

Effect of Hormones on Growth and Food Utilization of the Indian Major Carp, *Cirrhinus mrigala*

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The influence of human chorionic gonadotropin (HCG) and testosterone propionate (TP) at the dosages of 10 ppm and 3 ppm respectively, and their combination (HCG+TP) of 8 ppm and 1.5 ppm on the growth, food conversion, digestibility, enzyme activity, nucleic acid content, Oxygen consumption and ammonia excretion of the Indian Major Carp, *Cirrhinus mrigala* was assessed. The experiments were conducted in cement tanks (5x4x1 m) for 98 days by feeding hormones through fish meal based prepared diet having 35% protein. Growth of *C. mrigala* was high in hormone fed fishes than the control with the maximum growth recorded in the HCG treatment followed by HCG+TP, TP and control. Specific growth rate (SGR), food conversion efficiency (FCE), apparent protein and lipid digestibility were high in hormone fed fishes ($p < 0.01$) than the control. The enzyme activity in the foregut, midgut and hindgut showed marked variation with the highest activity noticed in the foregut followed by midgut and hindgut. The rates of oxygen consumption and ammonia excretion of hormone fed fishes were found to be not significantly different from control ($P > 0.05$). The hormones stimulate growth through increasing the appetite and enhancing food utilization and protein synthesis.

Key words : Hormones, growth, food utilization, *Cirrhinus mrigala*

In modern aquaculture, feeding is a major component which contributes to the cost of production. Much attention has been paid towards devising measures to increase the efficiency of feeds so that fishes can be raised to desired size in a short period at low cost. For achieving this goal, the role of hormones and growth promoters in several cultivable fishes have been evaluated (Ostrowski & Garling, 1986; Kondareddy *et al.*, 1987; Shyama & Keshavanath, 1988). Androgens having anabolic property are being considered as efficient growth promoters. Very recently a few investigations have evaluated the promising role of HCG as growth promoter in fish culture (Shyama & Keshavanath, 1990; Salini, 1993; Shambhu & Jayaprakas, 1994). The present work was therefore undertaken with a view to evaluating the effect of HCG, a peptide hormone and the anabolic steroid, testosterone propionate

(TP) singly and in combination on the Indian major carp, *Cirrhinus mrigala*.

Materials and Methods

The culture experiment was conducted in rectangular cement tanks (5x4x1 m) for a period of 98 days. The water level was maintained at 75 ± 0.5 cm throughout the period of study using well water. The standard fish meal based prepared diet pelleted by using fish meal (29.23%), ground nut oil cake (29.23%), rice bran (20.76%) and tapioca flour (20.76%) with 35% protein was used as a medium for hormone incorporation. Human chorionic gonadotropin (HCG) obtained from Serana SA., Switzerland and Testosterone propionate (TP) from INFAR India Ltd. were incorporated at the dosages of 10 ppm (T1) and 3 ppm (T2) respectively. For the combination treatment (T3), 8 ppm HCG and 1.5 TP were used while basal feed as used as the

control (T4). Three replicates of each treatment were maintained.

Fingerlings of *C. mrigala* were acclimatised for 2 weeks and then stocked at a density of 15 fish tank⁻¹ after noting the total length and weight. Feeding was done twice daily at 10% body weight per day. Fish were sampled once every 14 days to assess growth and the quantity of feed was re-adjusted after every sampling. Water quality parameters such as temperature, pH, dissolved oxygen, free carbon dioxide and total alkalinity were monitored fortnightly following APHA (1956) procedures.

After rearing for a period of 98 days, all the surviving fishes were caught and total length & weight were measured. Fish samples were taken for analysis of DNA, RNA, digestive enzymes and for estimating the proximate composition. Five fishes were dissected out; the viscera, liver and kidney were weighed and body indices, VSI, HSI and RSI, respectively were calculated using the following formula:

$$\text{Tissue indices} = \frac{\text{weight of tissue}}{\text{total weight of fish}} \times 100$$

Specific growth rate (SGR) was calculated as

$$\text{SGR (\%)} = \frac{\log_e W_2 - \log_e W_1}{T_2 - T_1} \times 100, \text{ where}$$

$$W_2 - \text{weight at time } T_2$$

$$W_1 - \text{weight at time } T_1$$

The enzyme activities in three regions of the intestine (foregut, midgut and hindgut) were assessed. The enzyme extracts were prepared in chilled distilled water and the protein content was analysed (Lowry *et al.*, 1951). Amylase activity was estimated by the saccharogenic assay (Henry & Chiameri, 1960) and the protease activity by the casein digestion method (Kunitz, 1947). Biers' titrimetric method

(Bier, 1962) with certain modifications was used for lipase activity. DNA and RNA contents were estimated using methodologies of Carlewis & Stone (1987). Oxygen consumption and ammonia excretion of the fish (11.3 to 18.06 g) were analysed on termination of the growth study at every 2 h after feeding for 24 h, using three fishes for each treatment.

