Pakistan J. Zool., vol. 47(1), pp. 31-36, 2015.

Optimizing Growth Potential of *Labeo rohita* Fingerlings Fed on Different Plant Origin Feeds

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Abstract.- Present study was focused to evaluate the efficacy of different plant origin feed ingredients on growth, feed conversion ratio (FCR) and survival of *Labeo rohita* fingerlings. A total of nine different feeds: fishmeal, guar meal, corn gluten meal (30%), soybean meal, sunflower meal, rice polish, cotton seed meal, canola meal and rape seed meal were used and each feed was considered as a treatment. Fishmeal was used as control feed, because control diets are formulated with high levels of protein and the test ingredients are included at graded protein and their effect on growth is monitored. There were three replicates for treatment and control feeds. Fish fingerlings were fed 5% of their wet biomass twice a day. Highest increase in fish length (6.15±0.83 cm) and weight (27.16±6.95 g) was observed when the fish were fed with guar meal while lowest increase of 1.85±0.13 cm and 5.32±1.06 g was observed for corn gluten (30%) fed fish. However, highest FCR (1.86±0.05) was recorded for soybean meal while lowest FCR (9.57±0.48) was observed for corn gluten (30%). Highest fish survival rate of 100% was observed in fish fed with soybean meal while lowest survival rate of 70% in fish fed with canola and rapeseed meals.

Keyword: Guar meal, fishmeal, soybean meal, FCR, *Labeo rohita.*

INTRODUCTION

Labeo rohita, member of commercially important and widely cultured Indian major carps in Asia in general and Indian subcontinent in particular, is a prime freshwater fish in current fish culture setting (Khan *et al.,* 2004; Iqbal *et al.,* 2014). With continuously widening gap in demand and supply, the present traditional fish culture cannot keep up with the pace and food shortages are emerging. This state of affairs draws attention on heavy inputs and major alterations in the current system. However, when we talk about intensification and production boost, fish feed has always been a top priority. Appropriate fish feed is an independent, cumbersome and high attention demanding task. Formulation and preparation of balanced and cost effective fish feed, which is acceptable to fish and manageable for fish framers, has always been a challenging task for both aquaculturists and nutritionists. A lot of research on nutrient requirements and fishmeal replacement with cheaper plant feeds has been conducted. In addition, research have devoted major part of their investigative work to take care of anti-nutritional factors which normally interact with other feeds and nutrients resulting in growth depressions and nutritional diseases (Agbo *et al.,* 2011; Fagbenro and Davies, 2000).

Commercially available fish feeds are formulated for general purpose and are used for all the fish species universally. It is well accepted that nutrient requirements and feeds vary from species to species, in different environments and even at different stages of development within the same species. In addition, there is lot of variation in response of various fish species to different feeds. Consequently, there are numerous factors working in one way or the other at ingredient, nutrient or species level. Hence, controlling and blending of all the variables and various facets in single formulation will not only be difficult but also impossible. Species-specific feed formulations and their proportionate preparation can not only support optimum fish production but is cost effective too (Craig, 2002).

Aquaculture promotion depends on many factors but feed is always at the top, and account for more than 50% of the total input costs (Craig and

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0030-9923/2015/0001-0031 $ 8.00/0

Helfrich, 2002). Presence of essential nutrients in appropriate concentrations and elimination or at least reduction of anti-nutrients to the minimum acceptable level play a key role in fish growth (Mokolensang *et al*., 2003). Elangovan and Shim (2000) replaced fishmeal partially with soybean meal and recommended 37% replacement for *Barbodes altus*. Yigit *et al.* (2012) examined the effect of canola meal on *Oncorhynchus mykiss* fry and suggested 8% canola meal in *O. mykiss* diets. Um-e-kalsoom *et al.* (2009) evaluated wheat bran, broken rice and blood meal for hybrid fish *Catla catla* x *Labeo rohita* and suggested wheat bran for better growth of hybrid fish. Sahzadi *et al.* (2006) observed growth performance and feed conversion ratio (FCR) of hybrid fingerlings (*Catla catla* x *Labeo rohita*) fed on sunflower meal, cottonseed meal and bone meal and suggested sunflower meal and cottonseed meal for fish feed formulations for hybrid fingerlings. Considering these findings, the present study was focused to analyse the efficacy of locally available feeds on one of the most preferred fish species *Labeo rohita* in the Indian subcontinent.

