Culture of Asian seabass *Lates calcarifer* (Bloch) in brackishwater tide-fed ponds: growth and condition factor based on length and weight under two feeding systems

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ABSTRACT

Culture of Asian seabass *Lates calcarifer* was conducted successfully for 330 days in brackishwater tide-fed ponds under two different feeding systems with live prey fish in one and minced trash fish in the second in duplicate ponds. Comparison of final growth, length-weight relationship and condition factor based on gravimetric data and survival rate was done at the end of rearing. Though there were no significant differences in growth rate and condition factor (p>0.05), final growth and survival rate showed significant differences (p<0.05) between the two culture systems. The length-weight relationship revealed negative allometric growth patterns with high slope value (*b* = 2.93) in trash fish fed system than that of fishes fed with live prey (*b* = 2.87) and both the *b* values were significantly different from 3 (p<0.05) indicating crowding and/or feeding problems. This study concludes that the trash fish feeding system could help to produce Asian seabass with higher growth, survival and optimum length-weight relationship as well as condition factor, as this system better meets up the feed requirement of the growing fish as compared to live prey feeding system.

Keywords: Brackishwater, Condition factor, Growth, *Lates calcarifer*, Length, Weight

Introduction

The carnivorous and predatory Asian seabass *Lates calcarifer* (Bloch) known as *bhetki* or *barramundi* in India and giant seaperch in Australia is gaining rapid popularity as a candidate species for diversification of coastal aquaculture. This species fetches higher market price owing to its good taste and flesh quality, for which it is recognized as a highly suitable culture species in ponds and cages (Barlow *et al.*, 1996; Singh, 2000). Many countries including India, with their concerted efforts over the last three decades have developed hatchery techniques for commercial seed production (Lim *et al.*, 1986; MacKinnon, 1987; Ruangpanit, 1987; Russell *et al.*, 1987; Almendras *et al.*, 1988; Garcia, 1989; Rimmer *et al.*, 1994; Thirunavukkarasu *et al.*, 2001).

Condition factor and length-weight relationship are two important parameters for the management of culture systems as they provide the producer with an evaluation of the specific conditions under which organisms are growing (Araneda *et al.*, 2008). Length-weight relationship (LWR) plays a significant role in studying the growth, rate of feeding, metamorphosis, fatness, onset of maturity, gonadal development and general well being of the fish population

(Le Cren, 1951; Pauly, 1993). Further, it helps in establishing the biomass and also in converting one variable to another as is often required during regular samplings for culture operation. Condition factor is a quantitative parameter estimated based on length-weight data which indicates the state of well-being of the fish for determining the present and future population success by its influence on growth, reproduction and survival (Hossain *et al.*, 2006). Many reports are available on LWR and condition factor of several marine fishes but only very few are available on Asian seabass, which are from closed recirculatory systems (Volvich and Appelbaum, 2001), wild catch (Rajkumar *et al.*, 2006) and hatchery rearing system (Kailasam *et al.*, 2006). The present study aims in comparing the growth, LWR and condition factor of seabass cultured in brackishwater tide-fed ponds under two different feeding systems.

Materials and methods

The study was conducted in the brackishwater tide-fed farm of the Kakdwip Research Centre of Central Institute of Brackishwater Aquaculture, Kakdwip (lat. 21° 51' 15.01" - 21° 51' 30.77" N, long. 88° 10' 58.44"- 88° 11' 12.09" E), South 24 Parganas, West Bengal, India for a period of 330 days from March 2007 to February 2008 in

four ponds of 600 m² each. The ponds were prepared properly one month prior to stocking following liming with lime stone powder @ 350 kg ha⁻¹ and initial fertilization with cattle dung, urea and super phosphate @ 500, 35 and 30 kg ha⁻¹, respectively. Study was conducted to examine the condition status based on length-weight data in Asian seabass cultured under two feeding systems, namely, Treatment-I (T-I) and Treatment-II (T-II), where the cultured species were fed with live prey and minced trash fish, respectively. Each treatment had two replicates. The live preys was introduced in T-I ponds @ 20,000 numbers ha⁻¹ 15 days prior to stocking of seabass (Thirunavukkarasu *et al.*, 2004). The prey biomass was 50 kg ha⁻¹ at the time of their stocking. All the ponds under the two treatments were stocked with uniform sized seabass seeds of 1.09 ± 0.08 g weight (42.57±2.47 mm) @ 10,000 numbers ha⁻¹. In T-II ponds, minced trash fish meat @ 100% body weight on wet weight basis was introduced for the first month, and then gradually reduced to 70, 50, 25, 20, 15 and 10% for the second, third, fourth to sixth, seventh, eighth and last three months of culture, respectively. The trash fish was broadcasted in the water surface in a single ration between 1200-1300 hours. Water exchange at 30-40% rate was done fortnightly during high tides by maintaining 1 m water level throughout the culture period. Lime stone powder at 250 kg ha⁻¹ and fertilizers like cattle dung, urea and superphosphate at aforesaid rates were applied monthly for maintaining desired water quality in conjunction with optimum natural productivity.

