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Comparative Study of Plant Based Isoproteinous Diets on the Growth Performance of *Labeo rohita* and *Catla catla* Fingerlings

Shri Kant Yadav [a], Tejpal Dahiya [b], Anshika Pathak [c++*], Shubham Kanaujiya [c++], Shankar Lal Yadav [d] and Mitrasen Maurya [e]

[a] Department of Aquaculture, COFS, CCS Haryana Agriculture University, Hisar-125004, India.
[b] Department of Zoology, COBS & H, CCS Haryana Agriculture University, Hisar-125004, India.
[c] ICAR- NBFGR, Lucknow- 226022, India.
[d] Department of Fisheries Resource Management, COFS, CCS Haryana Agriculture University, Hisar-125004, India.
[e] Department of Aquaculture, ANDUAT, Kumarganj, Ayodhya- 224229, India.

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

The present study was carried out to compare the effect of different plant based protein on the growth performance of *Labeo rohita* and *Catla catla* fingerlings. The experiment was designed as two experimental diets and one control group. Control groups contains (Mustard oil cake + Rice

[++] *Research scholar;*
**Corresponding author: E-mail: anshikaaqua111@gmail.com;*

bran) whereas, experimental diets T1 (Soybean meal + Corn flour) and T2 (Groundnut meal + Wheat flour), both formulated by using the Pearson square method to maintain protein content of 35%. The result showed that, the best survival and growth performances including SGR, FCR and PER was found in treatment T1(Soybean meal + Corn flour) as compared to other treatments. The findings suggested that the inclusion of Soya bean meal along with Corn flour in the diet led to superior fish growth and overall fish production compared to other plant-based feed ingredients investigated in this study. These results contributed valuable insights into optimizing plant-based diets for enhancing the growth and production efficiency of *L. rohita* and *C. catla* fingerlings during aquaculture operations.

Keywords: SGR (specific growth rate); FCR (feed conversion ratio); PER (protein efficiency ratio); EC (electrical conductivity).

1. INTRODUCTION

Aquaculture is the farming of aquatic animals in controlled aquatic environments. It is a rapidly growing industry, showing average increase of 6.7% per year in global aquaculture production since 1990 to 2020.Aquaculture is an important source of food, providing 49% of the world's fish supply. The Indian aquaculture sector is one of the fastest growing sectors in the world [1]. In 2021-22, the sector produced 16.24 million tonnes of fish, of which 12.12 million tonnes came from inland sector which is predominantly propelled by aquaculture sector. This represents a growth of 400% since 2000-01, when inland production was just 2.82 million tonnes [2].

Feed is the most important input in aquaculture, accounting for up to 60% of total production costs [3]. The quality and quantity of feed have a major impact on the growth, health, and reproduction of fish. Traditionally, fishmeal and fish oil have been the primary ingredients in commercial fish feeds, but these resources are becoming increasingly scarce and unsustainable due to overfishing and competition from the human food market. In this case, plant-based feeds offer a sustainable and alternative to fishmeal and fish oil [4]. Plant-based feed ingredients encompass a diverse array of sources, including soybeans, sunflower, and other legumes and oilseeds. These ingredients are rich source of protein, essential amino acids, and other nutrients crucial for the growth and health of farmed fish [5]. The utilization of plant proteins in aquafeeds not only addresses concerns related to the overexploitation of marine resources but also mitigates the environmental impact associated with the production of fishmeal. Furthermore, the cultivation of plant-based ingredients for aquafeeds often demands less environmental resources, such as water and land, contributing to a more sustainable and efficient aquaculture system [4]. Beyond their nutritional benefits, plant-based feeds play a pivotal role in reducing the overall carbon footprint of aquaculture operations, promoting a shift towards eco-friendly practices [6]

Certain plant protein sources offer high-quality protein content, yet they are accompanied by anti-nutritional factors like phytic acid, gossypol, and tannins, which can potentially impede growth performance and protein utilization in animals. Groundnut cake (GNC) is renowned for its excellent palatability and superior binding properties for pelleting compared to soybean meal [7].