Another experiment for 30 days was conducted in the laboratory in plastic troughs of 50 l capacity employing five fish in each trough. The fishes were fed with the hormone incorporated and control feed once daily at 10% body weight. The unconsumed feed and faecal matter were siphoned out separately, oven-dried and weighed. About a two-third of the water was replenished daily with fresh water causing minimum disturbance to the fishes. On termination of the experiment, the length and weight of the fishes were recorded, sacrificed, and dried in the oven (60°C). The nitrogen and lipid contents of the fish muscle and faecal matter were estimated following AOAC (1975) procedures. The following food utilization parameters were calculated.

$$\text{Food conversion efficiency (FCE)} = \frac{\text{wet weight gain (g)} \times 100}{\text{Dry weight of feed given (g)}}$$

$$\text{Assimilation efficiency} = \frac{\text{Assimilation} \times 100}{\text{Food intake (g)}}$$

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

$$\text{Apparent nitrogen/lipid} = \frac{\text{digestibility (\%)} (\text{Nitrogen/lipid intake} - \text{Nitrogen/lipid in faeces})}{\text{Nutrient intake}}$$

ANOVA and *t*-test were applied to find out the statistical significance differences in length, weight and tissue body

indices of *C. mrigala* between treatments and control.

Results and Discussion

The water quality parameters such as temperature, pH, dissolved oxygen, alkalinity and free carbondioxide were found to vary from 27 to 28.5°C, 7.01 to 7.64, 7.84 to 12.90 ppm, 36 to 50 ppm and 0 to 4.44 ppm, respectively during the period of study. The physico-chemical parameters were within the optimum range suitable for the culture of carps.

The final mean weight attained by fishes in each treatment (Table 1) showed highly significant variations between treatments and control ($p < 0.01$). The better growth of fishes in treated groups may be due to growth promoting influence of the hormones (Cowey *et al.*, 1973; Degani, 1985). Faster growth as also evidenced by high SGR Values (Table 1). Similar result was also reported by Nanjundappa & Varghese (1988). Superior growth of HCG fed fishes shows that HCG is a promising growth stimulant. Shyama & Keshavanath (1990) have found that 20 ppm HCG enhanced growth in silver carp and mahseer. Salini (1993) has also reported in increase in growth of *Labeo rohita* when fed HCG at 100 mg kg⁻¹ diet. Similarly HCG at 20 mg kg⁻¹ diet induced weight gain in *Etroplus suratensis* (Sambhu & Jayaprakas, 1994). Therefore it appears that the optimum dosage of HCG for better growth is species dependent.

The combination of HCG and TP produced higher growth rate than TP alone but lesser than HCG. Similar results have been reported by Shyama & Keshavanath (1990). Higgs *et al.* (1977) and Ostrowski & Garling (1986) have also reported the additive effect of hormones. The better growth of fishes fed with TP over the control diet in the present study is

comparable to the growth obtained in *L. rohita* by feeding a diet containing 5 ppm 17 - a - MT (Kondareddy *et al.*, 1987). Low levels of 17 - a - MT (1 and 3 ppm) have enhanced the growth in silver carp (Shyama & Keshavanath, 1988). The reduction in growth rate of fishes treated with HCG+TP in comparison to HCG alone, may be attributed to the reduced dose of HCG or the inhibitory effect of TP over the growth promoting effect of HCG.

Table 1 Growth and food utilization of *Cirrhinus mrigala* fed different diets

Growth parameters	HCG	Treatments		
		TP	HCG+TP	Control
Initial length, cm	5.18 ±0.58	5.18 ±0.58	5.18 ±0.58	5.18 ±0.58
Final length, cm	17.59 ±0.65	12.92 ±0.32	15.03 ±0.19	11.03 ±0.23
Initial weight, g	1.235 ±0.18	1.235 ±0.18	1.235 ±0.18	1.235 ±0.18
Final weight, g**	18.06 ±0.45	13.56 ±0.56	15.86 ±0.33	11.3 ±0.30
Net weight gain, g	16.83	12.33	14.63	9.90
Specific growth rate (SGR) (%)	2.74	2.45	2.61	2.26
Survival (%)	95	95	100	98
Feed consumption, g	10.14	9.9	10.02	11.31
Feed conversion efficiency, %	25.64	19.69	19.96	16.35
Assimilation efficiency, %	73.37	75.76	76.05	76.92
Protein efficiency ratio (PER)	0.73	0.56	0.57	0.47
Nitrogen digestibility, %	90.74	90.04	91.66	90.76
Fat digestibility, %	93.49	90.78	92.54	85.88

