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FOOD INTAKE, GROWTH, FOOD CONVERSION, AND BODY COMPOSITION OF CATFISH EXPOSED TO DIFFERENT SALINITIES

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ABSTRACT

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The effects of different salinities (0, 2, 4, 6 and 10‰) on food intake, growth, food conversion, and body composition of the freshwater catfish *Mystus vittatus* (Bloch) were studied. Under a restricted feeding schedule daily intake of food was found to be salinity dependent. Fish reared in 10‰ consumed more *Tubifex tubifex*, converted less efficiently and displayed poor growth as compared to individuals reared in fresh water. Fish flesh production decreased from 483 g (fresh water) to 177 g (10‰ salinity) as the salinity was increased. Water content of the fish was found to decrease with increase in salinity, while maximum ash (25.56%) and fat (42.25%) were exhibited by fish reared in 10‰ salinity.

INTRODUCTION

It is a well established fact that an organism and its environment cannot be separated and that an organism reacts to its total environment rather than to a single factor (Al Dahan and Bhatti, 1977). A single factor like salinity is found to influence the metabolism of fish (Canagaratnam, 1959; Otto, 1971; Brockson and Cole, 1972; Raghuraman, 1973; De Silva and Perera, 1976). Kinne (1962) demonstrated that growth and food conversion efficiency in fish are valuable indicators of functional adaptation to salinity. Data on the metabolic rates of fish at different salinities are essential for comparative purposes in assessing the effects of sublethal stresses caused by extremes of salinity and low oxygen levels (Hettler, 1976). The present paper details the influence of salinity on food conversion, flesh production and body composition of *Mystus vittatus* (Bloch).

M. vittatus, an indigenous predatory siluroid fish (Moitra, 1956) is abundant in natural and artificial freshwater habitats of South India. Its occurrence, distribution (Muddanna, 1971) and biology (Qayyam and Qasim, 1961) have been studied. The fish is found to be hardy and to feed on algae, crustaceans, insect larvae, oligochaete worms, cladocerans and small fish in its natural habitat (Moitra, 1956; Haffef and Qasim, 1960; Arunachalam, 1978b).

MATERIAL AND METHODS

For the present work, juvenile *Mystus vittatus* ranging in weight from 1.605 to 2.160 g were selected from the Agaram tank (near Bangalore) and used for the feeding experiments. The experimental fish were reared at five salinities (0, 2, 4, 6 and 10‰). At each salinity, three experimental fish were reared in aquaria containing 5 l of water. The required salinities were made up by adding common salt to fresh water and the water was aerated for 10 h/day. The fish were fed ad libitum on the oligochaete worm *Tubifex tubifex* for 4 h/day. The feeding was thus continued for 30 days. The fish were then sacrificed in order to study the food intake, growth and body composition. At the beginning of each experiment, a group of individuals was sacrificed for measurement of initial weights and composition.

All chemical analyses were made on material dried to constant weight in a hot-air oven at 95° C. Fat was estimated as the difference between dry weight (40 mg) and fat free weight of the sample determined after extraction with chloroform—methanol mixture (2 : 1) in a soxhlet apparatus. The extraction was run for 20 h, the time recommended by the Association of Official Agricultural Chemists (1950). Ash was determined by incineration of the dried sample (50 mg) at 560° C for 5 h (Paine, 1964).

TABLE I

Effect of salinity on the different metabolic parameters of *Mystus vittatus*. Values in the fifth, seventh and eighth columns represent the average performance of three individuals

Salinity (‰)	Serial No.	Initial biomass (g)	Total food consumed (g)	Daily intake (mg/fish·day)	Yield (g)	Growth (mg/fish·day)	Conversion efficiency (K_1, %)
0	1	1.936	3.732	17.84	2.532	2.71	15.10
	2	1.085	2.839		1.418		
	3	1.900	3.485		2.396		
2	1	1.990	3.869	17.92	2.485	2.63	14.68
	2	1.340	3.056		1.697		
	3	1.650	3.258		2.016		
4	1	2.220	4.744	22.80	2.600	2.39	10.10
	2	2.110	4.925		2.751		
	3	2.150	4.835		2.675		
6	1	1.695	4.676	23.19	2.045	1.96	8.58
	2	1.615	4.402		1.973		
	3	1.625	4.302		1.896		
10	1	1.605	4.438	23.64	1.786	1.13	3.07
	2	1.410	4.207		1.506		
	3	1.800	4.688		2.065		

RESULTS

Food intake

The data in Table I indicate that at 24° C, maximum food intake (23.64 ± 1.287 mg dry food/fish•day) was exhibited by fish reared at the highest salinity level (10‰). During the present study, there appeared to be an increase in food intake as the salinity increased from fresh water (17.84 ± 2.445 mg dry food/fish•day) to 10‰ (23.64 mg dry food/fish•day).