MATERIALS AND METHODS

This three month trial on optimizing growth potential of *Labeo rohita* fingerlings fed on different plant based feeds was conducted at the Department of Fisheries and Aquaculture, Ravi Campus, University of Veterinary and Animal Sciences, Lahore. A total of nine feeds: fishmeal, guar meal, corn gluten meal (30%), soybean meal, sunflower meal, rice polish, cotton seed meal, canola meal and rape seed meal individually. Each feed was considered as an independent treatment while fishmeal served as control in these studies. The experiment was conducted in concrete tanks having dimensions 1.187 m × 0.537 m × 0.583 m (length × width × depth). Each feed was analyzed for fat, moisture, protein, fiber, ash and phosphorus by Büchi NIR Technology (Büchi NIRFlex N-500) (Table I). A total of 270 individual fish (30 for each treatment, 10 for each replicate) with an average mass of 5.2±1.04 g were stocked and all the fish were fed 5% wet body weight twice daily.

Growth variables

Initial body weight and length of all fish were

Table I.- Proximate composition of different feeds.

Analysis	FM %	CSM %	CM %	GM %	RP %	RSM %	CGM %	SM %	SBM%
Fat	8.76±0.02	0.55±0.07	0.88±0.05	2.51±0.06	3.08±0.09	0.57±0.05	0.47±0.04	N.D.	N.D.
Moisture	6.06±0.08	8.59±0.09	8.49±0.07	5.56±0.07	4.86±0.07	8.63±0.07	12.21±0.05	8.96±0.05	10.66±0.06
Protein	40.96±0.07	41.37±0.08	39.64±0.06	33.8±0.05	6.00±0.09	40.76±0.09	25.66±0.08	26.45±0.07	35.40±0.07
Fiber	1.49±0.07	7.39±0.06	8.17±0.06	8.66±0.07	24.69±0.08	9.05±0.02	9.57±0.04	19.77±0.09	13.58±0.07
Ash	25.37±0.06	13.99±0.06	5.74±0.04	10.61±0.08	6.24±0.07	5.69±0.06	9.77±0.04	8.68±0.02	10.88±0.04
Phosphorus	-	0.64±0.06	0.96±0.035	0.61±0.04	0.22±0.02	0.79±0.04	0.49±0.03	0.63±0.06	N.D.

N.D. Not detected, Fishmeal (FM), Cotton Seed Meal (CSM), Canola Meal (CM), Guar Meal (GM), Rice Polish (RP), Rape Seed Meal (RSM), Corn Gluten Meal (CGM), Sunflower Meal (SM), Soybean Meal (SBM)

taken at the time of stocking and thereafter the increase in weight and length was recorded on fortnightly basis.

Average weight gain (AWG) = Final average weight (g) - initial average weight (g).

Specific growth rate (SGR) was determined by following formula;

$$SGR\ (\%) = \frac{\ln (\text{Final wet body weight}) - \ln (\text{Initial wet body weight})}{\text{Number of days}} \times 100$$

Fish survival (%) (S) = 100 × (LC/LS)

LC, Number of fish recovered at the end of the experiment; LS, Number of fish stocked at the start of the experiment.

Water quality parameters

Dissolved oxygen (DO), pH, electrical conductivity, water temperature, salinity and total dissolved solids (TDS) were monitored on daily. Water temperature and DO were recorded by DO meter (YSI 55 Incorporated, Yellow Springs, Ohio, 4387, USA), pH by pH meter (LT-Lutron pH-207 Taiwan) and electrical conductivity, salinity and TDS by salinity meter (Condi 330i WTW 82362 Weilheim Germany).

Statistical analysis

The obtained data was analyzed through statistical software SAS (version 9.1) and Analysis of Variance (ANOVA) was applied to compare the effects of different feeds on fish growth. Correlation studies were carried out to find out the relationship between different water quality parameters.

RESULTS

Fish showed significant ($P \leq 0.05$) differences in growth (weight and length), average weight gain, average length increase and specific growth rate when fed different feeds (Table II). Fish showed higher average weight gain (27.16±6.95 g) on guar meal, followed by canola meal (25.54±3.81 g), cotton seed meal (23.13±3.28 g), rape seed meal (22.85±2.32 g), soybean meal (21.42±0.49 g), fishmeal (13.94±1.30 g), rice polish (7.53±0.22 g), sunflower meal (6.95±0.15 g) and corn gluten (5.33±1.07 g) (Table II).

