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Protein Sparing Effect and the Efficiency of Different Compositions of Carbohydrates, Lipids and Proteins on the Growth of Rohu (*Labeo rohita*) Fingerlings

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Abstract: This study was aimed to evaluate the efficiency of three experimental feeds, given to three groups of rohu (*Labeo rohita*) fingerlings, reared in cemented tanks for 45 days. One group of fishes (control group) was fed with hatchery feed; and growth of this group was compared with the other experimental groups. In all the three experimental groups the protein level was kept below the required level and almost equal, while carbohydrate and lipids level were kept above the required level to study the protein sparing effect of both of these, especially of the lipids. The important water parameters which influence the physiology of fishes were also taken into consideration and were properly monitored throughout the experimental duration. The growth of fishes was checked after every 15 days hence an overall of three readings were made. As the growth and efficiency of fishes are reflected by the FCR (Food Conversion Ratio), therefore, the FCR of fishes were also recorded at each reading (at every 15 days after stocking). The mean FCR recorded for each tank was, control group 4.7±0.53 feed 1 (3.86±0.14) feed 2 (3.2±0.04) feed 3 (3.0±0.12) respectively. The result obtained from this study reveals that the composition of feed 3 is relatively more suitable for fingerlings of Rohu as it has shown lowest FCR. The hatchery food produced highest FCR and hence will be less efficient. Among the three experimental feeds, feed 3 had a good protein sparing effect.

Key words: Food Conversion Ratio (FCR) · Hatchery · Cemented Tanks

INTRODUCTION

With the continuous grooming of the fisheries industry we are compelled to give attention to boast production of fish for the improved survival of this industry. Diet is among the various important factors that affect fish health so for the adequate growth fish must be fed with adequate amount of diet that meet all the nutritional requirements [1]. The present study was carried out to find the optimum dietary levels of proteins carbohydrates and lipids for rohu fingerlings under the biological parameters in Carp Hatchery and Training Center Peshawar. The study also aimed to find a better formulation of the available feed components in hatchery. The more costly protein component of the fish diet can be partly replaced by providing adequate energy through dietary lipids and carbohydrates [2-4]. Improving the utilization of protein and reducing its level as dietary component of fish feed is widely studied. Various studies have been performed for sparing protein by increasing the dietary energy levels and the efficiency of such compositions are then reflected by the overall growth of fishes [2, 5-8]. The dietary protein has a key role in the growth of fish, it is obvious that utilization of protein can be enhanced by partially replacing the protein with lipids and carbohydrates i.e. non-protein energy sources [9-13]. In the present study lipids are included much more than the required level in the formulated experimental diet because lipids are digested more easily and are good energy source to spare protein than carbohydrates, meanwhile excess lipids may also result in puffiness of fish and value of "C" (conditioned factor) does not remain constant [14].

Rohu (*Labeo rohita*) is the most important among the three Indian major carp speciesused in the carp polyculture systems. This species is the natural inhabitant of the riverine system of northern and central India and the rivers of Pakistan, Bangladesh and Myanmar [15]. The compatibility of Rohu with other carps like Catla (*Catla catla*) and Mrigal (*Cirrhinus mrigala*) made it an ideal candidate for carp polyculture system [16].

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MATERIALS AND METHODS

The feeding formulae were based on quantitative assessment of requirements of carbohydrates, lipids and proteins by Rohu fingerlings. The proteins content of all the three feeds were kept almost constant, but with a slight variation. To observe the proteins sparing effect of carbohydrates and lipids, their proportion in diet was raised above the required level. In the first experimental feed, carbohydrate content was kept almost 42% and its protein sparing efficiency was observed from the growth of fishes. In the second and third feed lipid content were kept approximately 25% and 30%, respectively. In these two feeding formulae the role of lipids as protein sparing component was studied. The control group is fed with soybean powder only, which contains 36.49% protein, 20.86% carbohydrates and 1 9.94% lipids.

A 3×3 factorial design containing three levels of lipids (189.7, 245.6 and 292.8g/kg, dry matter basis) and three carbohydrate levels (418.9, 376.1 and 346.8 g/kg, dry matter basis) was used in this experiment to investigate the dietary requirements of fingerlings of rohu.

Stocking of Fingerlings: Fishes to be observed were stocked in four cemented tanks (L x B x H: 4.4m x 2.4m x 1.2m). Each group was in a separate tank. All the food supplied to the fingerlings was made outside the tank, because in cemented tanks the fish has no or very little access to the natural food. The tanks were marked as 1, 2, 3 and 4.

