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Comparative Study of Mustard Oil Cake and Soybean Meal Based Artificial Diet for Rohu, *Labeo rohita* (Ham.) Fingerlings

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Abstract

An experiment was conducted to evaluate the nutritive potential of soybean meal and mustard oil cake based diets for rearing of *Labeo rohita* fingerlings under pond condition at the Bangladesh Agricultural University, Mymonsingh during 2008. Three diets designated as treatments were formulated and fed to the stocked fingerlings. Studies have revealed an increase in final weight, average live weight gain, specific growth rate (SGR), lower food conversion ratio (FCR), protein efficacy ratio (PER) and apparent net protein utilization (ANPU%) and survival of fingerlings fed on diet D_3, a soybean meal based diet. Carcass composition also revealed high protein and lipid in fish fed on the diet D_3.

Keywords*: Mustard oil cake, soybean meal, *Labeo rohita

1. Introduction

Supplementary feeding is an important tool for augmenting fish production and optimization of fish production requires research on feeding techniques. In fish diet, protein is an important ingredient for its influence on growth and diet cost.

Fishmeal has traditionally been used as a major protein source in feeds for semi intensive and intensive fish farming because of its high nutritive value and palatability. However, fishmeal is expensive and is difficult to be obtained in many countries. So, its high demand has resulted in price increase, making it a burden for fish farmers. Dependency on fishmeal is a severe constraint to fish farming in Bangladesh. High cost and short supply of fishmeal have necessitated its substitution with cheaper plant protein sources. In recent years, plant proteins are being extensively used in fish and prawn feeds, mainly to replace the fishmeal component, in order to reduce the feed cost (Priyadarshini *et al.*, 2011).

The amount of plant protein used in fish diet depends on the species, availability, cost and acceptability by fish, presence of nutrient and antinutritional factors (Lim and Dominy, 1990). Singh *et al.* (2005) opined that optimum protein requirements vary with the protein sources and feed ingredients that are locally available and cheap protein sources should be used to develop a suitable feed for carp. In Bangladesh, most promising alternatives to fishmeal in carp diets are oilseed meal i.e. mustard oil cake, linseed meals and sesame meal (Hossain and Jauncey, 1989). Besides, soybean meals is considered to be the most nutritive plant protein and are used as the major protein source in diets (El-Sayed, 1999). Devi *et al.* (1999) observed that rohu fingerlings can accept up to 60% soybean meal based diet which is exhibited through their

growth. An attempt was therefore, made to address the nutritive potential of soybean meal based diets compared to mustard oil cake based diets on the growth of *L. rohita* fingerlings.

2. Materials and Methods

2.1. Experimental design

The experiment was conducted in 9 earthen ponds for a period of 60 days in the Field Laboratory Complex of the Faculty of Fisheries, Bangladesh Agricultural University, Mymonsingh during 2008. The area of each pond was 60 m^2. The experimental design was CRD. Three treatments each with three replications were designed to evaluate the nutritional potential of the formulated diets.

2.2. Pond preparation

The ponds were drained out completely and were then exposed to sunlight for three days; treated with lime at the rate of 250 kg ha^{-1} and left for 3 days. Organic and inorganic fertilizers such as cowdung, urea and triple super phosphate were applied at the rate of 1000, 25 and 25 kg ha^{-1}, respectively for pond fertilization as a basal dose. After the fingerling stocking, 50% of the basal dose was applied at every 15 days interval throughout the experimental period. After pond preparation the fishes (2.80 g ± 0.01) were stocked at a density of 75,000 ha^{-1}.

2.3. Experimental diets

The conventional mixture of mustard oil cake and rice bran in equal proportion (50:50) was used as the control diet (D_1) whereas diet D_2 consisted of mustard oil cake, soybean meal and rice bran (25:25:50) and diet D_3 consisted of soybean meal and rice bran (50:50). Prior to prepare pellet feed, all the ingredients were finely powdered, mixed and then sieved. Proximate compositions of the ingredients used in the formulated diets are presented in Table 1 and the experimental diets in Table 2. Fishes were fed at the rate of 3% of their body weight for initial 5 days, followed by 5% in the subsequent days of the culture period. Feeding was done by broadcasting the mixture in two installments, 50% in the morning (7-8 am) and the rest 50% in the afternoon (3-4 pm).

