

Growth response of African catfish, *Clarias gariepinus* (Burchell) to varied protein and lipid levels

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To study the growth response of African catfish (*Clarias gariepinus*) to the diets containing two protein (30 and 35%) and two lipid levels (12 and 18%) in a closed recirculatory system for 60 days, fish were fed to satiation twice daily. The experiment was carried out in triplicate groups. Fortnightly sampling of fish and water samples was carried out. The best result in terms of growth was obtained with the diet containing 34.62% protein and 12.12% lipid. The protein to lipid ratio was 18.57 in the diet that gave best percentage weight gain. However best survival, food conversion ratio and protein efficiency ratio were recorded in the diet containing 29.86% protein and 18.08% lipid.

The African catfish or sharp tooth catfish which is known as Nile catfish, *Clarias gariepinus* (= *lazera*) is a recent addition to Asian aquaculture. It is native to Africa and its farming activity in India is scanty. The species is highly suitable for high density tank culture but such a system is not yet adopted on commercial scale¹. General characteristics and hardiness of air breathing fishes allow them to be cultured in areas which are not suitable for culture of Indian major carps.

Relationship of dietary protein to lipid (P:L) ratio and rate of growth are perhaps indicative of the P:L ratio that gives optimal growth at a particular dietary protein level². The protein requirement of any fish varies with water temperature, water quality and fish size³. The non-protein energy level may also influence the protein requirement of fish. High levels of protein without sufficient energy in the diet may be harmful to fish⁴. Larger fish require more energy and less protein compared to smaller fish⁵. The protein sparing effect of fat and carbohydrate has been studied in other fishes⁶.

The present experiment has been carried out to study the response of African catfish to diets containing two protein levels and each level with two lipid levels on growth, survival and feed utilization.

Materials and Methods

Fry of African catfish (*Clarias gariepinus*) procured from a private hatchery in Trissur, Kerala, brought to the farm of the College of Fisheries, Man-

galore, Karnataka, and reared to fingerling stage in 25 m² cement cisterns. During these time they were fed a practical fishmeal based diet developed in the college.

A closed recirculatory system consisting of 12 circular fibre glass tanks (diam. 66 cm) of 120 litre capacity were used for the experiment (Fig. 1). Water was recirculated after passing through a three stage biological filter⁷. In the first stage graded layers of sand filter the water mechanically and biologically. Second stage filter consists of oyster shells and third stage has clam shells which filter water biologically, wherein *Nitrobacter* reduce toxic ammonia to less toxic nitrate and *Nitrosomonas* convert nitrite to harmless nitrate (Fig. 2). Filter water was then pumped to an overhead tank (1000 litre capacity) and the water flow to culture tanks was maintained by gravity at 1 litre/min and culture tanks were aerated for 6 hr during day time. Each tank was stocked with 4 fingerlings (average of 6.58 g).

Four test diets (A, B, C and D) were formulated (Table 1) using locally available ingredient along with soya flour, which was supplied by Soya Good Rich (Pvt.) Ltd., Shimoga. Supplevite-M supplied by Sarabhai Chemicals, Baroda, was used as source of vitamin and mineral premix (Table 2). Out of four diets, diets A and B were formulated for 30% protein and C and D for 35% protein, while diets A and C had around 12% protein and B and D 18% lipid (Table 3). The diets were analysed for proximate composition⁸. Nitrogen-free extract (NFE) was calculated as

carbohydrate by the difference method⁹. The gross energy content of the diets was calculated using physiological fuel values of 5 kcal/g for protein¹⁰ and 9 and 4 kcal/g for fat and carbohydrate (NFE) respectively¹¹ (Table 3).

The experimental diets were fed to catfish to satiation twice daily in triplicate groups. Fishes were sampled fortnightly to record their weight and length and to adjust the quantity of feed given. Unconsumed feed was siphoned out and actual feed taken by fish was calculated. Faecal matter was also removed daily and the experimental tanks were cleaned to remove dirt and algal scum adhered to the sides of tanks regularly.

Water samples collected on the day of fish sampling were analysed for pH, temperature, dissolved oxygen, free carbon dioxide and total alkalinity¹².

The specific growth rate (SGR), food conversion rate (FCR) and protein efficiency ration (PER) were calculated using the formulae,

$$\text{SGR} = \frac{\log_e \text{Final weight} - \log_e \text{Initial weight}}{\text{number of days}} \times 100$$

$$\text{FCR} = \frac{\text{Dry weight of feed consumed (g)}}{\text{increment in body weight (g)}}$$

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

The average weight gain of fish obtained at the end of the experiment was tested using one way analysis of variance technique¹³.

Results and Discussion

The results are presented in Tables 4 and 5.

The water quality parameters recorded during the period of study were well within the range suitable for fish culture¹⁴. The effect of protein and lipid levels on African catfish growth and survival in the present study is comparable to that found earlier for sev-



Fig. 1—Closed recirculatory system-view of culture tanks (24) arranged in 2 tier system.

Fig. 2—Closed recirculatory system-view of biological filter tanks.