The feeding rate, expressed as mg dry food/g live fish•day, of *M. vittatus* at the tested salinities are presented in Fig.1. The value increased from 10.83 mg/g live fish•day in fresh water to 16.35 mg/g live fish•day at a salinity of 10‰, confirming that food intake is affected by salinity.

Growth

Maximum growth (2.71 mg/fish•day, Table I) was displayed by individuals reared in fresh water and as the salinity was increased, growth decreased and the least value (1.13 mg/fish•day) was observed at 10‰. As seen from Fig.1, growth rate decreased from 1.65 mg/g live fish•day (fresh water) to 0.73 mg/g live fish•day (10‰).

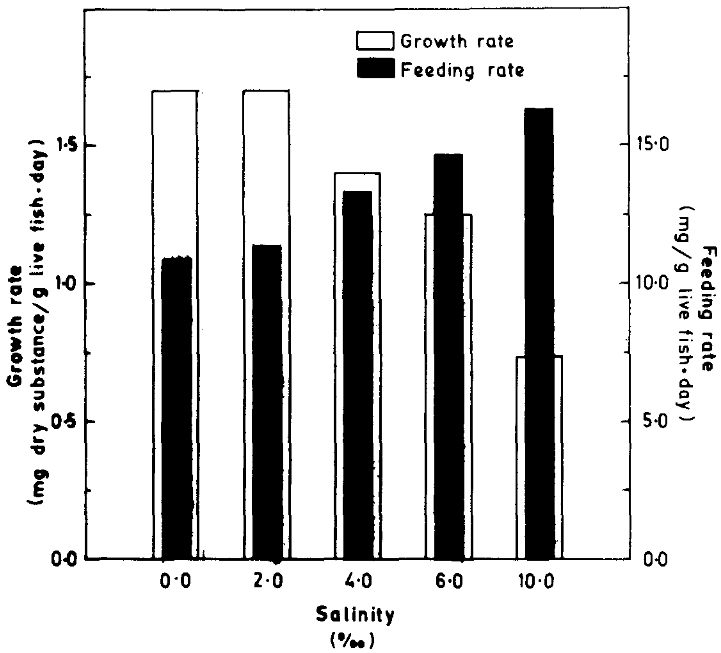

Fig.1. Effect of salinity on the feeding (mg dry food/g live fish•day) and growth rates (mg dry substance/g live fish•day) of *Mystus vittatus*.

Food conversion

The conversion efficiency (K_1) has been defined in this paper as the percent of dry food material that is converted into fish flesh and was calculated as follows:

$$K_1 = \frac{\text{Growth (mg)/day}}{\text{Food intake (mg)/day}} \times 100$$

Fish reared in fresh water not only consumed less food but exhibited the best food conversion efficiency (15.10%, Table I). The value decreased to 3.07% when salinity was increased to $10^0/_{00}$.

Specific growth rate and flesh production

In the present study, the specific growth rate (g/day) was calculated using the method described by Kosi Onodera (1962). In Table I, it is shown that a fish biomass (fresh water) of 1.936 g can yield 2.532 g at the end of the 30-day feeding period. Hence, the total increment amounts to 0.596 g. Therefore, in 30 days the specific growth rate calculated is 0.596/1.936/30 = 0.0103 which is equivalent to 10.3 mg/day. The total amount of food given was 3.732 g which is equivalent to 3.732/1.936/30 = 0.0641 g/day. Therefore, a daily ration of fish food equivalent to 6.41% of the initial biomass produced a daily weight increment of fish flesh equivalent to 0.0103/0.0641 × 100 = 16.07% of the given amount of fish food during the 30 days. Thus the 'house keeping' of *M. vittatus* in different salinities may be established. In 50 days, the necessary food will amount to 0.0641 × 50 = 3.2050 times the initial biomass, while the daily increment accumulates to yield 0.0641 × 0.1607 = 0.516 times the initial biomass.

