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Growth Performance of Mrigal (*Cirrhinus cirrhosus*) Fingerlings Affected by Local Diets Through Energy Ratio in Aquarium Condition

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Abstract

Mrigal (Cirrhinus cirrhosus) is a first growing commercial cultured species in Bangladesh. The initial energy gain of this fast growing specis depends on the protein and energy ratio in the diet. Insufficient amount of essential protein in feed hampers growth and new body tissue building. Therefore, an aquarium trial of 60 days was undertaken to evaluate the growth performance of Mrigal, with considering energy ratio in laboratory condition. The experiment was conducted with Cirrhinus cirrhosus fingerlings to measure protein energy ratio of five formulated feed with locally available ingredient which containing 33% dietary protein level. The experiment was comprised of five treatments having with two replicates containing 15 fingerlings of mean total initial weight of 13± 0.02g. Five diets were formulated with five group energy levels (4.22, 4.06, 4.07, 4.35, 4.25 Kcal/g). From this study it has been found that F_5 (mixed plant based protein) and F_1 (fishmeal) showed highest and lowest food conversion ratio (FCR), respectively. While the lowest and the highest value of specific growth rate (SGR) and FCR was determine the vice versa between F_1 and F_5 treatments. The result showed that diet containing with 4.35 Kcal/g gross energy level and 75.86 mg protein energy ratio produced significantly (P<0.01) best growth.

***Key words**: Cirrhinus cirrhosus, feed, aquarium and protein quality*

I. Introduction

The first growing Indian major carp, Mrigal (*Cirrhinus cirrhosus*) is a very popular, tasty and commercial cultured species in Bangladesh. It is a bottom feeder and thrives on decaying organic matter and vegetable debris. In our country, this species has been cultured at farm levels to a larger extent more than other single fish species (Roy, 2004). As like as other family members, it is poikilothermic and its growth, food consumption, food conversion and other body functions are markedly influenced by water temperature (Andrews *et al*., 1978; Elliott, 1982). This fish is also imperative because of its seed availability, relatively faster growth, acceptability by consumers and high market value. Energy is the key characteristics of any life beings with no exception in case of fish. Initially energy gain depends on the protein energy ration in the diet (Cho and Kaushik, 1985).

Artificial feed in the form of single ingredient or mixture of two or more ingredients where fish meal serves a vital protein source then becomes obligatory to improve fish growth and to increase final output. Among others fish meal is a widely used and costly protein component (Carter and Hauler, 2000; Engin and Carter, 2005). It is well recognized that the partial or total substitute of fish meal in

fish diets with cheaper and more reliable alternate protein sources without compromising growth has been a priority in aquaculture nutrition research (Hardy, 1996). To reduce the production cost of feed and protein growth of fish, the relationship between protein and energy is one of the most prime attribute. Because inadequate of required energy intake by fish, dietary proteins are utilized as energy source and finally increases production cost. Although insufficient required amount of protein in fish feed new body tissue building and growth are hampered. Protein ratio of energy and protein in the diet should be optimized carefully. Unless sufficient dietary energy is supplied, the quality of dietary protein can not reflect protein synthesis. Hence, the present research has been aimed to determine the protein to energy ratio of different locally available animal and plant based formulated feed having some protein level for *Cirrhinus cirrhosus* fingerlings.

II. Materials and Method

Experimental System

This trial was carried out for 60 days in a static indoor aquarium system in wet laboratory of Brackishwater Station of Bangladesh Fisheries Research Institute. Ten glass aquaria with each of size 90 cm x 30 cm x 30 cm having a capacity of 75 L each were used as experimental tank. All the aquaria were kept on 1m high cemented platform to make easy for better observation and management. During experimental period tap water was used as the source of water supply in the aquaria. About one-third of each of the aquarium was filled with tap water. Artificial aeration was provided by using pump (Davio pump NS 7200). A natural photo period of day and night length was maintained throughout the experimental period.

Sources of fish fingerlings and acclimatization

Fingerlings of Indian major carps, mrigal (*Cirrhinus cirrhosus*) were collected from Suvro Fish Hatchery, Jessore. The fish were transferred in the stocking tank and given a prophylactic treatment with 0.5% NaCl dip for 25 minutes and methylene blue of 0.5 ppm for 3 days. The experimental fish fingerlings were then redistributed in three other aquaria with adequate aeration in water in order to be acclimatized to the experimental condition for next 15 days. During acclimatization the fish were fed on formulated pelleted diet condition 33% crude protein at a rate of 10% body weight as preservation ratio.

