Pakistan J. Sci. Ind. Res., Vol. 31, No. 4, April 1988

GROWTH, FOOD CONVERSION AND PROTEIN UTILIZATION OF MAJOR CARP *CIRRHINA MRIGALA* FRY FED ARTIFICIAL DIETS

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(Received February 21, 1988; revised April 24, 1988)

Growth, feed efficiency, protein efficiency ratio and food quotient of the fry of major carp *Cirrhina mrigala,* supplied three compounded diets were studied. Diet 'A' comprised linseed oil cake, wheat bran, sugarcane roughage, hyacinth meal, blood meal and egg shell; diet 'B' included all three ingredients except hyacinth meal, and diet 'C' contained only linseed oil cake, sugarcane roughage and blood meal. Proportions of different components were altered resulting in varied percentages of protein (45.5-50.7), fat (0.95-1.35), (carbohydrate (40.1-43.3), inorganic matter (5.6-10.2) and the energy value (363.9-384.3 Kcal/100 g). Instantaneous growth rate, feed efficiency and protein efficiency ratio increased but food quotient declined with intake of dietary protein and the non-protein energy. Quality of energy entering the body appreciably influenced these nutritional parameters. Protein sparing action of carbohydrate and fat components of the diet was clearly evident. Mineral supplementation of feeds exceeding 5.5 % was found unnecessary.

Key words: Food conversion, Growth, *Cirrhina mrigala*.

INTRODUCTION

Major carps are commercially most important and constitute capture as well as culture fisheries of fairly good magnitude in the Indian sub-continent. These include mainly *Catla catla*, rohu *Labeo rohita* and mirgal *Cirrhina mrigala*. The success of carp culture is largely due to the hardness of the species. For the forseable future the carp will continue to be the chief supplier of fish protein to man and an increasing proportion of that protein will come from intensively cultured carp. As such it is of great importance to know the nutritional requirement of these fishes.

The aim of the present study was to examine the growth promoting effects and nutritional efficacy of cost-effective dietary combinations in the fry of major carp *Cirrhina mrigala*. Limited supplies and hike in prices of conventional protein sources call for exploring alternative least-cost agricultural/agro-industrial byproducts and roughages that can be used for formulating balanced rations for fishes. Rational management of early stages (fry, fingerling) of *Cirrhina mrigala* is essential to meet the growing demands of aquaculture. The performance of economically feasible diets through growth rate, protein utilization, food quotient is encouraging. The information assumes universal importance in as much as the formulated diets used in this study can be tried on other species of carps, murrels etc.

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MATERIALS AND METHODS

Major carp (*Cirrhina mrigala*) fry of the same induced bred stock (average body length and weight 1.35 cm and 0.2 g, respectively) were released in artificially constructed ponds (3ft x 3 ft x 3ft) and acclimated for three days. Temperature, dissolved oxygen concentration and pH of the water were 30-31^{o}, 8 ppm and 7.5, respectively. Three types of compounded diets (Table 1) in dry and powdered form were supplied to different batches of fry. Their chemical composition and energy value have been indicated in Table 2. Specimens of each batch totalling 100 were fed daily four times their body weight. Ration size was determined through preliminary laboratory experiments. Fish were fed and libitum, the amount of uneaten food was removed and food intake calculated. The

Table 1. Composition of artificial diets fed to *Cirrhina mrigala* fry.

Dietary ingredients	Proportions of ingredients in diets A	B	C
Linseed oil cake	30.0	30.0	50.0
Wheat bran	25.0	25.0	–
Sugarcane roughage	10.0	12.0	40.0
Water hyacinth meal	5.0	–	–
Blood meal	27.0	30.0	10.0
Egg shell	3.0	3.0	–

Table 2. Chemical composition and energy value of diets.

Diet	Protein (%)	Fat (%)	Carbohydrate (%)	Total inorganic matter (%)	Total Organic matter (%)	Fuel value (Kcal/100 g diet) Protein (cal)	Fat (cal)	Carbohyd- (cal)	Total (cal)
A	48.62	1.25	40.13	10.0	90.0	194.48	11.25	160.52	366.25
B	45.54	0.95	43.31	10.2	89.8	182.16	8.55	173.24	363.95
C	50.77	1.35	42.28	5.6	94.4	203.08	12.15	169.12	384.35

ration size was determined thus avoiding wastage. Feeding was continued for 4 weeks after which fish were taken out and measured for their length and weight for determination of their nutritional and growth parameters.

Instantaneous Growth Rate (IGR) was calculated by the equation :

$$IGR = \frac{(\log_e W_2 - \log_e W_1)}{D} \times 100$$

where, W_1 = Initial body weight (g); W_2 = Final body weight (g); D = Days of feeding

Gross food conversion efficiency (FCE) was evaluated as:

$$FCE = G/I \times 100$$

where, G = Gain in body weight (g); I = Amount of food consumed

To measure the proteineEfficiency ratio (PER) the following eqution was used

$$PER = \frac{\text{Gain in body weight (g)}}{\text{Protein intake (g)}}$$

The food quotient (FQ) was ascertained using the formula:

$$FQ = \frac{\text{Weight of food supplied (g)}}{\text{Increase in body weight (g)}}$$

Dietary protein was determined by the help of the method of Lowry *et al.* [1]. Fat was extracted from diet samples by the help of soxhlet apparatus where petroleum ether (boiling point 40-60°) was used as solvent [2]. Both fat and ash were calculated on percent basis and carbohydrate content evaluated according to the rule-of-thumb [3] in which the percentages of protein, fat and ash in dry samples were summed up and the total was subtracted from 100.