- Tank 1 contained Rohu fingerlings fed with soybean powder (control group).
- Tank 2 contained Rohu fingerlings fed with experimental feed 1.
- Tank 3 contained Rohu fingerlings fed with experimental feed 2.
- Tank 4 contained Rohu fingerlings fed with experimental feed 3.

Feed Formulation: While formulating fish feed the availability of ingredients, price used anti-nutritional factors and palatability of mixtures must be kept under considerations also that it meets the desired production level [17]. Three experimental feeds were designed and were checked against the controlled group. The controlled group was fed only with soybean powder.

Feeding Pattern Followed: The fishes selected for experiment were started feeding with experimental supplement at the age of 15 days and were kept feeding for the next 45 days, under controlled environment. The tanks were monitored properly. Four sets of Rohu hatchlings, each set of the same batch of spawning was taken.

The fishes were fed at the rate of seven percent of their body weight. The amount of ration needed for each tank was calculated using formula

$$\frac{\text{Average weight of fish} \times \text{No of fish} \times 7}{100}$$

If there are 40 specimens in a tank each weighing 5 g, the total weight of fishes in the tank is 200 g. Therefore the daily need of food for this tank at the rate of 7 % of body weight is

$$\frac{200 \times 7}{100} = 14 \text{ grams}$$

The fishes were fed twice a day at 0900 hours and 1700 hours, accurate observations were made throughout the experimental duration to regularly monitor the rate of consumption. The tanks were equipped with a constant supply of freshwater from tube well. Throughout experiment water was kept well oxygenated.

Length-Weight Relationship: For length-Weight relationship each time a sample of 10 fishes was taken randomly. The specimens were weighted by digital balance (Denver Instrument Company AA - 200). The average weight of fishes was multiplied with the number of specimens in the tank to obtain the total weight. Both the average and total weight were recorded after and interval of 15 days.

Ruler was used to measure the total length (up to mm) of fishes. Each time 10 fishes were taken randomly and the average length was calculated. At each reading of 15 days interval the constant C was calculated by the following formula:

$$C = \frac{W}{L^3}$$

To evaluate the growth and efficiency of fingerlings, the following parameters were recorded for controlled and experimental feeds.

Net Weight Gain (NWG): Net Weight Gain (g) = Mean final fish weight (g) – Mean initial fish weight (g)

Food Conversion Ratio (FCR):

$$FCR = \frac{\text{Weight of dry food given to the fish (g)}}{\text{Weight gained by the fish (g)}}$$

Specific Growth Rate (SGR): Was estimated by the formula given by Dhawan and Kaur [21].

$$SGR = \frac{\text{In (Final wet body weight) - In (Initial wet bodyweight)}}{\text{Time duration (days)}} \times 100$$

The survival rate were calculated as

$$\text{Survival rate} = \frac{\text{Number of fishes recovered}}{\text{Number of fishes stocked}} \times 100$$

RESULTS

FCR values of fishes were calculated at the interval of 15 days during the course of experiment. Three readings were taken for all the four groups of fishes. All the four groups were taken under controlled observation (selected for experiment) at the age of 15days. A comparative look on the values of FCRs of the four studied groups of fishes indicate that the values of FCR (3.0±0.12) was the smallest for the group fed with diet 3 (Fig. 1), contained in Tank 4,while the control group was found to have the highest value of FCR (4.7±0.53).

The percentages of the three major components in the three experimental feeds are represented in Tables 1, 2 and 3.

Growth Performance of Experimental Feed: The growth performance of experimental feeds and the response of rohu fingerlings were observed in terms of FCR values which are given here in the following Tables (4,5,6,7, 8) for different groups of fishes and for different feeds. Table 9 and Fig. 1 are a good reflection of the difference in the values of FCR.

From the above facts, in terms of growth and utilization of food, the fishes fed with diet 3 were efficient. On the other hand the controlled group was found to be relatively less efficient user of the food and hence with high FCR.

Length-Weight Relationships: Each time the average weight of fishes were calculated through random sampling and is multiplied with the total number of fishes to obtain the total weight of fishes in a tank. The average weights

