *Labeo rohita and* 53.33 ± 9.07g/ 206.8 ± 23.2mm for *Cirhinus mrigala.* The fingerlings were deprived off food for 48 hours to empty gut.

Three different inclusions of fishmeal were used in experimental diets (25%, 35% and 45%). Test diet-1 (25% fish meal), test diet-2 (35% fishmeal) and test diet -3 (45% fishmeal), were formulated by mixing of test ingredient i.e. fish meal with rice polish, corn gluten meal and canola oil (Table 1). Because of the increasing protein level some supplementary components varied among the experimental diets in accordance with protein concentration. Ingredients were ground, mixed and pelletized. Dried pellets were then kept for 24 hours at room temperature and then stored in freezer. The temperature of water throughout the experimental trial ranged from 10.2°C to 30.5°C. Range of pH was 7.9 - 8.4, while the range of dissolved oxygen was observed within 5.1-8.4 mg/l.

**Table 1.** Ingredient percentages and their proximate values per 100 gram of experimental diets.

| | Level of FM* | | |
|---|---|---|---|
| | **25%** | **35%** | **45%** |
| **Ingredients (%)** | | | |
| Fish meal | 25 | 35 | 45 |
| Rice polish | 63.83 | 38.30 | 14.00 |
| Corn gluten meal | 1.16 | 16.69 | 30.98 |
| Canola oil | 4.5 | 4.5 | 4.5 |
| Starch | 5 | 5 | 5 |
| Vitamins and mineral mixture | 0.5 | 0.5 | 0.5 |
| **Proximate profile (%)** | | | |
| Crude protein | 24.99 | 35.2 | 44.98 |
| Crude fat | 15.19 | 12.74 | 10.42 |
| Crude fiber | 2.56 | 2.48 | 2.38 |
| Ash | 13.7 | 13.42 | 13.25 |
| Nitrogen –free extract | 42.99 | 35.6 | 28.39 |
| DE (K cal/Kg) | 3109.9 | 3186.4 | 3263.4 |
| GE (K cal/Kg) | 4520.4 | 4554.3 | 4587.6 |

*FM = Fish meal.

Feed was given manually at the rate of 3% body weight twice daily (Dada et al., 2002). The amount of experimental diets was calculated as Daily feed allowance (DFA) by Formula 1.

$$DFA = ABW \times Number\ of\ stocks \times \%\ survival \times FR \quad (1)$$

ABW=average body weight
FR=Feeding rate

### *2.2. Estimation of feed response*

To monitor growth pattern of carps and to calculate daily feed allowance, wet body weight was measured on monthly basis. Fish were captured randomly after the end of each month and weighed individually and then released back into the respective raceway. After every month increase in body weight was calculated. Weight gain, specific growth rate (SGR), feed conversion ratio (FCR), survival rate, and digestible energy/Protein ratio were investigated monthly throughout the feeding trial by following Khan et al., (2004).

### *2.3. Nutrient analysis of flesh*

According to The Association of Official Analytical Chemist (AOAC, 2005), proximate composition of cultured fishes was find out in terms of carbohydrate, crude protein, crude fat, moisture and ash.

*2.4. Statistical analysis*

Statistical analysis of data was performed from MINTAB release 17. To confirm the associations among variables, Two-way analyses of variance were performed. Fisher's least-significant-difference test (LSD) was also performed to compare mean values of different parameters.

## 3. Results

Results of one year feeding trial on carps have been figured out in Table 2. Average weight was increased linearly in all Indian major carps (*Labeo rohita, Cattla cattla, Cirhinus mrigala*) by feeding with varying level of fishmeal along with some plant ingredients. It is evident that highest average daily growth was observed by 25% fishmeal diet (2.18g, 2.19g and 2.34g for catla, rohu and mrigal respectively), whereas 35%fishmeal based diet was next by showing 1.63g ADG for catla, 1.73g for rohu and 1.67g for mrigal. Diet with 45% fish meal ranked third with respect to the monthly weight gain and average daily growth (1.21g, 1.25g and 1.49g for catla, rohu and mrigal correspondingly). Mean values for monthly weight again and average daily growth showed significant differences among treatments. Growth was found to be higher in *C. mrigala* in case of 25% and 45% and *L. rohita* in case of 35% fishmeal. Minimum FCR was obtained by 25% FM based diets as 3.53±0.41 followed by 45% (3.82±0.33) and 35% (4.05±0.45). Survival rate was 80% which was not significantly different among all dietary treatments.

Two-way analysis of variance against levels of fishmeal and months has been illustrated in Table 3. Significant differences were observed among weight of all species of carps against months and level of fishmeal except in *C. mrigala* which showed a non-significant relation with level of fishmeal. The values of daily feed allowance and feed conversion ratio were also showed a highly significant relationship with months and level of fishmeal whereas Specific growth rate of all three species of carps was not significantly differ among all levels of fishmeal.

Regression has been done between daily feed allowance (DFA) and increase fish yield (IFY) (Table 4). All treatments (Levels of fishmeal) showed a significant relation between fish yield and daily feed allowance.

