Proc. Indian Acad. Sci. (Anim. Sci.), Vol. 95, No. 4, July 1986, pp. 457–462.

Growth and metabolism of the catfish *Clarias batrachus* (Linn.) fed with different experimental diets

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MS received 4 January 1985; revised 1 February 1986

Abstract. Specific growth rate and protein efficiency ratio were highest in *Clarias batrachus* (Linn.) fed with Halver's diet followed by fish fed with fishmeal, dried silkworm pupae, meatmeal and groundnut oilcake in decreasing order. Protein synthesis in liver was maximum in fish fed with standard test diet followed by those fed with silkworm pupae, fishmeal, meatmeal and oilcake fed fish. Intestinal protease activity was unaltered in all fishes except those on oilcake diet. Level of total serum protein of different groups of test fishes were comparable. Growth of fish and serum Ca : *P* ratio were positively correlated ($P < 0{\cdot}05$). The results suggest that animal protein component is a better source of protein in the diet of *Clarias batrachus* for satisfactory growth and that fishmeal and silkworm pupae can be incorporated in the operational diet with advantage.

Keywords. Nutrition; *Clarias batrachus.*

1. Introduction

Utilisation of protein by fishes is influenced by protein quality and gross protein level of the diet (Steffens 1981). In this paper, we report the influence of diets with different protein sources on the growth and metabolism of the tropical catfish *Clarias batrachus* (Linn.).

2. Materials and methods

Healthy specimens of *C. batrachus* (weight ~20·5 g, stocking density 15 per cistern) were fed with 5 different feeds (fishmeal diet, meatmeal diet, silkworm pupae diet, groundnut oilcake diet and Halver's standard diet, see table 1 for composition) at 8% of body weight per day for 8 weeks. The composition of the feed was adjusted to 25% protein content.

Individual fish was weighed every week and percentage gain over initial weight, conversion ratio, protein efficiency ratio and specific growth rate were calculated. At the end of the study period, physiological parameters (see below) were measured in the experimental fishes. The water temperature during the study ranged from 24·0–28·0°C.

For measuring the intestinal protease activity, the scrappings from the intestine were processed as per the method described by Mukhopadhyay *et al* (1978) and the proteolytic hydrolysis compounds were assayed following the method of Moore and

Table 1. Composition (in %) of experimental diets[a]

	Fishmeal diet (a)	Meatmeal diet (b)	Silkworm pupae diet (c)	Oilcake diet (d)	Halver's standard diet (e)
Bulk a,b,c,d or e	60·23	28·94	58·38	53·90	100·00
Rice bran	9·77	41·06	11·62	16·09	—
Wheat flour	29·00	29·00	29·00	29·00	—
Yeast	1·00	1·00	1·00	1·00	—
Moisture	15·64	15·58	16·62	18·16	50·00
Crude protein	24·73	25·48	24·73	24·30	25·00
Ash	19·75	11·83	4·68	6·75	2·00
Crude fat	6·50	4·97	10·60	7·54	4·50
Crude fibre	3·46	8·62	3·64	7·52	4·00
Nitrogen Free Extract (NFE)	29·92	33·88	39·73	35·72	14·50

[a]Proximate composition of all test diets except Halver's was estimated analytically.

Stein (1948). The protease activity was expressed as Δ absorbance at 570 nm/mg protein/hr.

Protein synthesis in liver was measured as incorporation of L-lysine-$U^{14}C$ (specific activity 120 mCi/m mol; obtained from Bhabha Atomic Research Centre, Trombay, Bombay). The fish was injected with the isotope at the rate of 10 μCi/100 g body weight, sacrificed after 2 hr and liver separated. Protein was precipitated at a final tricarboxylic acid concentration of 5%. The precipitate was processed and the radioactivity was counted in an automatic liquid scintillation counter and expressed as cpm/10 mg liver tissue.

Serum protein was estimated by the method of Lowry *et al* (1951).

Blood serum calcium and phosphorus were estimated by Clark-Collip modification of the Kramer-Tisdall method and Fiske and Subba Row method, respectively as described by Oser (1960).