RESULTS

All the three compounded diets produced a general pattern of healthy growth. It can be seen from the nutritional data emboided in Table 3 that the diet 'C' was most effective, followed by 'A' and 'B' in promoting growth in the young *C.mrigala*. After 30 days of feeding the gains in body weight were of the order of 50.5, 43.27 and 33.33 times their original values in 'C', 'A' and 'B', respectively. So was the case with instantaneous growth rate (IGR), food conversion efficiency (FCE) and protein efficiency ratio (PER) were quite sensitive to protein intake and increased with dietary protein level (DPL). Performance of the diets was also positively related to their energy value.

Table 3. Food assimilation and growth of *Cirrhina mrigal* fry fed artificial diets.

Diet	No of specimens	Instantaneous growth rate (%)	Food conversion efficiency (%)	Protein efficiency ratio	Food quotient
A	100	12.558	35.225	0.72	2.84
B	100	11.688	26.94	0.59	3.71
C	100	13.07	41.25	0.81	2.42

Comparitive efficacy of the diets is also evident by the values of food quotient (FQ) which was in an order reciprocal to IGR, FCE and PER. Obviously, larger quantity of food was required to yield unit gains in body weight of fish fed diets lower in protein.

Besides DPL, the proportions of the other two energy sources viz. carbohydrate and fat, also influence the efficiency of food conversion and protein assimilation. Inorganic substances exceeding 5.5 % of the diet did not seem to exert any favourable effect on growth.

DISCUSSION

Growth rate, food conversion efficiency and protein efficiency ratio increased with the amount of protein intake. These nutritional parameters were maximum when protein formed more than 50 % of the diet 'C'. During early phase of life characterized by most rapid growth, the requirement of protein is highest. Growth of the fish is accompanied by synthesis of protein which depends on a regular supply of raw materials by way of food. The rate at which the fry puts on weight is unmatched by growth in subsequent years of life.

Such a high protein requirement is not surprising considering the ambient temperature (30-31°) at which the fry were reared. Within normal limits, fishes are known to attain optimum growth at greater dietary level at higher temperature than when they are maintained at lower temperature. Chinook salmon (*Oncorhynchus tshwaytscha*) required food containing 40% protein at a water temperature of 8.3° but the protein requirement for sustaining same rate of growth increased to 55 % when the temperature was raised to 14° [4]. Likewise channel catfish (*Ictalurus punctatus*) has been reported to grow at optimum rate when supplied 35 % protein at 20° but needed 40 % protein food at 25° [5]. For the common carp (*Cyprinus carpio*) the optimum protein level is 38 % at 23° [6] and for eel. (*Anguilla japonica*) the same is 48 % at 25° [7]. Murray *et al.* [8] and NAS-NRC [9] have stressed the need of incorporating non-protein energy content of ration for dealing with increased caloric requirements of fish at high temperatures.

Total energy value of the proportions of carbohydrate and fat calories, besides protein calories determined the performance of the diets. In this study, quality of energy however seemed far more important. The most calorific diet with abundance of protein calories (diet 'C') gave the best results. In times of maximum protein requirements (early life) fats and carbohydrates are essential for their protein-sparing roles. The protein is spared for its primary function of growing and building the body tissues. Findings of Prather and Lovell [10] support this view. These authors observed that the ability of the channel catfish to utilize protein to sustain optimum growth was limited to 29 % when total energy value was 220 Kcal/100 g diet, and energy level of diet was raised to 286 Kcal/100 g the fish utilized 42 % protein and grew faster.

Sparing effects of carbohydrate and fat calories on the need for protein in catabolic processes assumes special significance in fish nutrition when capacity of the body to handle or assimilate protein is retarded but demand of this nutrient spuriously high for growth, maintenance or reparation. In the light of published information by Mustafa [11] on limitations of fishes to deal with nutrients related to the enzyme equipment the amount of protein assimilated under such a critical situation is indispensable and must be protected for enabling it to perform its basic function. Carbohydrate and fat play the rescue roles and undergo combustion for the uninterrupted supply of energy. Sparing action is, however, not extended to quantities of protein which either exceed body's requirements or cross body's threshold for assimilation. Deamination of amino acid raw materials in excess and their elimination as ammonia in freshwater fishes is one of the most probable pathways. Feeding additional amounts of protein to fish will, therefore, not result in growth enhancement. Rather it will decline the PER.

It is an undeniable fact that carbohydrate is the most readily utilizable source of energy than any other nutrients. However, when carbohydrate in adequate amount is available, further addition of this nutrient to the diet will not improve its performance. This is explicitly indicated by the present study. From the foregoing discussion it is pretty certain that augmenting energy intake of fish feeding a fixed adequate protein in the diet will promote nitrogen balance. This complex dietary interrelations emphasize the need of more experimental work on this aspect.

Enrichment of diet by inorganic substances beyond about 5.5 % did not enhance the nutritional quality of the diet for fish. Supplementation of the diet by powdered egg shells (diet 'A') can be dispensed with. Presumably, the remaining items of the formulated feeds and the aquatic medium supply the required amount of minerals. Calcium, the most needed of the minerals, occurs in ionizable form and enters the fish directly through gills. The so called chloride cells of the gills are perhaps involved in active transport of calcium in fishes which are hyperosmotic with respect to their medium. According to Hastings [12] the environment contributes ionized mineral compounds and their exchange with body's metabolites takes place by way of simple diffusion, enzymatic action, metabolic carriers or special cellular selection. The amount exchanged must, however, be governed by the principles of homeostasis. Further, since calcium absorption improves with protein level in the diet [13] it is certain that the fishes fed protein rich diets are in a position to make better use of the available amount of minerals. Substitution of extra proportion of inorganic matter in the diet by more needed, least-cost ingredients will improve the ration quality.

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