In terms of nutrient profile (Table 5), similarities were observed in all treatments and in all carps. The percentage of moisture differed significantly in treatments; while fat, carbohydrate, crude protein, and ash were respond non-significantly.

## 4. Discussion

Protein is crucial to obtain optimized fish biomass. Because of varying dietary protein requirements, different fishes require specific nutrients which may fluctuate with weight, maturity, and stress, as the protein and amino acid balance supplies energy and amplify growth.

A gradually decreasing pattern of growth was observed by increasing the level of fish meal which confirms the optimum dietary requirement of these carps (Table 2). It was observed by the results of these experimental trials that the optimum dietary fishmeal requirement is 25% for carps in polyculture. It proves that a feed by the combination of animal and plant protein is much preferable by carps as compare to a feed with augmentation of fish meal in higher concentration. Combine intake of animal and vegetable proteins may improve absorption of protein in carps and build muscles.

Mohsen and Lovell (1990) performed two different indoor feeding trials on fingerlings of channel catfish *(Ictalurus punctatus*). They used menhaden fish meal in the inclusion of 5, 10, 20 and 40% into basal diet in first experiment and obtained an increase of up to 20% ($P<0.05$) in weight, muscles protein and fat. In the second experiment, a mixture of bone and blood meal with a ratio of 60:40 was added in diet. Fish meal produced better growth over isonitrogenous levels of other animal protein.

By the analysis of growth performance among these three species of carps, it was revealed that mrigal showed a higher growth as compare to rohu and catla in all treatments except in 35% FM based diet where rohu ranked first in terms of growth. According to preferred food nich *Catla catla* is a surface feeder, while *Labeo rohita* and *Cirhinus mrigala* are column and bottom feeders correspondingly. Accumulation of a large amount of uneaten feed at the bottom of the raceway could be one of the possible reasons for this specific pattern of growth of mrigal. Rohu came next to the mrigal in terms of growth of individual specie. Jena et al. (1998) also observed similar pattern of growth in their feed trail for these three carps.

The value of FCR ranged from 3.53 to 4.05 in all these treatments. Similar observations were also reported for *Labeo rohita* by Ali and Salim (2004). Although no considerable variations were established among mean value of FCR and SGR but tese values were increased by increasing the level of fishmeal except in case of FCR and SGR of *C. mrigala* when fed 45% FM based diet (Table 3). It was also revealed that 25% FM based diet had higher DE/P ratio as compared to 35% FM diet and 45% FM diet. Due to the high utilization of high protein diet, 45% FM based diet showed the lowest DE/P ratio (Kim et al., 1991; Santinha et al., 1996). When a high protein diet is given to the fish, a high percentage of protein is used to obtain energy. High protein diet produced high amount of ammonia also in excreta. Muscles composition of all fish species was greatly altered by the concentration of dietary protein in diet.

Apart from environmental factors and fish husbandry practices, feeding rate is the most critical factor that affecting FCR (Cole and Boyd, 1986). In term of nutrient profile no significant differences were observed among all levels of FM. All species did not show any specific trend in relation to concentration of FM (Table 5). The percentage of moisture differed significantly in treatments. An inverse relationship was existed between protein and fat in all species. Rohu was fond to be superior owing to higher protein and fat and low moisture. These results coincide with the findings of Nandeesha et al. (2001).

Fishmeal contains balanced profile of amino acids which is the possible reason for better growth of fish on fishmeal. Ali and Salim (2004) also recommended fishmeal

**Table 2.** Values of different growth variables for observed carps fed with experimental diets.

| Level of *FM | | 25% | | | 35% | | | 45% | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | *C. catla* | *L. rohita* | *C.mrigala* | *C. catla* | *L. rohita* | *C.mrigala* | *C. catla* | *L. rohita* | *C.mrigala* |
| weight (g) | Initial | 36.11 | 18.90 | 44.25 | 36.11 | 18.90 | 44.25 | 27.31 | 37.52 | 62.51 |
| | Day 122 | 190.23 | 146.30 | 185.89 | 195.15 | 213.41 | 199.34 | 105.50 | 126.71 | 186.42 |
| | Day 242 | 339.84 | 303.08 | 338.74 | 335.71 | 361.68 | 331.54 | 224.77 | 283.94 | 367.09 |
| | Day 365 | 823.14 | 813.85 | 889.14 | 623.42 | 645.14 | 648.71 | 466.43 | 490.50 | 599.30 |
| | Monthly WG[1] | 65.6 ±13.3a | 66.0 ±14.3a | 70.4 ±15.6a | 48.94 ±6.4ab | 52.19 ±5.11ab | 50.37 ±6.7ab | 36.59 ±5.5b | 37.68 ±3.9b | 44.73 ±4.1ab |
| % Survival[2] | | 80 | 80 | 80 | 80 | 80 | 80 | 80 | 80 | 80 |
| ADG (g/day)[3] | | 2.18a | 2.19ab | 2.34b | 1.63a | 1.73ab | 1.67b | 1.21a | 1.25ab | 1.49ab |
| SGR (%/day)[4] | | 0.37 ±0.09a | 0.34 ±0.10a | 0.34 ±0.04a | 0.45 ±0.10a | 0.42 ±0.15a | 0.31 ±0.03a | 0.36 ±0.05a | 0.32 ±0.07a | 0.27 ±0.03a |
| FCR[5] | | | 3.53±0.41a | | | 4.05±0.45a | | | 3.82±0.33a | |
| Individual harvested weight (g) | | 21401.6 | 21160.1 | 24006.7 | 16208.9 | 16773.6 | 17515.1 | 12126.4 | 12753.0 | 16181.1 |
| Percent individual contribution at harvest (%) | | 32.14 | 31.75 | 36.06 | 32.09 | 33.21 | 34.68 | 29.53 | 31.05 | 39.40 |
| Total harvested weight (Kg per treatment) | | | 66.5684 | | | 50.4976 | | | 41.0605 | |
| Total fish production Kg/hectare/year | | | 665.684 | | | 504.976 | | | 410.605 | |