Mean of triplicates ** $F_{3,9} = 11.45$ $p < 0.01$

Table 2. Mean DNA and RNA contents in the muscle of *Cirrhinus mrigala* fed different diets in mg g⁻¹

Treatments	HCG	TP	HCG+TP	Control
DNA	83.42 ±3.09	65.38 ±0.43	69.35 ±0.81	58.91 ±4.02
RNA	973.20 ±2.63	986.48 ±1.32	1150.32 ±1.32	943.43 ±3.48
RNA/DNA ratio	15.34	15.08	16.58	16.01

The HCG treated fish showed significantly higher VSI than control ($p < 0.01$) (Fig. 1). Anabolic steroids have been found to bring about changes in tissue body indices (Matty and Cheema, 1978; Lone, 1980). A significant decrease in VSI of TP treated carps ($p < 0.05$) from that of the control was observed in the present study. Similar observations have also been reported by Lone (1980) and Basavaraja *et al.* (1989). A significant increase in HSI was noticed in all the hormone treated groups

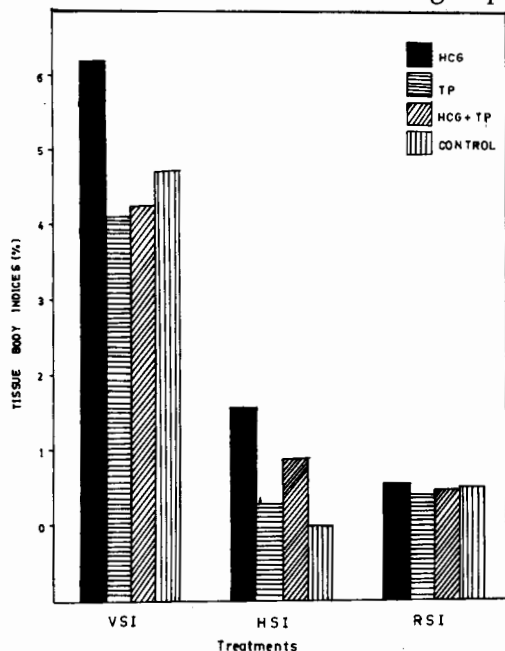


Fig. 1. TISSUE-BODY INDICES FOR VISCERA (VSI), LIVER (HSI) AND KIDNEY (RSI) OF *C. MRIGALA* FED DIFFERENT DIETS

Fig. 1. Tissue body indices for Viscera (VSI), Liver (HSI), and Kidney (RSI) of *Cirrhinus mrigala* fed different diets

over control ($p < 0.01$) (Fig. 1). The response of liver to hormone treatment is in agreement with that reported earlier (Bukley & Swihart, 1973). No significant variation ($p > 0.05$) was observed in the RSI between treatments and control indicating no hypertrophy of renal tissue as the weight of the fish increased. Reduction in HSI was more evident in slow growing fish indicating that HSI is growth dependent. These indicate that the incorporation of exogenous hormones not only enhances growth but also increases food utilization efficiency and storage of nutrient reserves in liver. Highest food conversion efficiency was noticed in the HCG treatment (25.64%) and lowest in the control (16.35%) (Table 1). Improvements in FCE fish fed on 17- α -MT have been reported in rainbow trout (Matty & Cheema, 1978). Coho salmon (Fagerlund *et al.*, 1979), common carp (Lone, 1980) and murrel (Nirmala & Pandian, 1983). Fat digestibility was high in all the treatments. Gogoi & Keshavanath (1988) suggested that feed digestibility and assimilation may be dependent more on the dosages of hormones used. Protein efficiency ratio showed a decreasing trend from HCG to control. The highest PER value with HCG which induced the highest growth rate indicates better utilization of protein from the diet. Similar results on mahseer and silver carp have been reported by Shyama and Keshavanath (1990).

A clear cut difference ($p < 0.01$) in the enzyme activity was noticed, with the maximum activity in the foregut followed by midgut and hindgut (Fig. 2). Similar observation was reported by Dhage (1968). Enzymes activity in the gut of the fish have been shown to be a function of species, feeding habit, diet, temperature, pH, age of fish and exogenous enzymes (Hofer, 1979). Only marginal variations in enzyme activity between treatments were noticed. Hence it is suggested that the exogenous hormones may not be enhancing enzyme

secretion, but may act to enhance the absorption process by the intestine.