Currently, the most commonly used plant protein supplement in an aquaculture operation is soybean meal, due to its high nutritional value, cost effectiveness and availability of essential amino acids in balanced form [8]. However, the success of soybean meal substitution has exhibited variability. Numerous studies have proposed the partial replacement of fish meal with soybean meal, reaching substitution rates of up to 60%, or alternatively incorporating its by-products [9]. The viability of such substantial substitutions is attributed to the favorable protein and amino acid contents of soybean meal, coupled with its commendable digestibility and palatability characteristics. These factors collectively contribute to its widespread application in aquaculture as a key component in formulating nutritionally balanced and sustainable feeds [10,11].

The choice of plant protein sources in aquafeeds is a multifaceted decision, influenced by factors such as nutritional composition, availability, cost-effectiveness, and the specific dietary

preferences of the target species. *L.rohita* and *C.catla*, being prominent freshwater carp species in aquaculture, present an intriguing comparative context for investigating the influence of diverse plant proteins on their growth performance. By examining the physiological responses of these two species to different plant-derived ingredients, this research aims to provide valuable insights into optimizing feed formulations for enhanced growth and overall productivity.

2. MATERIALS AND METHODS

The study employed a 45-day experimental design to evaluate the effects of three different feeding treatments on the growth and survival of *L. rohita* and *C. catla* fingerlings.

2.1 Experimental Design

45 days experimental study was carried out in wet laboratory of College of fisheries, CCSHAU, Hisar, the primary objective of current study was to evaluate the effect of three different feeding treatments on growth and survival of *L. rohita* and *C. catla* fingerlings. The experimental setup involved the use of nine glass aquarium tanks, each measuring 1.5×0.6×0.6 m^3. The experiment was designed as a Completely Randomized Design (CRD), ensuring a randomized and unbiased allocation of treatments to the tanks. During the experimentation dissolve oxygen was maintained in each glass aquarium by using aerators. Any kind of organic and inorganic fertilizers was not applied to any treatment tanks during the experimental period.

2.2 Experimental Procedure

Fingerlings of *L. rohita* and *C. catla* were procured from a local fish hatchery and fish farm. The collected fingerlings underwent a one-week acclimatization period before being stocked in aquariums. The stocking density employed was 10 fish per aquarium, maintaining a balanced ratio of 50% *L. rohita* and 50% *C. catla*, creating a 1:1 proportion. Throughout the experimental period, the fishes were subjected to a feeding regimen equivalent to 5% of their body weight. The feeding routine was divided into three parts, with 40% of the total daily feed distributed in the morning between 7 am and 8 am, followed by 20% in the afternoon between 1 pm and 2 pm, and the remaining 40% in the evening between 6 pm and 7 pm.

2.3 Experimental Diets

In current study, three isoproteinous diets were meticulously formulated to investigate their impact on fish growth and survival. The dietary compositions for each treatment were as follows: Control group, comprised conventional fish feed ingredients such as Mustard oil cake and Rice bran, with a percentage proportion of (79.70 + 20.3). Treatment T1 consisted of a blend of Soybean flour and Corn flour with a percentage proportion of (66.5 + 33.5) and Treatment T2 featured Groundnut meal and Wheat flour with a percentage proportion of (69.4 + 30.60). To prepare the pellet feed, all the ingredients were finely powdered, thoroughly mixed, and then sieved to ensure a homogeneous and consistent composition. Proximate compositions of the ingredients used in the formulated diets are presented in Table 2.