3. Results

Fish fed on Halver's standard diet for 56 days showed 179·1% increase over initial weight while those fed on fishmeal diet, silkworm pupae diet, meatmeal diet and groundnut oilcake diet recorded 67, 65·9, 36 and 6·2% increase respectively (figure 1). The best conversion ratio was obtained with Halver's standard diet followed by fishmeal diet, silkworm pupae diet, meatmeal diet and groundnut oilcake diet. Protein efficiency ratio and specific growth rate of fish fed on different diets also followed similar trends (table 2).

Table 3 presents details of physiological parameters recorded from fishes fed with experimental diets. Fish fed with oilcake and meatmeal diets showed significantly lower levels of intestinal protease than those fed with other diets ($P < 0{\cdot}1$). The rate of protein synthesis varied with diets and was highest in fish fed with standard diet and lowest in fish fed with oilcake diet. Protein synthesis rates in fish fed with silkworm pupae and fishmeal diet were significantly higher than that in fish fed with meatmeal diet.

Between the different groups of fishes the serum $Ca:P$ ratios were significantly

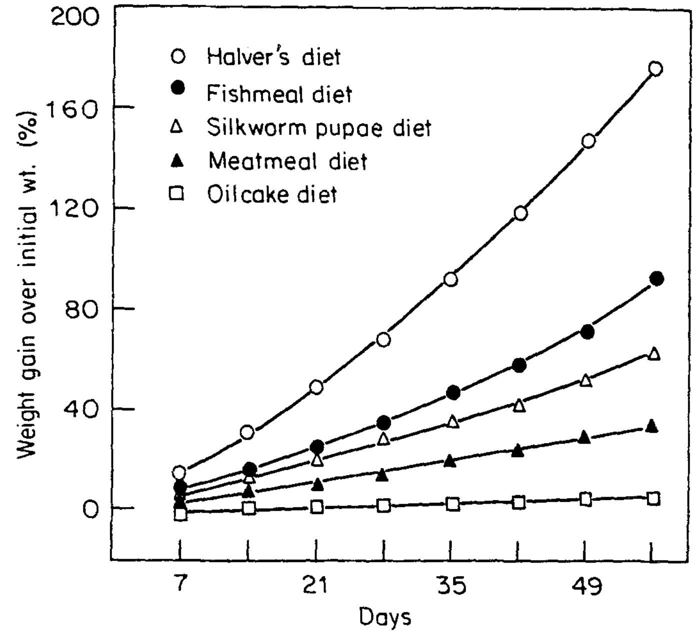

Figure 1. Weight gain of *C. batrachus* fed with different diets.

Table 2. Effect of different diets on growth and conversion efficiency of *C. batrachus*.

	Halver's standard diet	Fishmeal diet	Meatmeal diet	Silkworm pupae diet	Oilcake diet
Conversion ratio	3·36	5·19	10·98	5·31	39·67
Protein efficiency ratio	0·82	0·61	0·38	0·59	0·17
Specific Growth Rate[a]	1·7	1·2	0·6	1·0	0·1

[a]Expressed as growth per day as percentage of body weight (α)

$$W_t = W_o \left(1 + \frac{\alpha}{100}\right)^t$$

different and related to the growth responses of fish. Analysis of the blood revealed no significant variation in the levels of serum protein in fish fed with different diets.

4. Discussion

The 5 feeds used in the present study were isonitrogenous (25% crude protein) and as such the differences in the responses between the various groups of fish may be related mainly to the differences in protein quality. The lower than the normal growth rate (recorded under earthern pond conditions) may be related to the lower water temperatures (24–28°C). Halver's standard diet (protein source casein and gelatin) gave the highest growth and conversion and protein efficiency ratio. Apparently, the proteins in fishmeal and silkworm pupae diets were utilised equally by the fish while the meatmeal diet was poorly utilised. The plant protein based

Table 3. Effect of different diets on certain physiological parameters of *C. batrachus*.