Maximum average length increase were observed in guar meal (6.15±0.83 cm) and followed by canola meal (5.92±0.43 cm), rape seed meal (5.96±0.29 cm), cotton seed meal (5.57±0.59 cm), soybean meal (5.56±0.30 cm), fishmeal (3.46±0.29 cm), rice polish (2.53±0.005 cm), sunflower meal (2.42±0.100 cm) while minimum in corn gluten (1.86±0.14 cm) (Table II).

Specific growth rate maximum were observed in canola meal (0.79±0.05) and followed by guar meal (0.78±0.06), rape seed meal (0.75±0.04), cotton seed meal (0.73±0.04), soybean meal (0.584±0.006), fishmeal (0.41±0.05), rice polish (0.26±0.007), sunflower meal (0.25±0.01) while minimum in corn gluten (0.19±0.09) (Table II).

When FCR values were ranked in decreasing order of performance, the following trend emerged; soybean meal (1.86±0.05), guar meal (2.01±0.08), canola meal (2.44±0.04), cotton seed meal (2.47±0.03), rape seed meal (2.65±0.06), fishmeal (3.60±0.04), sunflower meal (7.61±0.45), rice polish (8.16±0.12) and corn gluten with the lowest FCR value (9.57±0.48) (Table II).

Growth parameters (weight and length) have negative relation with TDS (Correlation = -0.725; $P < 0.001$ and Correlation = -0.736; $P < 0.001$), DO (Correlation = -0.599; $P < 0.001$and Correlation = -0.597; < 0.001) and pH (Correlation = -0.574; $P < 0.001$ and Correlation = -0.629; $P < 0.001$). Length-weight relationship showed positive significant correlation (Correlation = 0.979; $P < 0.001$) (Table III).

DISCUSSION

Saeed *et al*. (2005) recorded highest growth in *Labeo rohita* fingerlings when fed with 60% corn gluten meal based diet as compared to blood meal and soybean meal based diets though all the three diets were isonitrogenous (30% CP). According to Inayat and Salim (2005) *Cirrhinus mrigala* grow better when fed with soybean meal while the species showed lowest growth for whole maize diets.

Among other feeds used in the present study, *Labeo rohita* showed higher performance on cotton seed meal (23.13±3.28g) when compared with

Table II.- Average weight gain, average length increase, specific growth rate, FCR and survival %

Feeds	Avg. weight gain	Avg. length increase	Specific growth rate	FCR	Survival %
Guar meal	27.16±6.95^{a}	6.15±0.83^{a}	0.78±0.06^{a}	2.01±0.08	80
Canola meal	25.54±3.81^{a}	5.91±0.43^{a}	0.79±0.05^{a}	2.44±0.04	70
Cotton seed meal	23.13±3.28^{ab}	5.56±0.58^{a}	0.73±0.03^{a}	2.47±0.03	80
Rape seed meal	22.85±2.32^{ab}	5.96±0.28^{a}	0.75±0.04a	2.65±0.06	70
Soybean meal	21.41±0.49^{ab}	5.56±0.30^{a}	0.58±0.06^{b}	1.86±0.05	100
Fishmeal	13.94±1.3^{bc}	3.46±0.29^{b}	0.41±0.05^{c}	3.60±0.04	90
Rice polish	7.53±0.21^{c}	2.53±0.05^{bc}	0.25±0.07^{d}	8.16±0.12	80
Sunflower meal	6.95±0.14^{c}	2.42±0.10^{bc}	0.24±0.03^{d}	7.61±0.45	90
Corn gluten meal	5.32±1.06^{c}	1.85±0.13^{c}	0.19±0.09^{d}	9.57±0.48	90

Means with same letter superscript letters are not significantly different at P>0.05

Table III.- Correlations among different physico-chemical parameters.

	EC	Salinity	Temperature	TDS	DO	pH	Weight
Salinity	0.931						
	0.000						
Temperature	0.094	0.048					
	0.334	0.623					
TDS	0.293	0.220	0.123				
	0.002	0.022	0.205				
DO	0.155	0.131	0.133	0.502			
	0.110	0.177	0.977	0.000			
pH	0.810	0.148	-0.612	0.513	0.696		
	0.063	0.126	0.095	0.000	0.000		
Weight	-0.003	0.063	0.255	-0.725	0.599	-0.574	
	0.972	0.520	0.050	0.000	0.000	0.000	
Length	-0.041	0.033	0.234	-0.736	0.597	-0.629	0.979
	0.673	0.736	0.046	0.000	0.000	0.000	0.000