Table1. Ingredients composition of the experimental feed

Treatment	Ingredient	Percentage
Control	Mustard oilcake+ Rice bran	79.70 +20.3
T1	Soybean meal+ Corn flour	66.5+33.5
T2	Groundnut meal +Wheat flour	69.4+30.60

Table 2. Proximate composition of feed Ingredients

Feed ingredient	Protein (%)	Lipid (%)	Ash (%)	Fiber (%)
Mustard oil cake	28.86	6.64	15.13	8.23
Rice bran	10.85	2.74	11.87	9.87
Soybean meal	48.8	1.37	6.42	5.67
Groundnut meal	43.8	9.4	5.25	6.6
Wheat flour	15.04	5.23	2.72	6.81
Corn flour	7.04	5.01	1.1	1.0

2.4 Proximate Composition Analysis

The proximate composition of feed ingredients was analyzed before and after formulating the feed. Samples of whole fish were analyzed after the end of the experiment. Following methods were used to analyze the proximate composition.

a. Moisture content: By drying the sample (about 5 gm for feed and whole fish carcass) in an oven at 90-105ºC for 24 hours (AOAC, 2000).
b. Crude Protein: Kjeldahl method. Nitrogen content was multiplied by factor 6.25 (AOAC,2000).
c. Crude Lipid: Lipid of about 2 gm samples was extracted by petroleum ether (Boiling point 60 to 80ºC) in a soxhlet system for 1:30hrs (AOAC, 2000).
d. Crude fibre: Determination by acid and alkali digestion in Fibertech system (AOAC, 2000).
e. Ash content: 550ºC in Muffle furnace for 6 hours (AOAC, 2000)

2.5 Growth Parameters

The various growth parameters viz. DWG, ADG, FCR, SGR, PER, feed acceptability and survival rate etc. and percentage length measurement, percentage weight measurement, total weight gain, initial minimum length, initial minimum weight, initial maximum length, initial maximum weight, final maximum weight, final maximum length, final mean body weight and final mean body length were recorded and evaluated from the given formulae.

a) Average daily weight gain (ADWG) =

$$\frac{\text{Mean final weight (g)} - \text{Mean initial weight(g)}}{\text{Culture days}}$$

b) Feed conversion ratio (FCR)=

$$\frac{\text{Total dry feed intake (g)}}{\text{Total live weight(g)}}$$

c) Protein Efficiency Ratio (PER) =

$$\frac{\text{Total weight gain (g)}}{\text{Total protein intake(g)}}$$

d) Specific growth rate (SGR)=

$$\frac{\ln(\text{final weight})\text{g} \times \ln(\text{Initial weight})\text{g}}{\text{No. of days}} \times 100$$

e) Survival rate (%) =

$$\frac{\text{Final number of fishes}}{\text{Initial number of fishes}} \times 100$$

2.6 Water Quality Parameters

Water temperature, dissolved oxygen, pH, and conductivity were measured on a daily basis, whereas total alkalinity, chloride content, total hardness, and calcium hardness were measured weekly. Water temperature was measured using comet Borosilicate glass mercury thermometer. While, pH and electrical conductivity were determined using pH strip and a portable TDS conductivity meter (Microprocessor COND - TDS - SAL Meter LT – 51) respectively. Dissolved oxygen was measured by Winkler's method with azide modification. Total alkalinity, total hardness, salinity, nitrite and nitrate were measured by phenolphthalein indicator, titration, Microprocessor COND-TDS-SAL meter (LT-51-LABTRONICS MAKE) and colorimetric method respectively.

2.7 Statistical Analysis

All statistical analysis was performed using Statistical analysis OPSTAT. Bar diagram and graphs were made in Micro-soft Excel 2007. Statistical analysis was carried out using one way, frequencies, percentages, averages and chi-square and ANOVA analysis of variance. Probability levels of 0.05 were used to find out the significance in all cases.

3. RESULTS AND DISCUSSION

3.1 Growth Parameters

3.1.1 Survival rate

Survival rate of fishes was 100 percent in control and T1treatment for *L. rohita* and *C. catla* where as in treatment T2, 93.33% survival rate was observed as shown in Tables 3 and 4.