	Halver's diet	Fishmeal diet	Meatmeal diet	Silkworm pupae diet	Oilcake diet
Intestinal protease activity (ΔOD 570/mg protein/h)	12·0 ± 0·03	12·52 ± 0·30	10·14 ± 0·61	12·89 ± 0·60	8·02 ± 0·15^{a}
Aminoacid (l-lysine-U^{14}C) incorporation (cpm/10 mg liver tissue)	375·53 ± 2·79	146·30 ± 2·58	86·30 ± 1·86^{b}	166·24 ± 3·83	13·78 ± 1·36^{b}
Serum protein (g/100 ml)	4·01 ± 0·004	4·04 ± 0·0011	4·12 ± 0·0374	3·80 ± 0·2160	4·01 ± 0·0838
Serum Ca: *P* ratio	0·079 ± 0·0008	0·075 ± 0·0041	0·058 ± 0·0015	0·071 ± 0·0009	0·053 ± 0·0015^{c}

Values are expressed as Mean ± S.E. of 5 observations. Levels of significance are indicated for values on the same row.
$^{a}P < 0{\cdot}1$; $^{b}P < 0{\cdot}01$; $^{c}P < 0{\cdot}05$.

oilcake diet resulted in very low growth rate and poor conversion and protein efficiency ratios. A loss in weight of fish fed with this diet was recorded during the first week. Protein from groundnut oilcake appears to be nutritionally unsuitable for growth of *C. batrachus*.

High protease activity has been reported in the intestine of *C. batrachus* which exhibit predilection for carnivorous diet (Mukhopadhyay *et al* 1978). The present study shows that the level of protease activity in fish fed with predominantly animal protein diet was higher than that in fish fed with a total plant protein diet. While the influence of dietary protein level on the protease activity in fishes is well documented (Kawai and Ikeda 1973; Mukhopadhyay *et al* 1978; Steffens 1981), there is no conclusive evidence to illustrate the relationship between the source of dietary protein and the level of protease activity. Such variations in enzyme activity may be related to the structure of protein and the duration of retention of feed in the intestine which in turn depends on the fibre content and physical consistency of the diet.

Protein synthesis rates in fishes fed with different diets followed the same trend exhibited by the growth rate of the fishes. This indicates the probable role of the composition of diets on protein synthesis and also the nutritive value of their ingredients.

The serum Ca-*P* ratios of fish fed with different diets are correlated with growth and conversion efficiency of fish. This indicates some limited application of the serum Ca-*P* ratio for evaluating the nutritional background/history of fishes under experimental conditions.

Steady levels of serum protein in fish with varied rates of protein synthesis indicate the inherent ability to maintain constant serum protein levels even under varied nutritional conditions. This is similar to the ability of the toad fish, *Opsanus tau* to maintain a certain level of circulating plasma protein under conditions of increased protein synthesis in the liver (Hashemeyer 1973).

Superiority of fishmeal over other ingredients in the practical diets of various fishes has been reported (Andrew and Page 1974; Viola 1975; Fowler and Banks 1976; Davis and Stanley 1978). In the present experiment, comparison of the growth rate and other physiological parameters of fish fed with fishmeal diet and silkworm pupae diet indicates that the nutritional value of silkworm pupae compares well with that of fishmeal but the better growth response may be related to higher fat and carbohydrate contents and protein quality. In *Catla catla,* silkworm pupae diet was found to result in a better growth rate than that by fishmeal diet (Jayaram and Shetty 1980). Thus, silkworm pupae, a waste product in silk industry, can replace fishmeal in formulated fish diets.

5. Conclusion

Fishmeal and silkworm pupae are better sources of protein in the diet of *C. batrachus* than meatmeal and groundnut oilcake. The conventional diet used in carp culture, a mixture of oilcake, rice-bran and wheat flour, was a nutritionally poor diet for *C. batrachus.*

Acknowledgements

We wish to express our gratefulness to Dr A V Natarajan, for his keen interest and constant encouragement. We are also thankful to Dr Babulal, for his help in radioactivity counting.

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