Gravimetric data were collected monthly throughout the 330-day experimental period. The total length (TL, mm) was recorded with a slide caliper, while body weight (w, g) was measured using a digital electronic balance for 30 samples from each treatment.

Growth rate is the function of weight and time and was estimated for each treatment with the formula:

$$GR = \frac{W_f - W_i}{t}$$

Where *GR* is the growth rate, W_f and W_i are the average final and initial weight in time *t*. The mathematical relationship between length and weight was calculated using the conventional formula (Pauly, 1984):

$$W = a.TL^b$$

Where *W* is fish weight (g), *TL* is total length (mm), *a* is the proportionality constant and *b* is the isometric exponent. The parameters *a* and *b* were estimated by nonlinear regression analysis.

Fulton's condition equation was used to find out the condition factor (Ricker, 1975; Chow and Sandifer, 1991):

$$K = \frac{\overline{W}}{\overline{TL}^3} \times 10^5$$

Where *K* is the condition factor, $\overline{W}$ is average weight (g) and $\overline{TL}$ is average total length (mm).

Statistical significance of the isometric exponent (*b*) was analyzed to evaluate the relationship between weight and total length in each treatment using the t test (Snedecor and Cochran, 1967).

Comparison of growth rate, condition factor, final length and weight as well as survival rate between the two treatments was made with one way analysis of variance (ANOVA). Data were expressed as mean ± standard deviation. The analyses were performed using SPSS for Windows v. 17.0 programme (SPSS Inc., Chicago, IL, USA).

Water samples were collected from surface of the experimental ponds between 0800 and 0900 h at 15-day intervals to measure parameters such as temperature, pH, dissolved oxygen (DO), salinity and alkalinity (APHA, 1989).

Results and discussion

The water parameters of the ponds under two treatments are presented in Table 1. The recorded parameters were within the optimum ranges for brackishwater aquaculture (Bhowmik *et al.*, 1992; Chakraborti *et al.*, 2002). However, salinity showed wide variation (1.0 - 15.5 g l⁻¹) throughout the culture period in both the treatments with the highest value during May (summer) and the lowest during August (monsoon). This is the usual seasonal salinity variation of the tidal water in this region (Saha *et al.*, 2001).

Table 1. Variations in water quality parameters in the experimental ponds

Parameters	T-I	T-II
Water temperature (⁰C)	26.03 ± 3.99	26.00 ± 4.09
pH	7.79 ± 0.24	7.82 ± 0.19
Dissolved oxygen (mg l⁻¹)	6.60 ± 0.95	6.49 ± 1.05
Salinity (g l⁻¹)	8.41 ± 5.04	8.04 ± 5.00
Total alkalinity (mg CaCO₃ l⁻¹)	136.68 ± 15.90	130.52 ± 24.49

Values are expressed as mean ± S.D.

Higher growth rate was observed in T-II ponds with an average of 1.47 g day⁻¹, whereas the growth rate in T-I ponds was 1.11 g day⁻¹ (Table 2). There was no significant difference between the two treatments (p>0.05). However, growth in terms of length and weight was significantly higher in T-II with trash fish feeding (p<0.05) compared to T-I with live prey as feed (Table 2). MacKinnon (1989)

Table 2. Growth, condition factor and survival of seabass cultured in brackishwater tide-fed ponds under two different feeding systems

Treatment	Days of culture	Final length (mm)	Final weight (g)	Growth rate (g day^{-1})	Condition factor	Survival (%)
T-I	330	305.53±25.27[b]	366.43±116.89[b]	1.11±0.011[a]	1.285±0.030[a]	21±0.64[b]
T-II	330	325.33±32.52[a]	486.33±130.56[a]	1.47±0.293[a]	1.402±0.079[a]	45±5.13[a]