Experimental diets

Earlier to formulation of feeds all the locally available ingredients were initiated to proximate analysis and the results are presented in Table 1. Five iso-nitrogenous diets were formulated to contain 33% crude protein from different ingredients of plants and animal sources. The diets (F_1 to F_5) contained fishmeal, protein concentrate, meat, bone meal and mixed plant based protein respectively as major sources of dietary protein. Formulations of the experimental diets are shown in Table 2. Proximate analysis showed little variation in protein content in the various diets, which ranged from 33.10 to 33.57%. Crude lipid content in the diets ranged between 10.57 and 12.60% where the maximum value of 12.60% crude lipid was found in diet F_5 (Table 2). The gross energy contents as was expressed as K cal/g were more or less similar in all the five diets and ranged between 4.06 (F_2) and 4.35 (F_4).

Experimental procedure

Five treatments were scheduled for the study. Each treatment had two replicates and ten fingerlings per replicate with a mean initial weight of 1.00±1g size, weighed on a precision balance. The fishes were fed with the formulated diets up to satiation level twice daily at 6 hours interval between 9.00 and 15.00 hours. Record of the amount of food fed was kept for subsequent calculation of food conversion ratio (FCR), Protein efficiency ratio (PER), Specific growth rate (SGR) and apparent net protein utilization (ANPU).

Water quality

The water quality parameters such as dissolved oxygen, pH and temperature were monitored weekly throughout the experimental period. Dissolved oxygen was measured using DO meter (HACH multipara meter) and pH by a pH meter (Portable digital pH meter OSK 1148) and temperature was recorded by using a Celsius thermometer.

Sampling procedure

Initial and final weights of fish in catch replicate group were recorded. Fish in each replicate group was bulk weighed and recorded at every 10^{th} day. Fish were weighed to the nearest 0.01g on fine electric balance (College B2002-S).

Carcass composition

At the start of the study 30 fingerlings from the stock tanks was randomly sacrificed, wet weighed and dried in oven at 100^0C and sampled for proximate composition analysis. At the end of the experiment, all the fishes of replicate groups in each treatment were again analyzed for proximate composition as before.

Analytical methods

The dietary ingredients, diets, faeces and the fish samples were analyzed for their proximate composition in triplicate according to standard procedures given in Official Method of analysis of the Association of Official Analytical Chemists (AOAC, 1990). If main effects were significantly different, differences among the treatments were tested with Tukey's multi-comparison test of means. The analyses were run at 5% significance level using statistical package (SPSS Version 16).

III. Results and Discussion

Formulation and proximate composition of various experimental diets are presented in Table 1 & 2. It has been found that the protein content in various diets ranged very little from 33.10 to 33.57% and the crude lipid content ranged between 10.57 and 12.60 %. The nitrogen free extract (NFE) varied between a short ranges of 39.83 - 45.48. The gross energy contents as was expressed as K cal/g were more or less similar in all the five diets ranged between 4.06 (F_2) and 4.35 (F_4).

Table 1. Formulation of different experimental diets (33% crude protein level dry weight basis)

Sl. No.	Ingredients	Feed / Diet				
		F_1	F_2	F_3	F_4	F_5
1	Fish meal	13.60	-		43	-
2	Protein conc.	17.20	52		-	-
3	Meat & bone meal	15.90	-	45.20	-	-
4	MOC	-	-		-	13.0
5	Soyabean meal	-	-		-	49.0
6	Sesame cake	-	-		-	10.5
7	Rice bran	-	-		-	15.0
8	Wheat flour	30	30	30	30	10
9	CMC	2	2	2	2	-
10	Testing salt	0.50	0.50	0.50	0.5	0.50
11	Vit. premix	1.0	1.0	1.0	1.0	1.0
12	Chromic –oxide	0.50	0.50	0.50	0.5	0.50
13	∞- Celulose	16.0	10.40	16.2	19.0	-
14	Soyabean oil	3.30	3.60	3.0	4.0	-
15	Crude protein	33	33	33	33	33
16	Energy (Kcal/g)	4.22	4.06	4.07	4.35	4.25
17	PE (mg protein/ kcal energy)	78.19	81.28	81.08	75.86	77.64