Table 3. Survival rate (%) of *L. rohita* in different treatments

Treatment	Initial	8th day	15th day	22th Day	29th Day	36th day	45th day	Survival Rate (%)
C	5	5	5	5	5	5	5	100
T_1	5	5	5	5	5	5	5	100
T2	5	5	5	5	5	5	4	80

Table 4. Survival rate (%) of *C.catla* in different treatments

Treatment	Initial	8th Day	15th Day	22th Day	29th Day	36th Day	45th Day	Survival Rate (%)
C	5	5	5	5	5	5	5	100
T_1	5	5	5	5	5	5	5	100
T_2	5	5	5	5	5	5	5	100

3.1.2 Daily average weight gain

As shown in Tables 5 and 6 highest average daily weight gain in *C. catla* (0.18±0.005 g) and *L. rohita* (0.12±0.005 g) was found in treatment T1 and lowest (0.11±0.006 g) for *C.catla* and (0.09±0.008 g) for *L. rohita* in the control treatment at the end of experiment.

3.1.3 Feed conversion ratio (FCR)

In this experiment as shown in Table 7 recorded FCR value for *L. rohita* and *C. catla* during different days was found lowest (1.50±0.02) in treatment T1 and it was found gradually increased in treatment T2 whereas highest FCR value was recorded in control treatment.

3.1.4 Specific growth rate

The highest value of SGR for *C. catla* was (2.81±0.13g) recorded in treatment T1 whereas lowest SGR value (2.16±0.14g) was found in control treatment. Similarly,in case of *L. rohita* it was found maximum (2.50±0.10g) in treatment T1 and minimum (2.02±0.11g) in control treatment as shown in Tables 8 and 9.

3.1.5 Protein efficiency ratio

The PER value for *C. catla* was found highest (0.38±0.02) in treatment T1, followed by (0.33±0.09) in treatment T2, and lowest (0.29±0.05) in the control treatment similarly in case of *L. rohita*, it was recorded highest (0.31±0.02) in treatment T1, followed by (0.29±0.06) in treatment T2, and lowest (0.28±0.07) in the control treatment as shown in Tables 10 and 11.

3.1.6 Feed acceptance

The feed acceptance of different treatments was calculated and it was observed that Soybean meal i.e., T1 has highest feed acceptability whereas it was lowest for control as mentioned in Table 12.

Table 5. Average daily weight gain (g) of *C. catla* in different treatments

Treatment	Number of days					
	8th	15th	22nd	29th	36th	45th
Control	0.07±0.02	0.08 ±0.003	0.09 ±0.004	0.10 ±0.004	0.11 ±0.003	0.11 ±0.006
Soybean meal (T_1)	0.11±0.02	0.12 ±0.009	0.14 ±0.007	0.15 ±0.007	0.17 ±0.005	0.18 ±0.005
Groundnut oil cake (T_2)	0.08±0.03	0.10±0.02	0.11±0.01	0.12±0.01	0.13±0.01	0.14 ±0.005
CD(P=0.05)	N/S	N/S	0.027	0.034	0.036	0.018

Table 6. Average daily weight gain (g) of *L. rohita* in different treatments

Treatment	Number of days					
	8th	15th	22nd	29th	36th	45th
Control	0.05 ±0.015	0.06 ±0.001	0.06 ±0.004	0.07 ±0.007	0.08 ±0.004	0.09 ±0.008
Soybean meal(T_1)	0.07 ±0.005	0.08 ±0.014	0.09 ±0.008	0.11±0.07	0.12 ±0.006	0.12 ±0.005
Groundnut oil cake (T_2)	0.06 ±0.009	0.07 ±0.007	0.08 ±0.013	0.09 ±0.007	0.10 ±0.005	0.10 ±0.006
CD(P=0.05)	N/S	N/S	N/S	0.112	0.083	0.117

N/S =Non significant, (Mean± S.E.)