Cell Contents: Pearson correlation
P-Value

sunflower meal (6.95±0.14g). Contrary to our studies, Sahzadi *et al*. (2006) observed better growth in hybrid (*Catla catla* x *Labeo rohita*) on sunflower meal (1.62±0.0 g) than cotton seed meal (1.61±0.01 g) and bone meal (1.52±0.0 g). Shabbir *et al*. (2003) used *Cirrhinus mrigala* as experimental species and reported that sunflower meal showed better results than maize gluten meal and wheat bran. Jabeen *et al*. (2004) observed highest growth in *Cirrhinus mrigala* fingerlings when fed on fishmeal (1.23 g) than cotton seed meal (1.17 g), which is contrary to present study that may be due to poor quality of fishmeal or preference of fish species. However, Hasan *et al*. (1997) could not find any differences in growth in *Cyprinus carpio* for various plant origin feeds. These variations in growth performance might be attributed to species' genetic makeup as different species respond differently to offered diets (Craig, 2002).

Fish culture is actually a very complex system and so many factors are working around and acting on fish in one way or the other and are very hard to advocate the supremacy of one feed and inferiority of the other. Different fish species and research environment also play a vital role in its growth and other bodily functions. Previous feeding and culture history of fish are additional factors that may change behavior of fish to a given feed. Until and unless all the factors are not well controlled, it is hard to reach at any decisive statement.

During the present study, higher FCR (1.86±0.05) was observed for soybean meal feed the

lowest FCR (9.57±48) was observed for corn gluten fed fish. Our findings are in line with Inayat and Salim (2005), who found higher FCR (1.70) in *Cirrhinus mrigala* when fed on soybean meal and lowest (3.36) when fed on maize. Saeed *et al*. (2005) on the other hand reported that FCR values in *Labeo rohita* decrease in following order blood meal (2.31±0.87), followed by soybean meal (3.46±0.69) and corn gluten meal (60%) (5.00±1.27). Similarly, during present study fish showed better FCR (2.47±0.03) for cotton seed meal than sunflower meal (7.61±0.45) while totally different findings were reported by Sahzadi *et al*. (2006) who observed comparatively higher FCR on sunflower meal (1.78±0.05) than cottonseed meal (2.17±0.01) in hybrid (*Catla catla x Labeo rohita*).

Among the other feeds used in the present study, the FCR for sunflower meal (7.61±0.45) was higher than for rice polish (8.16±0.12) fed fish. Same was reported by Ali and Salim (2004) who observed better FCR for sunflower meal, followed by fishmeal and rice polish while Hasan *et al*. (1997) could not find any significant differences in FCR for plant origin feeds in common carp (*Cyprinus carpio*).

During present study, 100% survival rate of *Labeo rohita* fingerlings was observed when fed with soybean meal while the survival was reduced to 70% for canola and rapeseed meal feeds. Similar findings were reported by Abid and Ahmed (2009) and Ahmed *et al*. (2012), who observed 100% survival in *Labeo rohita* for different feeds. Mbahinzireki *et al*. (2001) replaced 50% fishmeal with cotton seed meal diet and observed that such changes in diet do not affect growth and survival of *Oreochromis* sp. Hasan *et al*. (1997) did not observe any differences in survival and growth on plant origin based feed compared with fishmeal fed to common carp (*Cyprinus carpio*). Similarly Victor *et al*. (1999) reported no differences in growth and survival of Nile tilapia when fed on fishmeal and/or corn gluten, meat and bone meal supplemented with required essential amino acids. This indicates that essential amino acids might be the key player and if they are supplemented in amino acid deficient feeds, these feeds can do equally well as fishmeal, which is the current standard and the most expensive feed. But Bakhtiyar *et al*. (2011) in their experiment on *Labeo rohita* larvae comparing artificial and natural feeds, observed that feed may have a significant effect on fish survival.

During present study, growth variables *i.e.* weight and length showed positively significant correlation with DO and temperature while the same parameters showed negatively significant correlation with TDS and pH (Table III). Hussain *et al*. (2011) reported reduction in fish growth with decrease in temperature from optimum range. The water quality parameters pH, temperature and DO have a great influence on fish growth (Ali *et al*., 2000; Ahmad *et al*., 2008; Noor *et al*., 2010).

In conclusion, guar meal and soybean meal are better feeds for *Labeo rohita* fingerling due to the overall better growth performance, FCR and survival.

ACKNOWLEDGEMENT

The authors are grateful to Higher Education Commission (HEC) of Pakistan for providing research grant for this study under Indigenous PhD Scholarship Scheme.

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(Received 8 March 2014, revised 15 October 2014)