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Effect of Betaine as a Feed Attractant on Growth, Survival, and Feed Utilization in Fingerlings of the Indian Major Carp, *Labeo rohita*

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Abstract

The study evaluated the efficiency of betaine as a feed attractant on growth, survival, and feed utilization in fingerlings of rohu (*Labeo rohita*). Betaine was incorporated at 0 (control), 0.25%, 0.50%, or 0.75% in a 30% protein diet and fed to fingerlings for 120 days in a closed and aerated recirculating system. Feed was offered twice daily at a rate of 5% of the fish biomass during the first 15 days and 3% afterwards. Significantly better growth, specific growth rate, survival, food conversion ratio, and protein efficiency ratio were obtained in the group fed 0.25% betaine.

Introduction

Aquatic animals utilize water-borne chemical signals to identify and orient themselves toward potential prey or food (Rittschof, 1992). Such signals are recognized in spite of the chemical complexity of aquatic environments. Chemical signals regulate feeding behavior and control reproduction, and are especially significant in a managed biological system that produces a single aquatic species. Since feed is a significant expense in all aquaculture operations, the need to maximize feed consumption and reduce feed wastage is of paramount importance. Chemo attractants and feeding stimulants are important means of reducing feed wastage by improving initial feeding and feed palatability (Lee and Meyers, 1996). Feed quality and environmental conditions (water quality, currents) directly influence the effectiveness of feed attractants and stimulants, ultimately determining the commercial value of a feed in an aquatic environment.

Betaine, a highly water soluble and therefore diffusible compound, stimulates the olfactory bulb of fish. It is found in relatively high quantities in marine invertebrates, microor-

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ganisms, and some plants (Meyers, 1987). Betaine is an effective attractant to several aquatic species. The main physiological or metabolic functions of betaine are related to osmoregulation and methyl donation. In fish, betaine can protect cells against dramatic changes in osmotic pressure. Betaine also helps prevent enzyme inhibition and plays an important role in tissues as a methyl donor in protein and energy metabolism.

When betaine was added to a basal diet for rainbow trout, feed intake and growth were significantly higher and did not differ from the control fed a fishmeal-based diet (Tiril et al., 2008). In combination with amino acids, betaine has produced encouraging results in fish and shellfish. The commercial feed attractant Finnstim, a betaine/amino acid mixture, produced higher growth in yearling chinook salmon during their seawater phase (Clarke et al., 1994). A diet supplemented by a taurine and an amino acid mixture enhanced growth, feed intake, and survival in *Penaeus monodon* (Hartati and Briggs, 1976).

In the present study, the effects of betaine on the growth and survival of fry of the Indian major carp, rohu (*Labeo rohita*), were examined.

Materials and Methods

Animals. Rohu fry were brought from the Bhadra Reservoir Project Fish Seed Farm in Shimoga, India, to the fish farm of the College of Fisheries in Mangalore, India, where they were fed a diet containing 30% crude protein and 6% lipid for two months until they reached fingerling size.

Experimental system and stocking. The experiment was carried out in a closed aerated recirculating system consisting of twelve 120-l fiberglass tanks (66 cm diameter). The tanks were cleaned and filled with water from a nearby perennial open well. Uniform-sized fingerlings (avg 2.72±0.23 g) were stocked at 11 fish/tank in three replicate groups.

Experimental diets and feeding. Three test diets incorporating betaine at 0.25%, 0.5%, or 0.75% were formulated while the control diet contained no betaine (Table 1). The fry were fed 5% of their biomass for the first 30 days, then 3% until the end of the experiment. Feed was offered twice daily for 120 days. At least 50% of the fish in each tank were sampled every 15 days and individually measured for weight and length. After every sampling, the feed quantity was adjusted based on the weight increase of the fish.

Water analysis. Water was analyzed every week. A portable digital kit (model CK 704) was used to record pH and temperature. Dissolved oxygen was estimated by Winkler's method. Total alkalinity, ammonia, and free carbon dioxide were determined by standard methods (APHA, 1995).

Chemical and statistical analysis. The proximate compositions of the feed ingredi-

Table 1. Proximate composition (%±SD) of diets fed to *Labeo rohita* fingerlings for 120 days.

	Betaine			
	0	*0.25*	*0.5*	*0.75*
Dry matter	95.82±0.36	97.18±0.06	95.32±0.06	97.98±0.02
Crude protein	29.67±0.23	29.83±0.08	30.09±0.76	30.14±0.13
Crude fat	5.82±0.20	6.37±0.14	6.96±0.27	6.68±0.62
Crude fiber	6.98±0.60	6.95±0.80	7.08±0.520	7.12±0.37
Ash	21.99±0.53	21.84±0.28	20.46±0.31	21.08±0.26
NFE	31.36±0.26	32.19±0.32	30.73±0.21	32.96±0.36
Gross energy (kJ/g)	13.61±0.26	13.82±0.17	13.85±0.23	13.75±0.27

ents and formulated diets were analyzed by standard methods (AOAC, 1975). Differences in growth between treatments were statistically analyzed by one-way analysis of variance (ANOVA). Duncan's Multiple Range test was used to identify significant differences.