Values are means ± SE of three replicates. Significantly different value of mean (at $P = 0.05$) in a row was represented by different letter. *FM = Fish meal. [1]Monthly weight gain (WG) (g) = Final value of growth variable – Initial value of growth variable. [2]%Survival = Number of fishes X 100 / Number of fishes stocked. [3]Average daily gain (ADG) (g/day) = weight gain/number of days. [4]Specific growth rate (SGR) (%/day) = Log Fish final weight – Log Fish initial weight / Time X 100. [5]Feed conversion ratio (FCR) = Weight of food presented/Weight of animal gained.

**Table 3.** Two-way ANOVA against inclusion of Fish meal (treatments) and months.

| Variables | Weight (g) | | | DFA[1] (g) | SGR[2] (%/day) | | | FCR[3] |
|---|---|---|---|---|---|---|---|---|
| | *C. catla* | *L. rohita* | *C. mrigala* | | *C. catla* | *L. rohita* | *C. mrigala* | |
| Levels of FM | 0.000** | 0.002** | 0.189* | 0.000** | 0.782* | 0.251* | 0.054* | 0.348* |
| Months | 0.000** | 0.000** | 0.000** | 0.000** | 0.000** | 0.000** | 0.000** | 0.000** |

[1]Daily feed allowance (DFA) (g) = Average body weight x Num of stocks x % survival x Feeding rate [2]Specific growth rate (SGR) (%/day) = Log Fish final weight – Log Fish initial weight / Time X 100. [3]Feed conversion ratio (FCR) = Weight of food presented/Weight of animal gained. FM = Fishmeal. * = Non significant ** = Significant

**Table 4.** Regression analysis of Daily feed allowance (DFA) on increase fish yield (IFY).

| Diet | Regression equations | R-Sq | R-sq (adj) | Prob. |
|---|---|---|---|---|
| FM 25% | IFY = - 21.00 + 0.3284 DFA | 86.7% | 85.4% | 0.000** |
| FM 35% | IFY = 71.51 + 0.1207 DFA | 47.4% | 42.1% | 0.013** |
| FM 45% | IFY = 47.45 + 0.1344 DFA | 84.8% | 83.2% | 0.000** |

FM = Fish meal. ** = Significant.

**Table 5.** Proximate values of experimental carps fed with fish meal based test diets.

| Level of FM* | | Moisture % | Crude Protein % | Crude Fat % | Carbohydrate % | Total Ash % |
|---|---|---|---|---|---|---|
| **25%** | ***Catla catla*** | 78.23ab | 16.50a | 1.94a | 1.52a | 1.81a |
| | ***Labeo rohita*** | 76.76ab | 17.54a | 2.25a | 1.60a | 1.57a |
| | ***Cirhinus mrigala*** | 78.44ab | 17.33a | 1.89a | 0.19a | 2.14a |
| | **Mean** | **77.81** | **17.12** | **2.02** | **1.10** | **1.84** |
| **35%** | ***Catla catla*** | 78.60ab | 16.88a | 2.05a | 1.33a | 1.14a |
| | ***Labeo rohita*** | 76.18b | 17.82a | 1.95a | 2.56a | 1.42a |
| | ***Cirhinus mrigala*** | 77.20ab | 17.54a | 2.01a | 1.42a | 1.70a |
| | **Mean** | **77.32** | **17.41** | **2.00** | **1.77** | **1.42** |
| **45%** | ***Catla catla*** | 76.52ab | 17.23a | 2.65a | 1.84a | 1.71a |
| | ***Labeo rohita*** | 79.48a | 16.31a | 1.90a | 0.65a | 1.65a |
| | ***Cirhinus mrigala*** | 77.69ab | 16.91a | 1.60a | 1.23a | 2.34a |
| | **Mean** | **77.89** | **16.81** | **2.05** | **1.24** | **1.9** |

Significantly different value of mean(at $P = 0.05$) in a column was represented by different letter. *FM = Fish meal.

and sunflower meal in fish feed as suitable and compatible ingredients for the growth of *Labeo rohita* fingerlings.

The findings of this research trial determine the effectiveness of fishmeal as an important ingredient in fish diets of Indian major carps and optimum dietary level of fishmeal for carps.

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