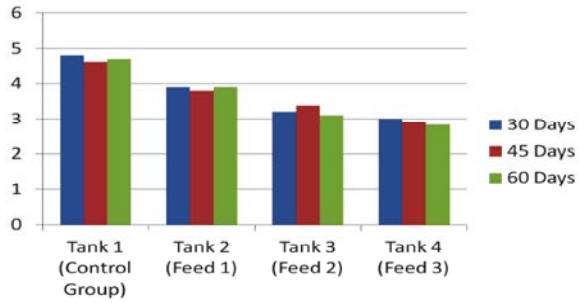

Fig. 1: Comparison of FCRs of fishes fed with different feeds

of fishes at each reading were compared against the average length to find the length-weight relationship. The controlled group has an average weight of 0.73g, 0.89g and 1.09g with average length of 2.73cm, 3.22cm and 4.31cm at first second and third reading respectively. The values of 'C' for the three readings were 0.01, 0.01 and 0.01. The fingerlings fed with the feed 1 showed an average of 0.76g, 0.97g and 1.23 g at first, second and third reading, while their average lengths were 2.85cm, 3.91cm and 4.88 cm. The values of 'C' for the three readings were 0.02, 0.01 and 0.01. Feed 2 gave to the fingerlings an average weight of 0.79g, 1.04g and 1.40g while the average lengths were 3.39cm, 4.65cm and 5.01cm. The values of 'C' for the three readings were 0.02, 0.01 and 0.01. Fingerlings fed with Feed 3 were found to have average weights of 0.81g, 1.10g and 1.51g while their average lengths were 3.91cm, 4.75cm and 5.20cm. The values of 'C' for the three readings were 0.02, 0.01 and 0.01.

L is the total length of fish while W is the weight. Table 10 represent the values of C (condition factor) is calculated periodically to know whether the growth of fish is isometric or not.

Water Quality Parameters: The important water parameters which influence the physiology of fishes were also taken into consideration. They are given here in and were properly monitored throughout the experimental duration. The water was kept changing after each three days. The mean values of pH throughout the experimental period in tanks 1, 2, 3 and 4 were 7.23±0.12, 7.33±0.12, 7.22±0.129 and 7.06±0.05. Dissolved oxygen (ppm) in tanks 1, 02, 03 and 04were 6.74±0.20, 6.78±0.20, 6.75±0.17, 6.93±0.60. Mean temperature in four tanks were 22.6±0.35°C, 22.6±0.138°C, 22.4±0.44°C and 22.6±0.66°C. Mean Alkalinity (ppm) were such that 204.66±5.98, 226.33±27.84, 224.33±7.36 and 232±10.65. Total hardness

Table 1: Components of experimental feeds (The numbers represent percentages)

Feed Ingredient	Feed 1	Feed 2	Feed 3
Wheat bran	50	40	35
Soybean powder	40	45	45
Soybean oil	10	15	20

Table 2: Compositions of experimental feeds (The numbers represent percentages)

Component/ Feed	Feed 1	Feed 2	Feed 3
Protein	20.24	20.94	20.37
Carbohydrate	41.89	37.61	34.68
Lipids	18.97	24.56	29.28

Table 3: Percentage composition of different dietary ingredients used in fish feed(The numbers represent percentages) Modified from [18,19,20]

Ingredients	Dry matter	Crude protein	Carbohydrate	Crude fat	Crude fiber	As
Wheat bran	87.2	11.3	58.6	2.6	8.8	55
Soybean powder	91.46	36.49	20.86	19.94	9.3	48
Soybean oil	----	----	----	97	----	03

Table 4: FCR of Rohu fingerlings, controlled group (Tank 1)

Fish age	Food consumed (g)	Total Initial weight(g)	Total Final weight(g)	Weight gained in 15 days	Mortality	Live specimens	Food Conversion
30 days	12.6	12	14.62	2.62	0	20	4.8
45 days	15.35	14.62	17.69	3.33	0	20	4.6
60 days	18.69	17.96	21.93	3.97	0	20	4.7

Table 5: Length-Weight Relationships and the values of condition factor

	Controlled group			Feed 1			Feed 2			Feed 3		
Fish age	Av.wt (g)	Av. L (cm)	$C=W/L^3$	Av. wt (g)	Av. L (cm)	$C=W/L^3$	Av.wt (g)	Av. L (cm)	$C=W/L^3$	Av. wt (g)	Av. L (cm)	C=W
30 days	0.72	3.35	0.01	0.76	3.15	0.02	0.79	3.39	0.02	0.81	3.45	0.02
45 days	0.89	3.75	0.01	0.97	3.91	0.01	1.04	4.65	0.01	1.10	4.75	0.01
60 days	1.09	4.31	0.01	1.23	4.88	0.01	1.40	5.01	0.01	1.51	5.20	0.01

Table 6: FCR of Rohu fingerlings fed with diet 1 (Tank 2)

Fish age	Food consumed (g)	Total Initial weight(g)	Total Final weight(g)	Weight gained in 15 days	Mortality	Live specimens	Food Conversion ratio
30 days	12.6	12	15.23	3.23	0	20	3.9
45 days	15.99	15.23	19.43	4.20	0	20	3.8
60 days	20.41	19.43	24.66	5.23	0	20	3.9

Table 7: FCR of Rohu fingerlings fed with diet 2 (Tank 3)

Fish age	Food consumed (g)	Total Initial weight(g)	Total Final weight (g)	Weight gained in 15 days	Mortality	Live specimens	Food Conversion ratio
30 days	12.6	12	15.93	3.93	0	20	3.2
45 days	16.72	15.93	20.99	5.06	1*	19	3.3
60 days	20.94	20.99-1.04=19.95*	28.10	6.75	0	19	3.1

*At third reading one specimen was reduced due to mortality. The final weight belongs to the number present at the end of this reading, so the average initial weight of died specimen was subtracted from initial total weight; similarly food eaten by died fishes was also subtracted from the recorded amount of feed given to the fishes.