Table 7. Feed conversion ratio during different treatments in different fish

(Polyculture)	Treatments	FCR
L. rohita* and *C.catla	Control	1.973±0.14
	Soybean meal(T_2)	1.507±0.02
	Groundnut cake(T_3)	1.76±0.07

Table 8. Specific growth rate (g) of *C. catla* in different treatments

Treatment	Number of days					
	8th	15th	22nd	29th	36th	45th
Control	2.32±0.73	2.30±0.23	2.31±0.24	2.29±0.13	2.31±0.18	2.16±0.14
Soybean meal (T_1)	3.13±0.75	3.08±0.31	3.06±0.23	3.01±0.09	3.01±0.15	2.81±0.13
Groundnut oil cake (T_2)	2.39±0.84	2.57±0.58	2.57±0.23	2.56±0.23	2.58±0.27	2.41±0.09
CD(P=0.05)	N/S	N/S	N/S	N/S	N/S	0.44

Table 9. Specific growth rates (g) of *L. rohita* in different treatments

Treatment	Number of days					
	8th	15th	22nd	29th	36th	45th
Control	1.97±0.56	2.02±0.10	2.06±0.16	2.11±0.18	2.16±0.10	2.02±0.11
Soybean meal(T_1)	2.50±0.24	2.56±0.45	2.66±0.24	2.73±0.15	2.71±0.11	2.50±0.10
Groundnut oil cake(T_2)	2.24±0.25	2.33±0.15	2.35±0.25	2.38±0.12	2.41±0.06	2.24±0.09
CD(P=0.05)	N/S	N/S	N/S	N/S	0.339	0.369

N/S=Nonsignificant, (Mean±S.E.)

Table 10. Protein efficiency ratio of *C.catla* in different treatments

Treatment	Number of days					
	8th	15th	22nd	29th	36th	45th
Control	0.29±0.09	0.28±0.03	0.28±0.03	0.27±0.04	0.29±0.06	0.29±0.05
Soybean meal (T_1)	0.40±0.11	0.39±0.09	0.38±0.02	0.36±0.06	0.39±0.07	0.38±0.02
Groundnut oil cake(T_2)	0.30±0.11	0.35±0.08	0.32±0.07	0.31±0.05	0.34±0.4	0.33±0.09
CD(P=0.05)	N/S	N/S	N/S	N/S	N/S	N/S

N/S =Non significant, (Mean± S.E.)

Table 11. Protein efficiency ratio of *L. rohita* in different treatments

Treatment	Number of days					
	8th	15th	22nd	29th	36th	45th
Control	0.24±0.07	0.25±0.04	0.26±0.03	0.28±0.05	0.29±0.09	0.28±0.07
Soybean meal (T_1)	0.31±0.03	0.33±0.09	0.36±0.03	0.37±0.03	0.33±0.009	0.31±0.02
Groundnut oil cake (T_2)	0.27±0.034	0.30±0.02	0.30±0.08	0.31±0.06	0.31±0.02	0.29±0.06
CD(P=0.05)	N/S	N/S	N/S	N/S	N/S	N/S

N/S =Non significant, (Mean± S.E.)

Table12. Feed acceptance

Control (C)	Quantity (g)	Soybean meal (T1)	Quantity (g)	Groundnut oil cake (T2)	Quantity (g)
Totalfeedgiven	365.04	Totalfeedgiven	415.98	Totalfeedgiven	387.62
Feed residue	18	Feed residue	9	Feed residue	14
Feedacceptability	95.07	Feedacceptability	97.84	Feedacceptability	96.39

3.1.7 Proximate composition of different treatments

Three isocaloric and isonitrogenous diets were prepared with the help of Pearson square method. The proximate analysis of different feed i.e., control, T1 and T2 were done and it was recorded that the crude protein (CP) % of control, T1, T2 was 34.01%, 34.50% and 34.20% respectively. The moisture content of control, T1, T2 was 8.85%, 6.11 and 7.25% respectively as shown in Table 13. The fat content of control, T1, T2 was 6.7%, 6.5% and 6.3% respectively. The crude fibre content of control, T1, T2 was 10.0%, 7.90%, and 7.06 respectively. While the composition of ash for control, T1, T2 was 9.16%, 8.49% and 6.74 respectively.

