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GROWTH RESPONSE OF *LABEO ROHITA* FINGERLINGS FED WITH DIFFERENT FEEDING REGIMES UNDER INTENSIVE REARING

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ABSTRACT

Feeding trials were conducted to determine the efficacy of varying dietary protein regimes on growth of *Labeo rohita* fingerlings under intensive rearing for a period of six months. Stocking density was 25fish/glass aquarium m^{-2} (280 liter water volume). Seven different diets were tested. Out of seven diets, three low cost based diets having (35%, 40% and 45% crude protein) and three high cost based diets having (35%, 40% and 45% crude protein) were evaluated against a control (rice polish) having (12% crude protein) in triplicate glass aquaria. Fish were fed daily @ 4% of wet body weight twice a day. Mean body weight gain, mean length gain, specific growth rate, feed conversion ratio and survival rate were evaluated to determine the growth performance in different treatments. The survival rate was 100 % at all feeding levels. In aquaria fish fingerlings fed with 45% low cost based diet showed significantly higher ($P<0.05$) weight gain (26.17g) than other diets and highly significant to control diet (9.77g.) Water quality variables such as temperature, dissolved oxygen, total hardness, etc. were found approximately constant for rapid growth and survival for *Labeo rohita* fingerlings.

Key words: Feed conversion ratio, freshwater fish, fingerlings, *Labeo rohita*, stocking density, survival rate.

INTRODUCTION

Labeo rohita is an important freshwater fish species normally cultured in Asia particularly in the Indian subcontinent (Khan, *et al.*, 2004). *Labeo Rohita* an important culturable fish in Pakistan, is normally cultured under semi-intensive poly-cultured system. The intensive fish culture is the first step towards industrial production methods offering several advantages (Meshe, 1985). Intensive fish culture is inevitable in recent years, because the ever increasing proportion of protein will surely come from intensive culture system only. This system can be industrialized where the only aim is to produce maximum fish biomass within a certain time. The success of intensive and semi-intensive fish culture depends to a large extent on the application of suitable feeds and using inexpensive locally available agro based feed ingredients. In order to make the intensive monoculture of major carps successful, it is indispensable to work out specific feed for each species (Muzammel *et al.*, 2003). In fish farming the management is directed towards the realization of maximum fish biomass within a certain time. The fastest and the most reliable way to realize this objective is maximizing increase in weight of individual fish (Verreth, 1991). It is a fact that growth of fish is a plastic process that can change considerably in response to internal factors of the fish (Weatherly, 1990 and Wooton, 1992). The development of fish feed is essentially based on the information of nutrients digestibility and its conversion rate. These two processes provide the basis for growth, which is suitable and compatible for the fish (Khan *et al.*, 2004). The estimation of feed conversion ratio (FCR) is an important step in the evaluation of feed and provides a rational basis for the formulation of feeds. Shim and Chua (1983) studied the growth and feed conversion ratio in guppy (*Poccilia reticulate*) fed on artificial feeds containing different levels of protein and reported that the feed containing 30 % protein gave the best weight gain and feed conversion efficiency.

In fish farming nutrition is critical because feed represent 40-50% of production costs (Craig and Helfrich, 2002). The general problem of high feed cost associated with fish culture has been addressed by studies on the use of cheaper ingredients as protein sources (Shiau *et al.*, 1987; De Silva *et al.*, 1988). Another approach to reduce feed cost is to develop appropriate feeding management strategies and other improvements in husbandry (Singh and Srivastava, 1984, 1985). Keeping in view the economic importance of fish feeding, present study was carried out to determine the growth response of *Labeo rohita* fingerlings fed with different feeding regimes under intensive rearing.

MATERIALS AND METHODS

The study was conducted at Fish Biology Laboratory, Department of Zoology, University of the Punjab Lahore, Pakistan. The fingerlings of mean initial body weight 4.20 ± 0.02g obtained from Government