Table 8: FCR of Rohu fingerlings fed with diet 3 (Tank 4)

Fish age	Food consumed (g)	Total Initial weight (g)	Total Final weight (g)	Weight gained in 15 days	Mortality	Live specimens	Food conversion
30 days	12.60	12	16.20	4.20	0	20	3.0
45 days	17.01	16.20	22.66	5.86	0	20	2.9
60 days	23.16	22.06	30.33	8.27	0	20	2.8

Table 9: Comparison of FCRs of fishes fed with different feeds

Fish age	Tank 1 (control group)	Tank 2 (Feed 1)	Tank 3 (Feed2)	Tank 4 (Feed3)
30 days	4.80	3.90	3.21	3.00
45 days	4.60	3.80	3.39	2.91
60 days	4.70	3.90	3.10	2.83
Mean±szSE	4.70±0.53	3.86±0.14	3.23±0.04	2.91±0.12

in each tank was 227.33±5.93 ppm, 221.33±13.33 ppm, 211.33±8.64 ppm and 215.66±8.17 ppm. Mean Conductivity (iS) in tanks 1, 2, 3 and 4 were 449.33±7.55, 436.66±8.71, 457.66±6.29 and 412±8.28.

DISCUSSION

These experiments were performed to find effect of varying composition of Carbohydrates, proteins and lipids on the growth and to calculate the FCR of fingerlings of rohu under the living parameter of Carp hatchery and training center Peshawar.

The result of this study reflected that the FCR value of the fishes reared in tank 4 (fed with feed 3) had the least value 3.0±0.12 while that of tank 1 was with the highest value 4.7±0.53, hence hatchery feed represent the least efficiency to the fingerlings of Rohu. On the other hand feed 3 cause the fishes to have least FCR and high efficiency. This is because feed 3 contained high proportion of carbohydrate and lipids than the normal level required by Rohu fingerlings, which spared protein and gave the fish good growth and food conversion efficiency. As the control group was fed with only one type of feed i.e. soybean powder, hence, showed least efficiency.

Although the experiment was performed for a short period of time i.e. 45 days still there was a slight decrease in temperature from first to third reading in each tank. But this temperature variation is not in coincidence with the variation in FCR value. However the variation in dissolved oxygen is in agreement with the variation in FCR. As according to Sumner and Lanhan [22] the increased oxygen intake indicates the increased metabolic rate and hence high efficiency. Beside this the FCR values also depend on other factors like sex of fish, other water qualities and fish activity [23].

An overall look on the FCR values of all the four groups of fishes indicate that three experimental feeds were relatively better than the hatchery feed. Umar [14] also suggested that increasing the level of lipid in feed stimulates the overall growth of *L. rohita*, while increased carbohydrate results in improved protein contents in fish meat.

The value of condition factor at the first reading in tanks with feed 1, 2 and 3 were 0.02 and for the rest of the two readings it was 0.01, it might be due to the fact that for the first 15 days the hatchlings were under controlled conditions of hatchery; their exposure for the first time to a comparatively lipid rich diet made them a bit fluffy. It is because the high energy diets may cause excessive carcass deposition of lipids [24,25] and may also cause stunted growth [26].

Fish can use lipid protein and carbohydrate as energy sources [27-30]. The present study indicated that there was a significant difference among the three experimental feeds and also between experimental feeds and control feed in terms of FCR, SGR and weight gain and length-weight relationships. The improvement is seen in agreement with increase in lipid content; this fact was also observed by Bromley [31] and Watanabe [25].

Improved protein efficiency and low FCR in the study is also in agreement with Einen and Roem [32] and Nematipour*et al*. [33]. Relatively good growth in all the three experimental groups of fingerlings is because of more carbohydrate content (35-40%) in the three experimental feeds; same observation were also made by Saha and Ray [34] they found that more weight gain and SGR is also a factor of carbohydrate level up to 40%. The present study also reflected that level of protein spared is a factor of dietary levels of energy fed to the fingerlings, lower the level of energy in diet is lower the protein sparing effect; This is in coordination with the work of Wilson [35].

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