2.4. Water sampling and analysis

The water quality parameters such as temperature (^oC), secchi depth (cm), pH, dissolved oxygen (mgL^1), ammonia (mgL^{-1}) and total hardness (mgL^{-1}) were analyzed at seven days interval according to standard method (APHA, 1990). Quantitive and qualitative abundance of phyto and zooplankton were analyzed according to Bellinger (1992) at an interval of 15 days by filtering of 50 L of water through silk netting (mesh size 64 µ).

2.5. Analytical methods and analysis of data

Proximate composition of diet ingredients, diets and whole body were analyzed following AOAC (1990) methods. Specific growth rate (SGR), % weight gain, food conversion ratio (FCR), protein efficiency ratio (PER) and apparent net protein utilization (ANPU%) were calculated as follows:

SGR (% / day) = [(Ln. Final body weight – Ln. Initial body weight) / days × 100]

% Weight gain = (Final body weight – Initial body weight / Initial body weight)× 100

FCR = Food fed (g dry weight)/Live weight gain (g)

PER = Live weight gain (g)/Crude protein fed (g dry weight)

ANPU (%) = (Net increase in carcass protein/Protein consumed) × 100

All data collected were subjected to one-way analysis of variance (ANOVA) followed by Duncan's multiple range tests (Duncan, 1955) to test the difference between means. Standard deviation (± SD) was calculated to identify the range of means.

Table 1. Proximate composition of the feed ingredients used in different diets (% on dry matter basis)

Ingredients	Dry matter	Crude protein	Crude lipid	Ash	Crude fiber	NFE[1]
Soybean meal	91.52	43.30	15.55	5.71	4.95	30.49
Mustard oil cake	86.31	28.50	14.87	10.40	12.21	34.02
Rice bran	90.44	12.40	8.82	10.48	16.34	51.96

[1] Nitrogen Free Extract

Table 2. Ingredient (%) and proximate composition of the different diets (% on dry matter basis)

	Diets/Treatments		
Ingredients (g 100 g^{-1})	**D_1**	**D_2**	**D_3**
Rice bran	50	50	50
Mustard oil cake	50	25	0
Soybean meal	0	25	50
Proximate composition			
Crude protein	$22.38^{c} \pm 0.23$	$26.32^{b} \pm 0.15$	$28.05^{a} \pm 0.26$
Crude lipid	$12.35^{a} \pm 0.26$	$11.79^{a} \pm 0.16$	$12.27^{a} \pm 0.27$
Ash	$09.33^{b} \pm 0.23$	$10.42^{a} \pm 0.14$	$07.63^{c} \pm 0.18$
Crude fibre	$15.65^{a} \pm 0.06$	$11.53^{b} \pm 0.29$	$12.36^{b} \pm 0.36$
NFE[1]	$40.29^{a} \pm 0.74$	$39.94^{a} \pm 0.20$	$39.69^{a} \pm 01.0$
Gross energy[2]	16.78	15.41	17.62
PE ratio[3]	13.34	17.07	15.62

*Values having the same subscripts in the same row are not significantly different (P>0.05)
[1] NFE = Nitrogen free extractives, calculated as 100 – (% protein + % Lipid + % Ash + % Fibre)
[2] GE = Gross energy content
[3] P / GE ratio = Protein to energy ratio in mg protein kJ^{-1} GE

3. Results and Discussion

During the experimental period, mean physio-chemical qualities of water as obtained from the different experimental ponds are presented in Table 3. Mean water quality parameters of the experimental ponds were in the following ranges: temperature 29.60 to 30.11°C, dissolved oxygen 4.90 to 5.90 mgL^{-1}, alkalinity 172.15 to 184.94 mgL^{-1}, pH 7.53 to 7.44, secchi depth 27.66 to 36.41 cm and ammonia 0.21 to 0.26 mgL^{-1}.