Fish Seed Hatchery, Manawan Lahore, were acclimated to experimental conditions for two weeks and fed on control diet (rice polish) only. The experiment designed contained twenty one -280 liter glass aquaria (erected on the iron stands) with a flow through water system of 300 ml/min. These three test aquaria contained the control, low cost and high cost feeds. Twenty five fingerlings were randomly stocked in each aquarium. Glass aquaria were continuously supplied Oxygen through aerator (Daivo pump NS 4200) and a 12:00 hour 12:00 hour light dark photoperiod. Individual weight of the *Labeo rohita* fingerlings was determined using an electronic scale (TSI model 58) at the start of experiment and biweekly thereafter in order to monitor the weight gain. Fingerlings individually taken out from each aquarium, anaesthetized with MS222. Individual fish wet body weight in each aquarium was measured fortnightly and the amount of diet was adjusted accordingly. All the low cost diets were formulated locally based on available ingredients. The feed ingredients were finely grounded and placed in desiccators to prevent from moisture and passed through 0.5 mm sieve size. All ingredients were mixed in a mixer (laboratory blender) for 5 minutes and fish oil was gradually added thereafter. Eighty-five (85) ml of water per 100 g of feed was slowly blended into the mix, resulting in suitably textured dough (Lovell, 1989) and was processed by manual pelleting machine to make pellets. Drying was carried out in an oven at 28 °C for 18 hours. The dry product was cut into pellets of 2 mm size, relative to match mouth gap of experimental fish fingerlings for its easy intake. The resulting pellets were stored in polythene bags at –10°C until fed.

The water quality parameters throughout the experiment did not vary significantly between the glass aquaria and was as follows: pH 7.1-7.5; temperature 28°C- 28.9°C and DO 6.0-6.9 $mg.I^{-1}$. These parameters were monitored and recorded on daily basis with digital pH meters (HANNA-HI-9023), DO and thermometer (HANNA-HI-9143). At the end of the feeding trial, the final average body weight of the fish was recorded and percent weight gain (PWG), body length gain (LG), percent body length gain (PLG), specific growth rate (SGR) and food conversion ratio (FCR), survival rate, total gross production and diet acceptability were calculated. Diet acceptability was regularly and closely observed in each treatment. The diet acceptability of *Labeo rohita* fingerlings were calculated on the basis of average scores gained by the fish under different treatments (T1-T7). Different treatments from T1-T7 are abbreviated viz; T1 (Control), T2 (PUD-1), T3 (TOK), T4 (PUD-2), T5 (URD-3), T6 (PUD-3) and T7 (MIR).

Left over feeds and fish faeces accumulated at the aquaria bottom, were regularly removed to maintain proper water quality conditions. While calculating FCR, loss of feeds because of fish agitation and leaching was not taken into account and there was no oily film on the water surface. At the end of feeding trail, water was lowered to one quarter of the total water volume and all the fish fingerlings were harvested and counted from each aquarium to calculate survival rate and then weighed to estimate body weight gain.

Proximate compositions of diets were determined according to the Association of Official Analytical Chemists (AOAC, 1995) and are also given in (Table 1). A duplicate sample from each diet was dried overnight in convection oven at 105^{o}C to determine dry matter contents. Protein was determined by microkjeldahl method. Total lipids were extracted in microkjeldahl method. Total lipids were extracted in petroleum ether for quantitative estimation (AOAC, 1995). Ash contents were determined after incinerating the feed samples in a muffle furnace at 550 ^{o}C. One way Analysis of variance (ANOVA) followed by Duncan's new Multiple Range test was used to evaluate the statistical significance of differences among the treatments. Differences between the treatment means were considered significant ($p<0.05$).

WG	=	Weight final (WF)-Weight initial (Wi)
LG	=	Final length (mm) – initial length (mm)
SGR	=	$[(\text{In } W_f - \text{In } W_i) \times 100]/\text{days}$
FCR	=	Total dry feed fed/ total wet weight gain.
Survival rate	=	$N_t \times 100 \div N_0$.

(N_0, initial number of fish in each replicate and N_t, final number of fish in each replicate).

RESULTS AND DISCUSSION

To obtain good growth in fishes under intensive culture conditions, the water quality parameters such as, pH, temperature, dissolved oxygen, total alkalinity and total hardness were similar for all the treatments. The mean values of water quality parameters were optimum for rearing of *Labeo rohita* fingerlings. Water temperature ranged from 28°C- 28.9°C. Dissolved oxygen concentration remained within the range 6.0-6.9 $mg.I^{-1}$. The pH and total alkalinity remained in the range of 7.1-7.5 and 416-421 mg/1, respectively, which are suitable for fish culture under controlled conditions (Ali, *et al*., 2000; Boyd, 1982; Jobling, 1994; Woynarovich and Horvath, 1980).