3.1.8 Physico-chemical parameters of water

In the context of carp culture, the water quality parameters across various treatments consistently maintained optimal levels, as illustrated in Table 14. The temperature exhibited a range of 27 to 29°C, while dissolved oxygen levels fluctuated between 6.5 and 7.3 mg/l. The

pH of the water ranged from 7.5 to 7.8, and alkalinity was observed within the range of 112.76 to 138.38 mg/l. Hardness values varied between 146.28 and 164.88 mg/l, and total dissolved solids (TDS) were recorded in the range of 126.88 to 140.52 mg/l. Ammonia concentrations remained within the narrow range of 0.03 to 0.07, and salinity levels were noted between 0.25 and 0.29 ppt.

3.1.9 Economics of feeding

The cost of feed production (Rs kg-1) was calculated for Control, T1 and T2 treatments, the observed values were Rs. 39.30 kg-1, Rs. 61.30 kg-1 and Rs. 54.10 kg-1 respectively. Which are depicted in Tables 14, 15 and 16. The FCR (Table 9) of Control (1.97), T1 (1.5) and T2 (1.76) was observed in polyculture as well as cost of production for each kg of fish was Rs 77.42, 91.95 and 96.83 for Control, T1 and T2 respectively.

A healthy and thriving fish population is the main goal of aquaculture operations, and it depends on the proper nutrition which is given to animals being cultivated. The most important source of nutrition for fish raised in intensive and semi-intensive cultures is exogenous feed that contains minerals, vitamins, and other necessary nutrients. The raw material which is used in fish feed formulations should be easily digested, palatable, and highly nutritious. Because of its high nutritional value and palatability, fishmeal has long been used as a major source of protein in feeds for semi-intensive and intensive fish farming. Nevertheless, fishmeal is costly and not easily available in many countries which necessitated its substitution with easily available plant protein resources. In current years, plant proteins are being mostly used in fish and prawn feeds, mainly to replace the fishmeal component, in order to reduce the feed cost [12]. The extent of plant protein used in fish diet depends on the species, availability, cost and acceptability by fish, presence of nutrient and antinutritional factors [13]. For carp, Singh et al. [14] opined that optimum protein requirements diverge with the protein sources and feed ingredients that are locally available and cheap protein sources should be used to develop a suitable feed. The most favourable replacements of fishmeal in carp diets are oilseed meal i.e. mustard oil cake, linseed meals and sesame meal [15]. Moreover, soybean meals is considered to be the most nutritive plant protein and are used as the major protein source in fish diets [16].

Table 13. Proximate compositions of the pelleted feed

Experimentalfeed	Protein (%)	Moisture (%)	Fat (%)	Fiber (%)	Ash (%)
Control(C)	34.01	8.85	6.7	10.0	9.16
Soybeanmeal(T1)	34.50	6.11	6.5	7.90	8.49
Groundnut oil meal(T_2)	34.20	7.25	6.3	7.06	6.74

Table 14. Cost of feed production in Control feed

Cost of feed production in Control feed				
Ingredients	**(Cost)Rs./kg**	**%inclusion**	**g**	**(Cost) Rs./g.**
Mustardoilcake	**21**	**74.5**	**74.5**	**1.56**
Ricebran	**17**	**13.5**	**13.5**	**0.23**
CMC(Carboxymethyl cellulose)	65	2	2.0	0.13
Vegetableoil	120	8	8.0	0.96
Mineralmixture	50	1	1.0	0.05
Vitaminmixture	**1000**	**1**	**1.0**	**1.00**
Total(g)		**100%**	**100g**	**3.93**

Table15. Cost of feed production in Soybean meal

Costoffeedproductionin Soybeanmeal				
Ingredients	**(Cost)Rs/kg.**	**%Inclusion**	**g**	**(Cost) Rs./g**
Soybeanmeal	**120**	**55**	**55**	**3.0**
Maizeflour	**28**	**33**	**33**	**0.92**
CMC(Carboxymethyl cellulose)	65	2	2	0.13
Vegetableoil	120	8	8	0.96
Mineral mixture	50	1	1	0.05
Vitaminmixture	**1000**	**1**	**1**	**1.00**
		100%	**100g**	**6.13**