The quantitative analysis of phytoplankton and zooplankton showed average density of $30.90 \pm 7.74 \times 10^{3} L^{-1}$ and $37.64 \pm 8.53 \times 10^{3} L^{-1}$, $47.47 \pm 8.04 \times 10^{3} L^{-1}$ and $13.95 \pm 4.58 \times 10^{3} L^{-1}$, $20.77 \pm 4.74 \times 10^{3} L^{-1}$ and $24.79 \pm 7.71 \times 10^{3} L^{-1}$ in diet/treatment 1, 2 and 3, respectively (Table 4). Treatment to treatment variation was not statistically significant (P>0.05) in case of density of zooplankton but statistically significant difference (P>0.05) was observed in phytoplankton density. Among plankton samples, phytoplankton constituted 68.01, 64.97, 67.8% while zooplankton constituted 30.07, 35.56, 31.10% of total population. Suitable water quality is a prerequisite for the maintenance of healthy aquatic environmental condition of the pond water. In the present study better planktonic population and optimum productivity were obtained through the application of fertilizer in ponds which agree with the report of Jhingran & Pullin (1985). It may be said that the

fertilizer might have enriched water quality to optimize planktonic population for carp culture.

In the present study, experimental diets were formulated to a protein level of 22-28% which was a fairly balance diet for better growth of fishes. Protein levels in successful feeds range from 20-60% to accommodate for differences in the physiological needs of different fish species (Hepher, 1988; Wilson, 1989). Singh *et al.* (2005) conducted an experiment to determine the effect of varying protein levels (25-40%) on *L. rohita* growth and digestibility. In the present study, the experimental diet D_3 gave significantly better growth in comparison with D_1 and D_2. Final weight gain and SGR increased with inclusion of soybean meal in the diets. Rohu achieved the maximum average weight of 14.18 g with diet D_3 against 7.72 g with control diet D_1 (Table 5). There were no statistical difference ($P>0.05$) between the treatment in respect of survival rate.

Protein content in the diet has significantly affected the growth of carp fingerlings. Better growth performance in fishes fed on diet D_3 could also be due to better feed management. Latif *et al.* (2008) reported that mustard oil cake, soybean meal, seasame meal, linseed meal (25:25:25:25) fed *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 (1996) obtained almost similar result in *C. carpio.*

In the present study, a decreasing trend in the FCR value with the increase in the proportion of soybean meal in diet was obtained and diet D_3 was found to be significantly better ($P<0.05$) than the other two diets (Table 5). Increased PER (1.85 ± 0.02) value was obtained with diet D_3 while the minimum (1.59 ± 0.80) with diet D_1 and there was no statistical difference ($P<0.05$) between the results of D_2 and D_3 but both showed significant difference from diet D_1. The effects on FCR and PER indicate that diet D_3 was better for rearing of rohu fingerlings. While Hossain and Jauncey (1989) attributed poor growth response of *C. carpio* fed on diets containing mustard oil cake. Moreover, Devi *et al.* (1999) observed higher feed protein efficacy in the diet of rohu having soybean meal and also obtained higher protein level in the tissues of rohu.

Results obtained on the carcass composition of fish belonging to different treatments are presented in Table 6. The crude protein value of fish fed with diet D_3 was $16.39 \pm 0.11\%$ compared to $14.33 \pm 0.32\%$ with control diet D_1 and corresponding crude lipid values were 4.56 ± 0.20 and $3.80 \pm 0.42\%$, respectively. Increased lipid levels in diet D_2 and D_3 could be due to the converted carbohydrate which was not utilized to provide energy. Jena *et al.* (1999) advocated that crude protein and lipid levels were also higher in rohu tissues fed with soybean meal based diet than a conventional mixture of mustard oil cake and rice bran.

Table 3. Physico-chemical parameters (mean±SE) of ponds' water as recorded during the experimental period of 60 days

Parameters	**Diets/Treatments**		
	D_1	**D_2**	**D_3**
Temperature (^oC)	$29.60^a \pm 0.19$	$29.97^a \pm 0.17$	$30.11^a \pm 0.13$
Dissolved oxygen (mgL^{-1})	$5.90^a \pm 0.19$	$4.96^b \pm 0.10$	$4.90^b \pm 0.13$
Total alkalinity (mgL^{-1})	$180^{ab} \pm 0.06$	$172.15^b \pm 4.84$	$184.94^a \pm 3.36$
pH	$7.40^a \pm 0.07$ (6.73-7.90)	$7.44^a \pm 0.091$ (6.75-7.98)	$7.53^a \pm 0.44$ (6.77-8.23)
Transparency (cm)	$36.41^a \pm 2.31$	$30.0^b \pm 2.0$	$27.66^b \pm 1.92$
NH^3-N (mgL^{-1})	$0.21^a \pm 0.02$	$0.26^a \pm 0.01$	$0.22^a \pm 0.02$