*CMC- Carboxymethyl Cellulose

The present study was demonstrated that the best feeding response and growth performance of fingerlings fed on diet a containing fish meal (33% crude protein and 4.35 Kcal/g gross energy with protein energy ratio of 75.86). To get an optimum growth response of the fish species selection of 33% crude protein level in the all diets of this experiment was a justified amount. The energy (4.35 Kcal) of the diet was adequate for maintenance and growth. Khan (1991) conducted an experiment on the economically optimal growth of *L. rohita* comprising with 34% crude protein level of diets where present study comprised of 33% crude protein. Catacutan and Coloso (1995) also reported that diet containing 42.5% crude protein and 10% lipid with a P/E ratio of 128 (mg protein/Kcal) was found to be optimum for juvenile (1.34g) sea bass. Garling and Wilson (1976) demonstrated the optimum P/E ratio for channel cat fish to be 88 with dietary protein levels of 24 to 36%. Silva and Gunasekera (1991) conducted an experiment on the economically optimal growth of *L. rohita* comprising with 31% crude protein level of diets which is lower than the present study. In channel cat fish bigger fish require more energy and less protein compared to smaller fish (Page and Andrew, 1973).

Table 2. Proximate composition of different diets (% dry matter basis)

Diet No.	Dry matter	Crude protein	Crude lipid	Ash	NFF
F_1	93.13	33.13	11.23	12.60	43.04
F_2	93.30	33.38	10.57	15.83	40.22
F_3	92.55	33.32	10.96	15.89	39.83
F_4	92.92	33.34	11.53	9.65	45.48
F_5	92.28	33.36	12.60	13.53	40.51

*NFE- Nitrogen Free Extract

In this experiment, mean initial weight of fingerlings were 13.08g and highest P/E ratio was found in diet F_2 containing 4.06 Kcal/g energy level. The protein energy relationship influenced on fish growth on fed of different diet. This may be due to the fact that this fish will meet their daily protein need for

optimal growth even if they are fed to satiation. This finding is similar to that of Hossain (1998) who reported that 26% digestible protein containing diet for *Clarias gariepinus*. Silva (1991) showed that growth is increasing with increasing energy level. Least growth was found in fish fed on plant source protein diet containing 33% crude protein and 4.25 Kcal energy. This may be due to the fact that when fish were fed higher in relation to protein, they could not meet their daily protein needs for optimum growth even if they were fed to satiation level. In addition, it might be due to less digestibility of plant protein compared to the protein form animal sources.

The water quality parameters such as temperature, dissolved oxygen and pH ranged from 26-30^{O}C, 5.0-6.5 mg/l and 6.8-7.3 respectively. The ranges of water quality values in the present study are well within the limit for fish life and could not have hampered the growth of fish (Jhingran, 1983).

The growth response and feed utilization by *Cirrhinus cirrhosus* in terms of initial weight, final weight, Food Conversion Ratio (FCR), Protein Efficiency Ratio (PER), Specific Growth Rate (SGR) and Apparent net protein utilization (ANPU%) are shown in Table 3. It is seen that fish fed on fish meal (F_4) containing 33% crude protein and 4.35 Kcal/g gross energy produced significantly highest ($P<0.05$) total percent growth among the experimental diets. There were no significant ($P<0.05$) difference between the weight gain (%) of fish fed diets F_3 and F_1. The SGR value of fish fed different experimental feeds varied between 0.82 and 1.16 where, fish fed feed F_4 produced significantly ($P<0.05$) the highest SGR (1.16) than the others. Feed F_5 (33% crude protein and 4.25 Kcal/g gross energy) showed significantly ($P<0.05$) the lowest growth and SGR.