The growth parameters for *Labeo rohita* fingerlings in the different treatments (T_1-T_7) in terms of mean body weight gain, %weight gain, mean length gain, % length gain, SGR % per day, FCR, Survival (%), diet acceptability and total gross production (kilogram / 180 days) were calculated and are shown in table 2. The results obtained from the feeding trial indicated a varied growth rate under different treatments. T-6 showed significantly ($P<0.05$) the highest growth among the treatments. The net weight gain of individual fish in the T-6 was higher (26.17g) than those of T-7 (22.38g) T-4

(20.10g) T-2 (17.85g), T-5 (16.85g) T-3 (16.15g) and T-1 (9.77g). Fingerlings reared with different feeds attained mean fork lengths of T-7 (101.75mm), T-6 (109.86mm), T-5 (89.69mm), T-4 (96.28mm) T-3 (90.42mm), T-2 (94.82mm), and T-1 (73.98mm). Garg, *et al*. (2002) reported better results for *Labeo rohita* as compared to *Cirrhinus mrigala* when fed with similar diets to that used in the present study. However, Khan, *et al*. (2003) has reported contrasting results and considered the high cost based diet (fish meal) as more effective for the better growth of *Labeo rohita*. The growth and FCR are good tools to compute the acceptability of feed in fish feeding experiments (Inayat and Salim, 2005). Better FCR were found in all formulated diets which are similar to the findings of Saeed *et al.* (2005), but the value of FCR higher than 0.99-1.79 was reported by Sahu *et al.*, (2007). Feed conversion ratio in relation to body weight decreased as body weight increased (Table 2) (NRC, 1993; Ng, *et al.* 2000), as compared to larger fish under similar culture conditions. The high FCR values recorded in diets are in accordance with the results of Li *et al.* (2000), who reported that when a fish fed on all plant diet (30% CP), it resulted in a significantly higher FCR than fish and fed on animal protein (30% CP).

Table 1 Ingredients and promixmate composition of experimental diets:-

INDIGENTS	Diets						
	Control (12.3 %) T1	**PUD-1 (35 %) T2**	**TOK (35 %) T3**	**PUD-2 (40 %) T4**	**URD-3 (40 %) T5**	**PUD-3 (45 %) T6**	**MIR (45 %) T7**
Rice polish	100	33.03	-	24.92	21.49	32.26	-
Glutton (30 %)	-	5.22	4.05	7.73	15.51	13.41	9.69
Soy bean Meal	-	17.82	-	6.52	-	2.22	-
Sunflower Meal	-	9.60	-	1.44	-	3.35	-
Fish Meal	-	-	16.26	-	7.31	-	3.16
Wheat meal	-	-	25.29	-	31.03	3.35	-
Canola meal	-	4.37	3.38	35.99	19.31	44.40	-
Soybean oil cake	-	-	-	-	4.34	-	21.11
Linseed Oil Cake	-	-	-	-	-	-	11.84
Rice Ran	-	-	22.09	-	-	-	21.11
Corn	-	-	27.94	-	-	-	-
Shrimp Meal	-	-	-	-	-	-	32.09
Wheat bran	-	28.96	-	22.40	-	-	-
Vitamin Premix	-	1.0	1.0	1.0	1.0	1.0	1.0
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Promixate Composion (%)							
Crude Protein	12.3	36.18	34.69	42.96	39.51	48.29	46.92
Fat	5.21	8.91	12.4	10.83	13.43	12.35	16.01
Moisture	0.88	9.6	7.7	9.4	9.2	9.9	13.5
NFE	42.1	33.87	19.32	30.56	20.22	32.5	18.36
Ash	15.0	6.53	5.39	7.37	6.78	8.51	7.79
Cost of feed per Kg (Rs.)[1]	15.00	22.00	120.00	25.00	46.00	34.00	190.00