Table 16. Cost of feed production in groundnut oil cake

Cost of feed production in ground nut oil cake				
Ingredients	**(Cost) Rs./kg**	**%Inclusion**	**g**	**(Cost) Rs./g**
Groundnutmeal	**45**	**65**	**65**	**2.75**
Wheatflour	**27**	**23.5**	**23.5**	**0.54**
CMC(Carbon-methyl cellulose)	65	2	2	0.13
Vegetableoil	120	8	8	0.96
Mineralmixture	50	1	1	0.05
Vitaminmixture	**1000**	**1**	**1**	**1.00**
Total		**100%**	**100g**	**5.41**

Present study was on the growth of *L.rohita* and *C.catla* under the different plant based isoprotineious diets revealed high average weight gain, SGR, PER and lowest FCR in treatment T1 where fishes were fed with soybean meal and cornflour based diet as compared to other treatment and control groups. The present study showed that the specific growth rate and FCR in *C. catla* and *L. rohita* was influenced by the diet based on different plant protein sources especially Soybean meal along with corn flour-based diet. The reason behind this could be feed acceptance because in treatment T1 residue of feed was 9 gm, whereas in treatment T2 and control residue it was 14gm. and 18gm. Respectively [17,18]. Zahan et al. [19] also observed the increase in final weight, average live weight gain, specific growth rate (SGR), lower food conversion ratio (FCR), protein efficacy ratio (PER), apparent net protein utilization (ANPU%) and survival of fingerlings fed on diet T3, a soybean meal-based diet. This study clearly indicated that soybean flour contain crude protein that made the feed easily digestible and more sustainable than conventional feed diet of mustard oil cake and rice brain (Zlaugotne, 2022) which gives maximum growth performance in case of *C.catla* as well as *L.rohita*..

Latif et al. [20] also reported that mustard oil cake, soybean meal, seasame meal, linseed meal (25:25:25:25) fed to *L. rohita* showed poor growth performance in comparison with the diet consisted of soybean meal, seasame meal, linseed meal (40:30:30). Singh and Dhawan [21] obtained almost similar result in *C. carpio*.There were no statistical difference (P>0.05) between the treatment in respect of survival rate.

In the present study a decreasing trend of FCR value was observed in control, treatment T2 and least in treatment T1. The result indicated that combination of soybean meal along with cornflour based diet gave the best better FCR and PER for both *C.catla* and *L.rohita*. While Hossain and Jauncey [15] attributed poor growth response of *C. carpio* fed on diets containing mustard oil cake. Moreover, Devi et al. [22] observed higher feed protein efficacy in the diet of rohu having soybean meal and also obtained higher protein level in the tissues of rohu.

4. CONCLUSIONS

The result of the present study indicated that conventional diets such as mustard oil cakealong with rice brain and groundnut along with wheat flour gave low growth and poor food conversion ratio compared to soybean-based diets. The use of soybean meal along with cornflour (66.5+ 33.4) might be advantageous for rearing of carp fingerlings.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. FAO. The state of world fisheries and aquaculture 2022. Towards Blue Transformation. Rome, FAO; 2022.
2. Press information Bureau. Sagar Parikrama Yatra Phase VII concluded today at Trivandrum by covering entire coastal regions of Kerala [Press release]; 2023, June 12. Available:https://www.pib.gov.in/PressReleseDetail.aspx?PRID=1931753
3. Govindharaj, Sathishkumar, Bhavatharaniya U, Nathan Feli, Ranjan Amit, Elangovan Prabu. Strategies to reduce feed cost by improving gut health and nutrient utilisation of fish in aquaculture; 2021.
4. Naylor RL, Hardy RW, Bureau DP, Chiu A, Elliott M, Farrell AP, Tyedmers PH. Feeding aquaculture in an era of finite resources. Proceedings of the National Academy of Sciences. 2009;106(36): 15103-15110.
5. Daniel N. A review on replacing fish meal in aqua feeds using plant protein sources.

