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Effect of Replacement of Fish Meal by Soybean and Sunflower Meal in the Diet of *Cyprinus carpio* Fingerlings

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Abstract: An 8 week experiment was conducted in glass aquaria to replace fish meal by soybean meal and sunflower meal in the diet of *Cyprinus carpio*. For that purpose fingerlings of approximately equal weight and length were distributed randomly in aquaria and fed on selective feeds based with fish meal (F_1), soybean meal (F_2), sunflower meal (F_3) and aquarium feed (F_4). The results of the trial showed that the total weight gain in gram was 28.06, 15.60, 20.15, 29.17 for F_1, F_2, F_3 and F_4 respectively. FCR was 2.40,4.09,3.17,2.16 and SGR was 0.904, 0.507,0.668,1.059 for F_1, F_2, F_3 and F_4, respectively. According to the data obtained aquarium feed was better than other feeds but statistical analysis for cost effectiveness ($p<0.05$) showed that aquarium feed was not suitable to use and fish meal was non replaceable but can be supplemented with sunflower and soybean meals to produce a cost effective feed. While among soybean and sunflower meals the latter was proved to be more effective.

Key words: Fish meal, diet *Cyprinus carpio*

Introduction

The protein component of the aquaculture diet is the single most expensive portion and important dietary nutrient. Fish meal remains the major dietary protein source ranging between 20-60% of the fish feed (Kaushik, 1989; Tacon and Jackson, 1985) but escalating cost, uncertainty in availability and lesser quantity has necessitated the use of other animal and plant protein sources to reduce the feed cost without compromising growth. Therefore, efforts are now being directed in different parts of the world to find alternate protein sources of good quality, which ideally are less expensive and readily available as substitutes for the expensive fish meal component in the practical diets. In this respect due to low cost and market availability soybean has been identified universally as most attractive vegetable protein source for animal feeds (Lim and Akiyama, 1989).

Wong *et al.* (1996), prepared a successful diet containing soybean residue with beef-liver mixture for common carp. Defatted soybean meal has universal acceptance both qualitatively and quantitatively. Soybean meal has a favorable amino acid profile as compared to other plant protein sources, is consistently available, cost effective and is reported to be palatable to most species of fish (Akiyama, 1988).

Studies on utilization of soybean meal in fish feeds have begun recently. Most of the work pertains to Trout, Salmon, Channel catfish and Tilapia, by several workers. Successful use of soybean and its products in fish feeds for the purpose of partial replacement of protein in diets of Indian fishes have been demonstrated by Chakrabarthy *et al.* (1973); Bhat *et al.* (1986); Keshabvappa, (1990) and Devaraj, (1991). Xie *et al.* (2001) tried a substitution experiment on gibel carp by using soybean cake, potato protein concentrate, peanut cake, cotton seed cake and rapeseed cake.

Little or no information is available on the utilization of sunflower meal in fish diet. Rab (1993) reported the partial utilization of sunflower meal in Trout feed with considerable success and better growth rate. The current experiment was conducted to determine the effect of replacement of fish meal on growth of common carp and to find out the nutritive value of soybean and sunflower meal in the feed, in order to minimize the dependence upon fishmeal as protein source and to reduce the cost of feed.

Materials and Methods

An eight week trial was conducted in the wet labs of Aquaculture and Fisheries Institute, National Agricultural

Table 1(a): Experimental feed compositions for *Cyprinus carpio*

Ingredients	F_1%	F_2 %	F_3%	F_4
Fish meal	27.86	-	-	Aquarium feed
Soybean meal	-	42.39	-	
Sunflower meal	-	-	32.5	
Maize Gluten meal	47.14	32.61	42.5	
Rice Bran meal	14.00	14.00	14.00	
Wheat Bran	7.00	7.00	7.00	
Vitamin Mix	1.00	1.00	1.00	
Mineral Mix	1.00	1.00	1.00	
Soybean Oil	2	2	2	