Using the data in Table I, the specific growth rates of *M. vittatus* in different salinities have been calculated and are presented in Fig.2. From this it is evident that juveniles reared in fresh water displayed better growth than juveniles reared in higher salinities (6 and $10^0/_{00}$).

Table II represents the flesh production in *M. vittatus* reared at the tested salinity levels. One kg of juvenile fish each weighing about 1.640 g reared in fresh water requires 3.540 kg of *Tubifex* worm to produce 483 g newly synthesized flesh in 50 days, while when reared in a salinity of $10^0/_{00}$, 1 kg of fish each weighing about 1.605 g requires 4.655 kg of *Tubifex* worm to produce 177 g newly synthesized flesh over the same time. Under an unrestricted feeding schedule, fed on the same food, the fish flesh production averaged 731 g (Aranuchalam, 1978b).

Chemical analysis of food

The average values obtained for water, ash and fat contents of *Tubifex tubifex* are given in Table III. The water content of worm amounted to 83.92%

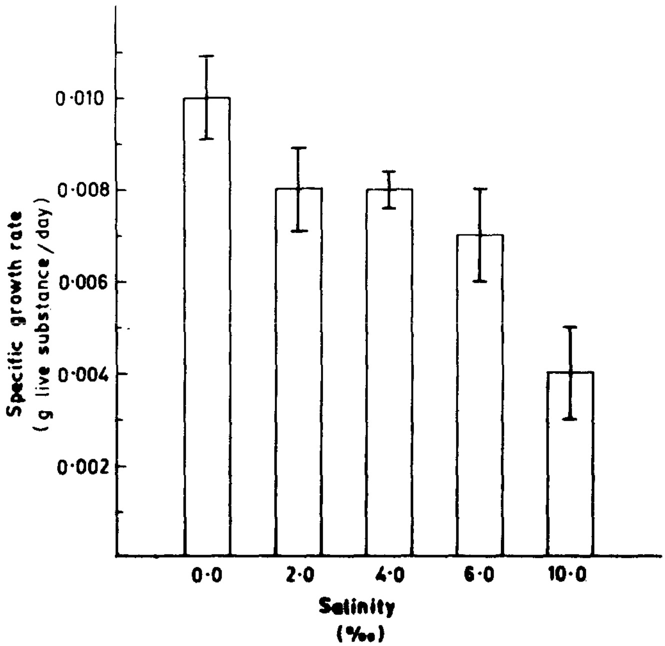

Fig. 2. Effect of salinity on the specific growth rate (g/day) of *Mystus vittatus*.

TABLE II

Effect of salinity on the fish flesh production in *Mystus vittatus*. Each value is the average performance of three individuals

Salinity (‰)	Initial biomass (g)	Food required by 1 kg of fish in 50 days (kg)	Amount of flesh produced by 1 kg of fish in 50 days (kg)
0	1.640	3.540	0.483
2	1.660	3.520	0.397
4	2.160	3.745	0.400
6	1.645	4.455	0.367
10	1.605	4.655	0.177

of the living matter. The ash content was 4.31% and the fat content averaged 35.21%. Since dry weight, ash and fat contents were estimated, the crude protein values could be calculated, and the value obtained was 60.48%. In the literature, the water content values reported for *Tubifex tubifex* are 82% (Ivlev, 1939), 84% (Warren and Davis, 1967), 83.9% (Pandian and Raghuraman, 1972) and 83.6/ (Katre and Reddy, 1979). Similarly, the ash content values reported in the literature are 4.0% (Raghuraman, 1973) and 4.2% (Katre and Reddy, 1979).

The mean water, ash, fat and crude protein values of *M. vittatus* reared at different salinities are summarized in Table IV. Fish reared in a salinity of 0‰ contained 78.89% water and the value decreased with increase in salinity. The lowest water content (75.47%) was seen in fish reared in a salinity of 10‰. In contrast to this, ash content increased from 21.65% (fresh water) to 25.65% (10‰). Fat content increased from 36.62% in fish reared in a salinity of 2‰ to 42.25% in individuals reared in 10‰, while fish reared in fresh water contained 39.33%. The crude protein content was lowest (32.19%) in individuals exposed to a salinity of 10‰.