Table 1—Ingredients proportion (%) in the experimental diets

Ingredients	Diets			
	A	B	C	D
Soya flour	13	15	13	13
Fish meal	29	27	38	41
Groundnut cake	15	17	15	10
Rice bran	10	10	08	05
Tapioca flour	10	10	09	04
Ragi flour	17	10	12	10
Vitamin & mineral premix	01	01	01	01
Sunflower oil	2.5	05	02	05
Sardine oil	2.5	05	02	05

Table 2—Composition of vitamin mineral premix (Supplevite-M supplied by Sarabhai Chemicals, Baroda)

Each 250g Supplevite-M provides

Vitamin A	500,000 IU
Vitamin D ₃	100,000 IU
Vitamin B ₂	0.02 g
Vitamin E	75 units
Vitamin K	0.1 g
Cal. pantothenate	0.25 g
Nicotinamide	1.00 g
Vitamin B ₁₂	0.6 g
Choline chloride	15 g
Calcium	75 g
Magnesium	2.75 g
Iodine	0.1 g
Iron	0.75 g
Zinc	1.5 g
Copper	0.2 g
Cobalt	0.045 g

Table 3—Proximate composition of experimental diets (% dry matter basis)

Parameters	Diets			
	A	B	C	D
Dry matter	91.96	91.24	91.69	90.66
Crude protein	30.04 (0.31)	29.86 (0.49)	34.62 (0.13)	34.84 (0.46)
Crude fat	11.98 (0.09)	18.08 (0.12)	12.12 (0.10)	17.79 (0.32)
Crude fibre	3.85 (0.28)	3.80 (0.22)	3.91 (0.25)	3.51 (0.32)
Ash	7.38 (0.18)	7.77 (0.42)	6.93 (0.33)	7.61 (0.23)
NFE	46.75	40.49	42.42	36.25
Gross energy (kJ/g)	18.41	19.61	18.70	19.83
P/E ratio (mg protein/kJ/g)	16.32	15.23	18.57	17.57

Average of three values with standard errors in the parentheses

eral other fish species^{2,15-19}. In this study, catfish fingerling grew best with the diet containing 34.62% protein and 12.12% fat. In red tilapia² and chinook salmon²⁰ growth rate was correlated to the daily protein consumption, irrespective of the dietary lipid content.

The level of lipid required for maximum growth, survival and food conversion of African catfish fingerlings in the present study has been found to be 12.12%. In common carp, growth was not depressed when fed diet containing 18% lipid²¹. Channel catfish, however showed growth depression when the dietary lipid was increased from 12 to 16% (ref. 22). Red tilapia could effectively utilize a lipid up to 18% (ref. 2). Snakehead fingerlings can utilize 13% lipid without any adverse effect²³. The relationship be-

Table 4—Water quality parameters mean values and ranges(parentheses) recorded during the experimental period

Parameters	Diets			
	A	B	C	D
Temperature (°C)				
Atmosphere	27.17 (26-28)	26.67 (26-28)	27.07 (26-28)	27.30 (26-28)
Water	28.83 (27-30)	28.63 (27-30)	28.73 (27-30)	28.60 (27-30)
pH	7.68 (7.47-8.00)	7.51 (7.13-7.90)	7.59 (7.30-7.93)	7.63 (7.43-7.80)
Dissolved oxygen (mg/l)	8.05 (7.63-8.57)	7.98 (7.60-8.40)	7.94 (7.53-8.30)	7.93 (7.63-8.30)
Free carbon dioxide (mg/l)	0.23 (0.00-0.43)	0.09 (0.00-0.17)	0.21 (0.00-0.37)	0.16 (0.00-0.27)
Alkalinity (mg/l of Ca CO ₃)	53.14 (48.00-56.57)	48.96 (47.30-50.33)	53.10 (46.50-59.30)	47.40 (44.30-49.31)

Table 5—Weight gain, SGR, FCR, PER and survival of African catfish (*Clarias gariepinus*)

Details	Diets			
	A	B	C	D
Crude protein (% dry matter)	30.04 (0.31)	29.86 (0.49)	34.62 (0.13)	34.84 (0.46)
Crude fat (% dry matter)	11.98 (0.09)	18.08 (0.12)	12.12 (0.10)	17.79 (0.32)
Initial weight (g)	5.43 (0.71)	5.00 (0.28)	5.39 (0.74)	10.49 (5.27)
Final weight (g)	38.58 (0.60)	37.61 (3.72)	49.92 (8.20)	60.35 (13.49)
Initial length (cm)	9.14 (0.60)	8.98 (0.17)	8.88 (0.42)	10.95 (2.08)
Final length (cm)	17.36 (0.27)	16.95 (0.66)	20.64 (1.26)	19.76 (2.06)
Mean weight gain (g)	33.15 (0.35)	32.61 (3.56)	44.53 (7.51)	49.86 (8.61)
Weight gain (%)	610.50	652.20	826.16	475.31
Survival (%)	83.25	91.67	66.67	75.67
SGR (%)	3.27	3.36	3.71	2.92
FCR	2.34 (0.12)	2.30 (0.02)	2.31 (0.05)	2.51 (0.34)
PER	1.42	1.46	1.25	1.14

Figures indicate mean of three values with standard errors in parentheses

tween dietary protein and lipid and rate of growth perhaps an indication of the protein and lipid ratio which gives optimal growth at a particular dietary protein level^{12,19,23,25}. Based on the studies conducted in various fish species, Tacon and Cowey²⁴ concluded that specific growth rate was positively correlated to the dietary protein requirement. In the present study the SGR of catfish was directly correlated to the dietary protein level up to 34.62%.

FCR and PER are known to decrease with increase in dietary protein up to a level that gives optimum growth^{21,26-29}. Results of the present study indicate that dietary lipid at two protein levels influence the PER. The highest P/E ratio for the African catfish was found to be 18.57 mg protein/kJ/g in the diet C which induced maximum percentage weight gain.

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