Table 1(b): Proximate analysis of the experimental feeds for *Cyprinus carpio*

Experimental feeds	Protein %	Moisture %	ASH %	FAT %	Crude fibre %
FISH MEAL F_1	26.65	8.26	14.27	7.42	6.88
SOYBEAN MEAL F_2	25.99	7.99	8.16	6.81	8.55
SUNFLOWER MEAL F_3	25.82	7.96	8.83	5.83	11.25
AQUARIUM FEED F_4	58.18	8.02	7.32	7.12	10.20

Research Center (NARC) Islamabad. In that 200 fingerlings of common carp (Cyprinus carpio) were collected by drag net from Mein Hart Dam and the Fishponds at Aquaculture and Fisheries (NARC), Islamabad. The fish was kept in the cemented raceways and acclimatized for fifteen days on the feed supplement containing rice bran and rapeseed, in order to habituate them for artificial feeding.

Eight glass aquaria (2`x1.5`x1`) were filled with 40 L of water and aerated properly through an air pump model SSP-40 GJ-L. Out of 200 fish, 80 fingerlings of approximately same weight and length were selected and distributed randomly among the aquaria.

Three iso-nitrogenous feeds were formulated, using Pearson method, with 26% crude protein level. Fishmeal based diet was designated as F_1, soybean meal diet as F_2, sunflower meal as F_3 where as aquarium feed (used for ornamental fish feeding) was designated as F_4. The level of ingredients in each test diet was calculated on the bases of level of replacement of fishmeal (Table 1a). The dry ingredients of the feed were grinded with the help of electric grinder, weighed and mixed together in the required quantity. Mineral premix, vitamin powder and required quantity of soybean oil were also added to the feed mixture. Proximate analysis of the experimental feeds was also done for comparison (Table 1b).

Water quality parameters viz. pH, Dissolved Oxygen content, CO_2, total alkalinity, total hardness and temperature were also analyzed weekly through Hatch Kit. Final weights of the stock were taken at the end of the experiment. From the data, Food Consumption Ratio (FCR) and Specific Growth Rate (SGR) were calculated. The data was then subjected to statistical analysis (ANOVA, DMR Test, Regression analysis), using MSTAT, for growth comparisons and calculation of cost effectiveness of the four test diets.

Results and Discussion

The results obtained for weight gain showed that fish fed on fish meal (F_1) and aquarium feed (F_4) both gained 2.82 g weight in the period of eight weeks, while Sunflower meal fed fish (F_3) gained 2.01 g and Soybean fed (F_2) gained 1.56 grams respectively (Table 2).

Statistical analysis for growth showed that specific growth rate of F_4 was highly significant as compared with F_1, because of the lesser FCR of F_4 (Table 3, Fig. 1). F_2 and F_3 showed less significant results for growth. This may be because F_1 and F_2 had animal protein source as compared to F_2 and F_3 having plant protein source (Mc Coy, 1990 and Keshabvappa *et al.*, 1990). Sunflower meal was proved better than the soybean meal, which may be

Table 2: Weight Gain of *Cyprinus carpio* with different treatments

	F_1			F_2			F_3			F_4		
No.	Initial	Final	Wt.Gain	Initial	Final	Wt.Gain	Initial	Final	Wt.Gain	Initial	Final	Wt. Gain
1	1.96	4.61	2.65	2.23	3.75	1.34	2.14	4.24	2.10	2.40	5.61	3.21
2	2.23	5.18	2.95	2.41	4.13	1.72	2.14	4.06	1.92	1.53	3.96	2.43
Mean	2.82			1.56			2.01			2.82		

Table 3: Statistical Results for comparison of Growth in different treatments

Parameters	Treat 1	Treat 2	Treat 3	Treat 4
Weight gain	2.82a	1.56c	2.01b	2.82a
Length	1.35a	0.66c	0.44c	1.03b
FCR	2.40c	4.09a	3.17b	2.16d
Specific Growth Rate (SGR)	0.904ab	0.507c	0.668b	1.059a