Table 3**.** Response of dietary protein to energy ratio on growth parameters and food utilization by *Cirrhinus cirrhosus* fed on five experimental diets

Parameters	Feed / Diet				
	F_1	F_2	F_3	F_4	F_5
Initial Wt.(g)	13.20	13.05	13.05	13.05	13.0
Final Wt. (g)	23.66	23.73	22.69	26.26	21.30
Weight gain (g)	10.46	10.68	9.64	13.16	8.30
Weight gain (%)	79.25^{c}	81.90^{b}	73.87^{bc}	100.53^{a}	65.85^{c}
SGR (%)	0.97^{bc}	1.00^{b}	0.92^{bc}	1.16^{a}	0.82^{c}
FCR	1.72^{bc}	1.69^{b}	1.88^{b}	1.37^{a}	2.17^{c}
PER	1.71^{bc}	1.76^{b}	1.60^{bc}	2.18^{a}	1.38^{c}
ANPU (%)	25.83^{bc}	26.01^{b}	16.43^{bc}	47.12^{a}	12.93^{bc}

The FCR values with different diets ranged between 1.37 and 2.17 with diet. It was significantly different ($P<0.05$) from other values. However, the FCR values in treatment F_2 and F_3 were not significantly different ($P<0.05$) from other values. The PER values ranged between 1.38 and 2.18. The PER of F_4 had significantly different ($P<0.05$) and higher values whereas F_5 showed significantly different ($P<0.05$) but lowest PER value. The Apparent net protein utilization (ANPU%) for the diets ranged between 12.93 and 47.12 (Table 3). The significantly ($P<0.05$) highest ANPU values were obtained with feed F_4 and the values was significantly different ($P<0.05$) among the treatments.

The FCR in the present study ranged between 1.37 and 2.18. Diet F4 (P/E ratio of 75.85) showed significantly least FCR values than others (Table 1). The FCR in the present study are a little higher than those reported by Biswas (1997) with *Cirrhinus cirrhosus*. Reis *et al.*(1998) reported a much lower FCR of 1.15 in channel catfish fed diet containing 35% protein with a P/E ratio of 120. Protein efficiency ratio (PER) in the present study followed more or less similar but opposite trend of FCR and ranged from 1.37 to 2.18. PER of 2.18 with fishmeal diet F_4 (P/E= 75.86) was maximum and value of 1.37 with plant source as dietary protein diet E (P/E ratio 77.64) was minimum. The PER values obtained in this study are higher than those reported by Das *et al.*(1991) for *L. rohita* The

ANPU% values in the present study ranged between 12.93 to 47.12% which are higher than the ANPU value reported by Hossain *et al.*(1994).

Table 4. Carcass composition of experimental fishes (% dry matter basis) at the start and end of the experiment

Feed No.	Dry matter (%)	Protein (%)	Lipid (%)	Ash (%)
F_1	94.70	68.80	10.03	21.17
F_2	94.30	68.41	10.71	20.88
F_3	94.80	68.01	10.02	21.97
F_4	94.00	69.32	11.96	18.72
F_5	94.20	68.19	10.17	21.64
Initial (all fishes)	91.00	68.13	6.59	25.28

Proximate carcass composition of the fish at the start and at the end of the experiment is shown in Table 4. The moisture and lipid content was influenced by the dietary P/E ratio. There was a marked increase in lipid content of fish fed on different diets in composition with initial lipid content of fish during experiment. The carcass lipid content ranged between 6.59 and 11.96%. The moisture content ranged between 94.0 to 94.8%. Fish fed diet F_4 produced the highest carcass protein content followed by diets F_1, F_2, F_5 and F_3.

Carcass protein content of fish was found a marked influenced by P/E ratio. In this study comparatively higher amount of lipid increment was found in fish fed on diet a containing fishmeal. Similar result of lipid increment was obtained with *Cirrhinus cirrhosus* fed on different diets containing treated and untreated soybean meal (Chisty, 1997).

Our findings comparable with other previous workers and further confirm that fish meal is more protein sources totally in herbivorous fish varieties while partially in carnivorous fish species. Nevertheless, it is much easier for *Cirrhinus mrigala* to utilize locally available animal proteins with their energy due to similar habitat, digestive morphology and physiology and feeding characteristics. Therefore, our studies are not only suggestive but can be conclusive in the inclusion of locally available animal proteins and its energy for mrigal in the formulation of cost effective artificial feeds.

IV. Conclusion

This study suggests that among all different locally available ingredient tested for formulating the fish feed because of its superior quality feed F4 (containing higher amounts of protein) can be a potential candidate for formulating cost effective and nutrient-rich diet for *Cirrhinus cirrhosus* fingerlings. Therefore, this study is not only suggestive but can be conclusive in the inclusion of locally available animal proteins and its energy for mrigal in the formulation of cost effective artificial feeds. Further research by employing various processes to either completely eliminate or reduce the local trash fish based diet is in progress.

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