DISCUSSION

The fish belonging to the genus *Mystus* have been recorded in fresh water and some are known to thrive in brackish waters (Pandian, 1970). Since there was heavy mortality of *M. vittatus* beyond a salinity of 10‰ (Arunachalam, 1978a), the food conversion studies were done up to salinity of 10‰. Further, at 10‰, the food organisms (*Tubifex tubifex*) were found to disintegrate within 24 h and hence the feeding schedule was restricted to 4 h/day.

TABLE III

Chemical composition of *Tubifex tubifex*. Water content is expressed as a percentage of live weight; ash, fat and crude protein as a percentage of dry weight. Each value is the mean of five estimations

Constituents	Mean values (%)
Water	83.92 ± 0.208
Ash	4.31 ± 1.215
Fat	35.21 ± 4.893
Crude protein	60.48

TABLE IV

Effect of salinity on the body composition of *Mystus vittatus*. Water content is given as a percentage of live weight; ash, fat and crude protein as percentages of dry weight. Each value is the mean of three estimations

Salinity (‰)	Water (%)	Ash (%)	Fat (%)	Crude protein (%)
0	78.89 ± 0.631	21.65 ± 0.764	39.33 ± 1.315	39.02
2	78.36 ± 0.714	20.47 ± 1.106	36.63 ± 0.658	42.91
4	76.63 ± 2.259	20.11 ± 0.524	36.86 ± 3.253	43.03
6	76.84 ± 2.273	20.04 ± 1.792	38.01 ± 2.309	41.95
10	75.47 ± 3.289	25.56 ± 2.683	42.25 ± 5.162	32.19

The IBP scheme of energy balance (Petrusewicz and McFadyen, 1970) for a fish is represented by the equation:

$$C = P + R + F + U$$

where

C = food consumed,
P = growth or production,
R = energy loss as heat due to metabolism,
F = undigested food,
U = nitrogenous excretory products.

In fishes, absorption efficiency, which has a bearing on the F value does not significantly vary as a function of body weight (Gerking, 1952; Pandian, 1967a), quantity of food (Pandian, 1967b) or temperature (Menzel, 1960; Hari Sethi, 1970). Therefore, any factor that alters either the C, the P and/or the R value is bound to influence the one which is not altered. The C value of *M. vittatus* fed for a restricted period increased as a function of salinity from 17.84 mg for fish in fresh water to 23.64 mg for fish at a salinity of 10‰. Working on the freshwater catfish *Heteropneustes fossilis*, Reddy et al. (1976) have reported a higher intake of food at higher salinity. For example, the fish under an unrestricted feeding schedule was found to consume 142.3 mg live worm/fish·day at a salinity of 7‰. Similarly, Raghuraman (1973) has also reported a higher intake of *Tubifex* worm in the euryplastic fish *Tilapia mossambica* at the highest salinity level (27‰). However, the present values cannot be compared with the values of Reddy et al. (1976), due to large size differences. In fresh water, under restricted feeding, *M. vittatus* consumed 17.84 mg dry food/fish·day, while under an unrestricted feeding schedule, the fish consumed 32.58 mg dry *Tubifex*/fish·day (Arunachalam, 1978b). The value of P is also found to be affected by salinity in *M. vittatus*. The value of P in the individuals decreased as a function of salinity. Niimi and Beamish (1974) have indicated that, in fishes, the net energy of the food is channeled to basal metabolism, growth and activity etc. In the present study, *M. vittatus* was found to be more active at high salinity and the apparent increased activity probably accelerated the feeding rate and the energy of the food was expended on osmotic regulation, and probably less energy was channeled for the growth process.

Although many workers have published analyses of the body composition of fish (see Love, 1970; Halver, 1972), few workers have attempted to examine the changes in body composition in relation to salinity (Katre, 1973; Raghuraman, 1973). Raghuraman (1973) observed that the body composition of *Tilapia mossambica* was greatly affected by salinity. A similar change in body composition in relation to salinity has been observed in *M. vittatus*. When salinity was increased, there was an immediate increase in fat content while water content decreased. Further, there was a corresponding decrease in crude protein. Working on *Tilapia mossambica*, Pandian and Raghuraman (1972) reported that changes in fat content are buffered by changes in crude protein. Thus it may be surmised that salinity influences the food conversion and body composition in *M. vittatus*.

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