Specific growth rate (SGR) of fingerlings under different treatment conditions are presented in table 2. SGR followed a similar pattern as observed in length and weight gain data. The fingerlings attained SGRs of 3.11 in T1, 7.57 in T2, 6.65 in T3, 8.83 in T4, 7.03 in T5, 12.21 in T6, and 10.09 in T7. There were no significant ($P>0.05$) differences in SGR between treatments (Table 2). Survival rates of *Labeo rohita* fingerlings containing different dietary protein levels are presented in table 2. Survival rate of fingerlings was 100%, it is obviously under good conditions. Teng and Chua (1979) in estuary grouper *Epinephelus salmoides;* Ali *et al.* (1999) in *Penaeus monodon* and Narejo *et al.* (2002b) in *Pisodonophis boro* reported similar survival rates of 99.1%, 99% and 90% respectively. Low cost based diet showed highest growth performance and survival rate. Formulated low cost based diets were eagerly taken up and well accepted by the fish while high cost based diets were second highest in acceptability and rice polish based diet was least accepted (Ashraf *et al*. 2008), table 2. The results of the present study are comparable to those reported by Hasan *et al.* (2005). They did not get any difference in growth, feed conversion ratio, survival, protein digestibility, feed acceptability, body composition in low cost based diet (agro-based) compared with high cost based diet (fish meal) in common carp.

The results of the present study reveal that plant proteins can efficiently replace high cost fish meal in herbivorous fishes completely. As regards the economics of feeding, it gave encouraging results which can alleviate the financial burden on fish farmers and can improve the economics of the fish farming sector. Fish can give promising and favorable response to formulated diets if fed properly.

Table 2 Growth parameters of the rohu, *labeo rohta* fingerlings fed with different feeding regimes under intensive rearing:

Parameters	Diets						
	Control (12.3 %) T1	PUD-1 (35 %) T2	TOK (35 %) T3	PUD-2 (40 %) T4	URD-3 (40 %) T5	PUD-3 (45 %) T6	MIR (45 %) T7
Mean initial Weight (g)	4.18±.28	4.22±.38	4.18±.45	4.20±.64	4.20±.25	4.20±.21	4.22±.18
Mean final weight (g)	9.77±.58	17.85±.29	16.15±.34	20.10±.24	16.85±.29	26.17±.26	22.38±.31
Mean weight gain (g)	5.59±.15	13.63±.22	11.97±.18	15.9±.45	12.65±.38	21.97±.29	18.16±.25
% weight gain	57.22±.53	76.36±.28	74.12±.36	79.10±.24	75.04±.21	83.06±.44	81.14±.20
Mean initial length (mm)	54.40±.28	54.24±.33	54.24±.25	54.32±.29	54.40±.32	54.32±.24	54.48±.26
Mean final length (mm)	73.98±.42	94.82±.39	90.42±.63	96.28±.29	89.72±.21	109.82±.43	101.75±.20
Mean length gain (mm)	19.58±.20	40.58±.34	36.18±.25	41.96±.30	34.32±.11	55.50±.17	47.27±.43
% length gain	26.47±.12	42.80±.21	40.20±.30	43.58±.39	39.37±.26	50.54±.21	46.46±.17
FCR	1.53±.19	1.36±.27	0.99±.21	1.79±.34	1.42±.65	1.35±.38	1.46±.47
SGR % day	3.11±.17	7.57±.10	6.65±.16	8.83±.11	7.03±.18	12.21±.24	10.09±.29
Survival rate (%)	100±0.0	100±0.0	100±0.0	100±0.0	100±0.0	100±0.0	100±0.0
Gross fish Production (g)	5.59±.56	13.63±.48	11.97±.67	15.9±.12	12.65±.21	21.97±.18	18.16±.20
Diet acceptability	05	08	06	09	08	10	10

Table 3 Physico-chemical conditions of water in fingerlings rearing system under different treatments (arithmetic mean ± sd)

Parameters	Diets						
	Control (12.3 %) T1	PUD-1 (35 %) T2	TOK (35 %) T3	PUD-2 (40 %) T4	URD-3 (40 %) T5	PUD-3 (45 %) T6	MIR (45 %) T7
Temperature (ºC)	28.1±1	28.0±2	28.4±1	28.2±1	28.0±1	28.0±2	28.2±2
Dissolved oxygen (mg/L)	6.7±0.1	6.6±0.1	6.7±.0.1	6.6±.0.1	6.7±.0.1	6.7±0.2	6.4±0.1
pH	7.2±0.5	7.1±0.5	7.1±0.5	7.2±.0.5	7.3±.0.5	7.1±.0.5	7.4±.0.5
total alkalinity	416±15	421±20	418±20	417±20	419±15	418±15	420±20
total hardness	148±12	150±10	149±11	143±15	149±.10	146±14	148±10
Free carbon dioxide (mg/L)	8.8±0.6	8.6±0.8	8.8±0.4	8.5±.0.9	8.8±.0.6	8.7±.0.7	8.7±.0.5

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