Table 4: Analysis in terms of Cost and Profit for different treatments

Treatments	Total feed offered	Total weight gain	Cost of feed/Kg	FCR	Cost/Kg of fish	Total Cost of feed	Total Price of fish	NET profit
Treatment 1	64.00	28.06	16.07	2.4	38.57	1.02848	1.6836	0.655 **
Treatment 2	64.99	15.60	14.72	4.09	60.20	0.956653	0.936	-0.021
Treatment 3	63.99	20.15	13.48	3.17	42.73	0.862585	1.209	0.346 *
Treatment 4	64.20	29.17	400.00	2.16	864.00	25.68	1.7502	-23.930

Table 5: Physico-chemical factors of water in Treatments 1, 2, 3 and 4

Parameters	Treatment 1	Treatment 2	Treatment 3	Treatment 4
Temperature (°C)	27.2	27.0	27.3	27.2
pH	7.5	7.5	7.5	7.5
Dissolved Oxygen mg l^{-1}	5.4	5.5	5.3	5.4
Electrical Conductivity (µS/cm)	546	542	534	545
Total Alkalinity (mg l^{-1})	440	400	420	430
Carbonates (mg l^{-1})	90	80	70	80
Bicarbonates (mg l^{-1})	350	320	350	350
Total hardness (mg l^{-1})	152	159	188	172

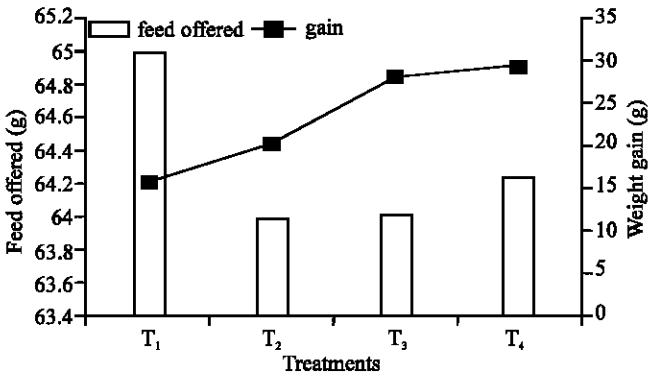

Fig. 1: Growth performance of *Cyprinus carpio* for different treatments

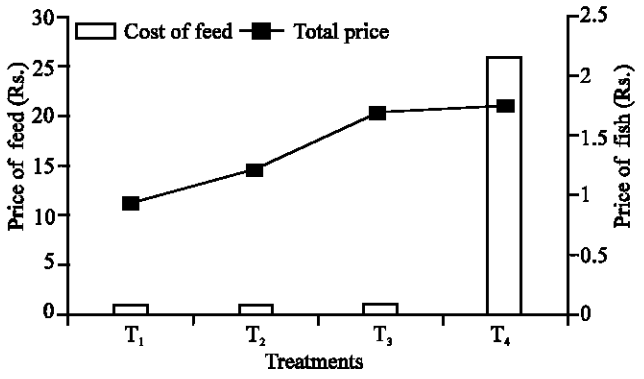

Fig. 2: Relationship between profit and cost of *Cyprinus carpio* for different treatments

because of low sulpher content (NRC, 1974), amino acid imbalance (Andrews and Page, 1974), anti nutritional factors other than trypsin inhibitors present in soybean meal (Wilson and Poe, 1985), low energy content (Viola *et al.*, 1982) or lack of Phosphorus (Kim and Oh, 1985). Which may make it unpalatable and cause growth reductions may reduce or delay feed intake (Tacon *et al.*, 1983). The better performance of Sunflower meal may be due to the absence of some of these growth inhibitors.

Contrary to the interpretation that aquarium feed is better than fish meal, when statistical analysis for cost effectiveness was done, aquarium feed proved highly non significant. In this analysis fishmeal came out to be highly significant while Soybean meal was also non-significant and Sunflower meal was significant (Table 4, Fig. 2).

Results of water quality parameters like temperature, pH, alkalinity, salinity, dissolved Oxygen, dissolved CO_2, NH_3 and nitrates are presented in Table 5. Since the difference between the physico-chemical factors of all aquaria was non-significant they were not supposed to affect the growth rate.

The experiment concludes that the fishmeal could not be replaced totally with plant products; however, partial replacement can be done using sunflower meal to reduce the cost without affecting growth rate.

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