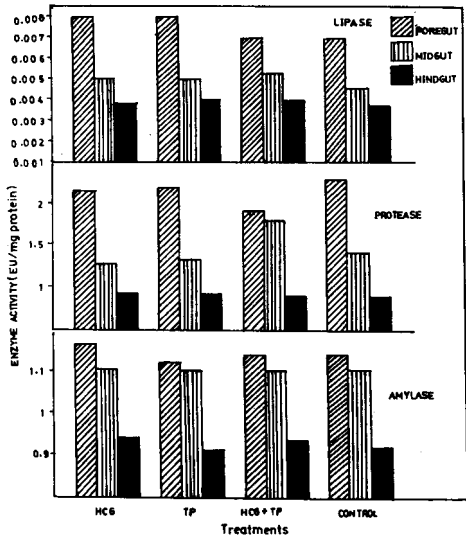


Fig. 2. Activity of digestive enzymes in fore, mid and hindgut of *Cirrhinus mrigala* fed different diets

RNA and DNA contents of fishes fed with hormone diets were higher than that

of the control (Table 2). This observation agrees with the results reported by Lone (1980) in the case of *C. carpio* fed 17 - a - MT. The RNA/DNA ratio did not show any significant difference between treatment and control. Bulow (1970) and Haines (1973) observed that with the increasing levels of food available to the fishes there was an increase in RNA/DNA ratio and protein synthesis with an overall increase in weight of the fish.

The oxygen consumption in all treatments increased steadily from the second to sixth hour and then became irregular while ammonia excretion increased from 2nd to 18th hour and decreased thereafter (Fig. 3). The metabolic activities in terms of oxygen consumption and ammonia excretion did not appear to be influenced by the dietary administration of hormones.

It appears that the mechanism by which the anabolic steroids promote growth and protein metabolism is entirely

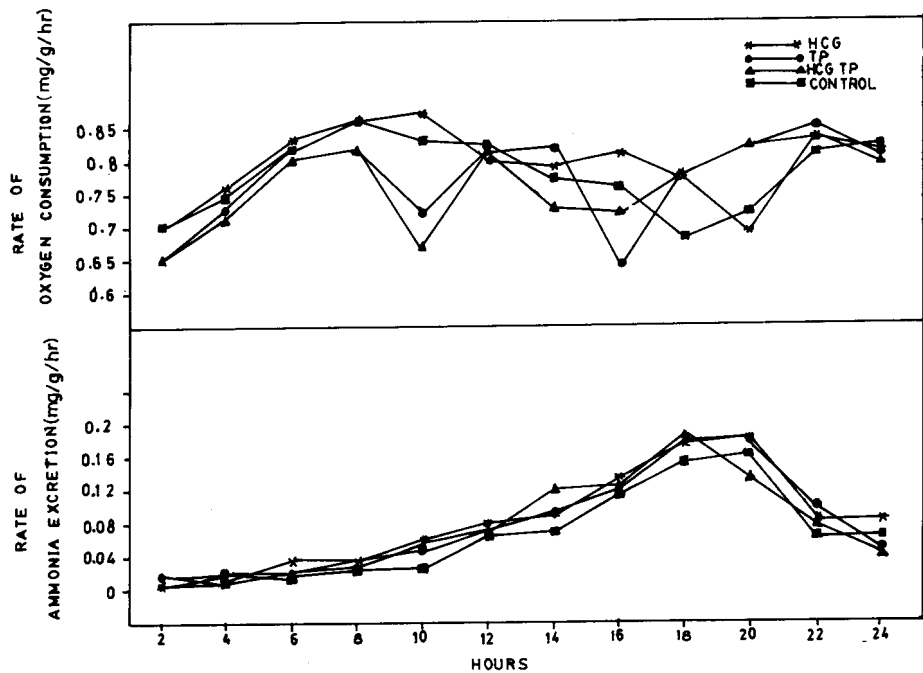


Fig. 3. Rate of oxygen consumption in *Cirrhinus mrigala* fed different fed different diets

physiological in action and depends on providing the normally operating anabolic processes with exogenous stimuli. The hormones may be inducing growth by influencing feed conversion efficiency. The peptide hormone like HCG and anabolic steroid can be effectively used in intensive Indian major carp culture for promoting growth and increased food conversion efficiency.

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