Table 4. Major groups of Phytoplankton and Zooplankton as recorded from water of the experimental pond ($\times 10^3$ L^{-1}) during the study period

Plankton group	Diets/Treatments		
	D_1	D_2	D_3
Phytoplankton			
Bacillariophyceae	$4.85^{b} \pm 1.08$	$6.10^{ab} \pm 3.29$	$8.28^{a} \pm 3.33$
Chlorophyceae	$17.71^{a} \pm 3.10$	$20.10^{a} \pm 7.22$	$23.04^{a} \pm 6.28$
Cyanophyceae	$6.67^{b} \pm 3.56$	$9.11^{ab} \pm 4.31$	$11.75^{a} \pm 3.88$
Euglenophyceae	$1.67^{b} \pm 0.57$	$2.33^{b} \pm 0.77$	$4.90^{a} \pm 2.80$
Total	**$30.90^{b} \pm 7.74$**	**$37.64^{ab} \pm 8.53$**	**$47.97^{a} \pm 8.04$**
Zooplankton			
Crustacea	$9.53^{b} \pm 5.11$	$14.89^{a} \pm 6.57$	$17.90^{a} \pm 6.54$
Rotifera	$4.42^{a} \pm 2.23$	$5.88^{a} \pm 2.8$	$6.89^{a} \pm 2.02$
Total	**13.95 ± 4.58**	**20.77 ± 4.74**	**24.79 ± 7.71**
Grand Total	**44.85 ± 6.32**	**58.41 ± 7.54**	**72.76 ± 7.88**

Table 5. Growth, food conversion ratio, survival rate and protein utilization of *L. rohita* fingerlings fed on different diets for 60 days (Mean ± SD)

Parameters	Diets/Treatments		
	D_1	D_2	D_3
Average initial weight (g)	2.80 ± 0.01	2.80 ± 0.01	2.80 ± 0.01
Average final weight (g)	$7.72^{c} \pm 0.29$	$11.98^{b} \pm 0.27$	$14.18^{a} \pm 0.35$
Average live weight gain (%)	$175.50^{c} \pm 8.94$	$327.72^{b} \pm 0.27$	$406.27^{a} \pm 8.60$
SGR (%)	$8.20^{c} \pm 0.46$	$15.29^{b} \pm 8.20$	$18.96^{a} \pm 0.55$
PER	$1.59^{b} \pm 0.80$	$1.84^{a} \pm 0.43$	$1.85^{a} \pm 0.02$
FCR	$3.07^{a} \pm 0.16$	$2.26^{b} \pm 0.02$	$1.96^{c} \pm 0.02$
ANPU (%)	$25.19^{b} \pm 0.50$	$29.67^{a} \pm 0.66$	$32.43^{a} \pm 1.93$
Survival rate	$89^{a} \pm 3.06$	$92^{a} \pm 2.00$	$90^{a} \pm 2.00$

Table 6. Mean Carcass composition of *L. rohita* fry fed on different diets for 60 days (% fresh matter basis)

Components	Initial value	Diets/Treatments		
		D_1	D_2	D_3
Moisture	77.09	$75.84^{a} \pm 0.76$	$74.87^{b} \pm 0.26$	$74.26^{b} \pm 0.10$
Crude protein	11.79	$14.33^{c} \pm 0.32$	$15.13^{b} \pm 0.27$	$16.39^{a} \pm 0.11$
Crude lipid	2.32	$3.80^{b} \pm 0.42$	$4.16^{ab} \pm 0.15$	$4.56^{a} \pm 0.20$
Ash	4.66	$2.23^{a} \pm 0.21$	$1.95^{ab} \pm 0.13$	$1.70^{b} \pm 0.18$

*Values having the same subscripts in the same row are not significantly different (P>0.05)

4. Conclusions

The result of the present study indicates that mustard oilcakes gave lower growth and poorer food conversion ratio compared to soybean based diets. The use of soybean meal (up to 50%) might be advantageous for rearing of carp fingerlings.

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