International Journal of Fisheries and Aquatic Studies. 2018;6(2):164-179.
6. Salineto S. Formulated diets based on the carbon footprint of the ingredients (Master's thesis, Università di Parma. Dipartimento di Scienze Medico-Veterinarie); 2022.
7. Lovell RT. Feed formulation and processing. In: Lovell RT, editor Nutrition and feeding of fish. New York, NY: Van Nostrand Reinhold. 1989;107127.
8. O'Keefe T. Plant protein ingredients for aquaculture feeds: Use considerations & quality standards. Seeds. 2003;5:04-597.
9. Elangovan A, Shim KF. The influence of replacing fish meal partially in the diet with soybean meal on growth and body composition of juvenile tin foil barb (*Barbodes altus*). Aquaculture. 2000;189(1-2):133-144.
10. Bureau DP, Hua K, Azevedo PA, Cyrino JEP. Efficiency of conversion of feed inputs into animal biomass: the usefulness of bioenergetics models and need for a transition to nutrient-flow models. Feeding and Digestive Functions of Fishes. 2008; 547-564.
11. Hasan MR. Nutrition and feeding for sustainable aquaculture development in the third millennium. In: Subasinghe RP, Bueno P, Phillips MJ, et al, Eds., Aquaculture in the third millennium. Technical proceedings of the conference on aquaculture in the third millennium, Bangkok, Thailand, 20-25 February 2000. NACA, Bangkok and FAO, Rome. 2001;193-219.
12. Priyadarshini M, Manissery JK, Gangadhara B, Rao LM, Keshavanath P. Growth responses of *Catla catla* (Actinopterygh: Cypriniformes: Cyprinidae) to soya and maize supplemented traditional feed mixture. Acta Ichthyologica Et Piscatoria, 2011;41(3):159- 164.
13. Lim C, Dominy W. Evaluation of soybean meal as a replacement for marine animal protein in diets for Shrimp *Penaeus vannamei*. Aquaculture. 1990;87:53- 64.
14. Singh PK, Gaur SR, Barik P, Sulochana Smriti S, Singh S. Effect of protein levels on growth and digestibility in the Indian major carp, *Labeo rohita* (Hamilton) using slaughter house waste as a protein sources. International Journal of Agriculture & Biology. 2005;7(6):939-9941.
15. Hossain MA, Jauncey K. Nutritional evaluation of some Bangladeshi oilseed meals as partial substitutes for fish meal in the diet of common carp, *Cyprinus carpio* L. Aquaculture Fish Management. 1989;20: 255-268.
16. El-Sayed AFM. Alternative dietary protein sources for farmed tilapia, *Oreochromis* spp. Aquaculture. 1999; 179(1-4):149-168.
17. DAHD. Annual report, 2022-23.Department of Fisheries, Ministry of Fisheries, Animal Husbandry & Dairying Government of India; 2022.
18. Desai AS, Singh RK, Sapkale PH. Comparative efficacy of supplemented de-oiled groundnut, sunflower, maize and cottonseed cakes on growth and body composition of fry of common carp, *Cyprinus carpio* (comm.). Journal of Applied Animal Research. 2011;39(3):221-224.
19. Jahan DA, Hussain L, Islam MA, Khan M. Comparative study of mustard oil cake and soybean meal based artificial diet for Rohu, *Labeo rohita* (Ham.) fingerlings. The Agriculturists. 2013;11(1):61-66.
20. Latif KA, Alam MT, Sayeed MA, Afzal Hossain M, Sultana S, Hassina MA. Comparative study on the effect of low cost oil seed cakes and fish meal as dietary protein sources for *Labeo rohita* (Hamilton) fingerling. Univ. J. Zool. Rajshahi Univ. 2008;27:25-30.
21. Singh R, Dhawan A. Effects of formulated diets on the growth and ovarian maturation in common carp *Cyprinus carpio* Commnunis Linn. Indian Journal of Fisheries. 1996;43(4):349-353.
22. Devi C, Vijayaraghavan S, Srinvasulu C. Effect of soybean meal (*Glycine max*) feeding on the bio-chemical composition of *Labeo rohita* fingerlings. Journal of Aquaculture Tropics. 1999;14(2):181-185.

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