Results

Growth, survival, food conversion ratio (FCR), and protein efficiency ratio (PER) were significantly best in the treatment containing 0.25% betaine (Table 2). Water quality is given in Table 3.

Table 2. Weight, specific growth rate (SGR), survival, food conversion rate (FCR), and protein efficiency ratio (PER) of *Labeo rohita* fingerlings fed diets containing different levels of betaine for 120 days.

	Betaine			
	0	*0.25*	*0.5*	*0.75*
Weight (g)*	16.5^{a}	20.4^{d}	17.3^{bc}	17.8^{c}
SGR (%/day)	1.50^{a}	1.67^{d}	1.53^{b}	1.56^{c}
Survival (%)	76.76^{a}	87.87^{b}	84.84^{b}	78.78^{a}
FCR	2.02^{a}	1.42^{b}	1.65^{a}	1.81^{a}
PER	0.45^{a}	0.58^{d}	0.48^{bc}	0.50^{c}

* Stocking weight was 2.72±0.23 g.

Table 3. Water quality parameters during the experimental period.

Parameter	*Range (avg weekly value)*
Temperature (°C)	23.73-28.80
pH	7.3-8.6
Dissolved oxygen (mg/l)	6.0-8.7
Free carbon dioxide (mg/l)	0.15-5.53
Total alkalinity (mg/l)	55-88
Ammonia-nitrogen (µg/l)	0.017-6.22

Discussion

The higher growth attained by rohu fed diets containing betaine is comparable to results reported by earlier workers. Diets supplemented with a feeding stimulant mixture at a rate of 1.7% resulted in a significant increase in feed intake in striped bass (Papatryphon and Soares, 2001). A significantly higher growth rate was recorded in yearling chinook salmon fed a diet containing 1% Finnstim, a betaine/amino acid mixture, during their seawater phase (Clarke et al., 1994). *Penaeus monodon* fed a diet containing 1.55% of a taurine and amino acid mixture had better growth, feed intake, assimilation, FCR, and survival (Hartati and Briggs, 1976) while dimethyl-beta-propiothetin (DMPT) and betaine increased body weight and molting rate in *Penaeus indicus* (Jasmine et al., 1993). Addition of a commercial feed attractant, Aquasavor, produced better growth in *Catla catla* when provided at a level of 2% (Swapnil, 2003) and in *Macrobrachium rosenbergii* at a level of 1% (Pavadi, 2004). A higher SGR was recorded in *M. rosenbergii* fed diets containing Nutripro-aqua (a feed additive) than in the control (Jayaram, 1998). Addition of betaine produced better growth in rainbow trout at a level of 1.5% (Tiril et al., 2008). The addition of betaine resulted in significantly higher weight gains possibly by improving feed intake and palatability through activation of the cephalic reflex induced by smell and taste of attractive substances in diets (Fange and Grove, 1979).

The highest weight gain and SGR were obtained with the lowest betaine supplementation, suggesting that feed additives or nutrients have a beneficial effect when given at the optimal level but, beyond that level, may negatively impact catabolic activity. On the other hand, the SGR of rohu decreases as culture progresses (Mohanty et al., 1996). In an earlier experiment, the best feed conversion and protein efficiency rates were also recorded in the 0.25% betaine group, possibly due to increased digestive enzyme activity (Srinivasa, 2000). Likewise, *P. monodon* fed a diet containing 1.5% Finnstim had a better FCR than those fed a diet containing an amino acid mixture only (Hartati and Briggs, 1976). In striped bass, feed conversion improved in animals fed a fishmeal-based diet supplemented with a feeding stimulant mixture of several amino acids and betaine at a rate of 2.7% of the diet (Papartyphon and Soares, 2001).

The PER was significantly higher in the 0.25% betaine treatment. Addition of feed attractants has been found to enhance PER in fish and prawns. The feed attractant, Aquasavor, resulted in the highest PER in *C. catla* when included in the diet at a 2% level (Swapnil, 2003) and in *M. rosenbergii* when included in the diet at 1% (Pavadi, 2004).

In fish, PER is a better indication of nutritional status with respect to dietary protein than FCR (Jauncey, 1982).

Survival was significantly better in the 0.25% treatment than in the control. Feed attractants enhanced survival in *P. monodon* (Hartati and Briggs, 1976) although it had no effect on freshwater prawn juveniles (Harpaz, 1997). Aquasavor resulted in the best survival when included in the diet at a 2% level for *C. catla* (Swapnil, 2003) and at 1% for *M. rosenbergii* (Pavadi, 2004).

In conclusion, when used as a feed attractant, betaine promoted growth, survival, and feed utilization in rohu, the Indian major carp (*L. rohita*). A level of 2.5 g/kg diet was optimal for all parameters. The physico-chemical water parameters remained within the required range for rohu culture and were not affected by the betaine incorporated diets.

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