Means bearing different superscripts indicate statistically significant differences in a column (p<0.05); values are expressed as mean ± S.D.

reported 400-450 g growth in a commercial grow-out trial of seabass with 35% survival over a period of 10 months. Weight increment showed increasing trend for both the treatments (Fig. 1). The growth was almost similar for the two treatments for 210 days, but an increasing trend was observed in T-II than T-I after 220 days, which continued till the end of culture. It indicates that the supply of young ones of Tilapia as feed was sufficient till 220 days of culture and then became inadequate for the requirement of growing fishes. Further, the size variation (Fig.1) with high standard deviation throughout the culture period indicates differential growth in seabass and from this, it may be inferred that larger fishes dominated over smaller ones for food in both the systems. The significant difference in final weight of seabass may be attributed to insufficient availability of prey fishes in T-I, whereas in T-II daily provision of certain amount of chopped trash fish met the food requirement and resulted in higher growth. From growth and production point of view, feed supply in the form of trash fish should be maintained for seabass culture in brackishwater tide-fed ponds, and live prey feeding system with adequate availability of prey may be an alternative option.
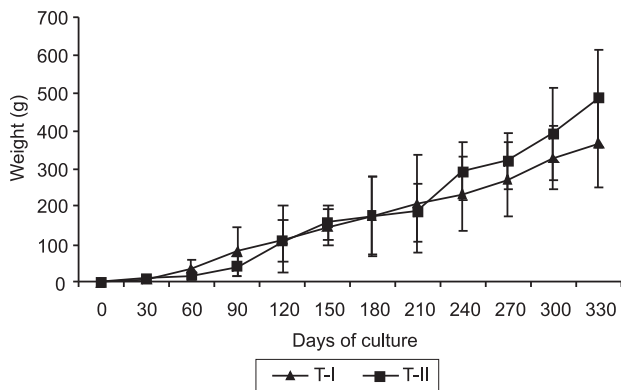

Fig. 1. Growth increment of Asian seabass cultured under two treatments

Significantly lower survival (p<0.05) of seabass in T-I (21%) in comparison to T-II (45%) may be due to insufficient food leading to emergence of larger individuals (Table 2). According to Parazo et al. (1991), larger individuals with a minimum size difference of approximately 33% from the rest of the stock are known as 'shooters'. The shooters which emerged in T-I might have caused cannibalism on the smaller ones resulting in poor survival.

According to slope values in T-I (b = 2.87) and T-II (b = 2.93), growth in both the treatments were allometric and based on t, were different from 3 (t = 7.143 and t = 5.370, respectively; p<0.05) (Fig. 2a, 2b). Here the b values obtained were found to be in between the values reported earlier for L. calcarifer captured from wild (b = 2.66) (Rajkumar et al., 2006) and reared under the laboratory condition (b = 3.03) (Volvich and Appelbaum, 2001). The lower values recorded as compared to the laboratory study may be due to insufficient food availability, competition and inferior culture environment in the ponds than in captivity. However, Castillo-Vargasmachuca et al. (2007) reported higher value of b (3.14) for similar type of carnivorous fish, spotted rose snapper Lutjanus guttatus reared in floating grow-out cages for 153 days. According to Enin (1994), when the parameter b is equal to 3, growth
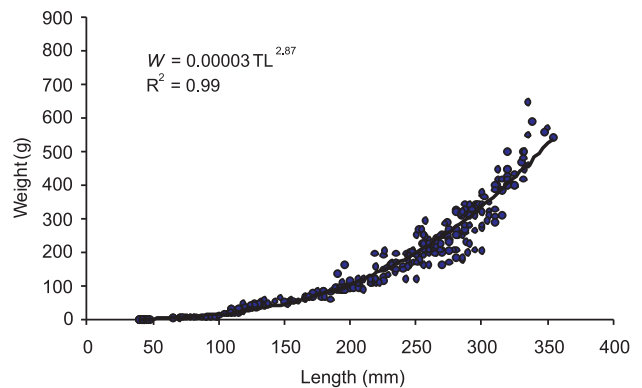

Fig. 2a. Length-weight relationship of Asian seabass grown under live prey feeding system (T-I ponds)
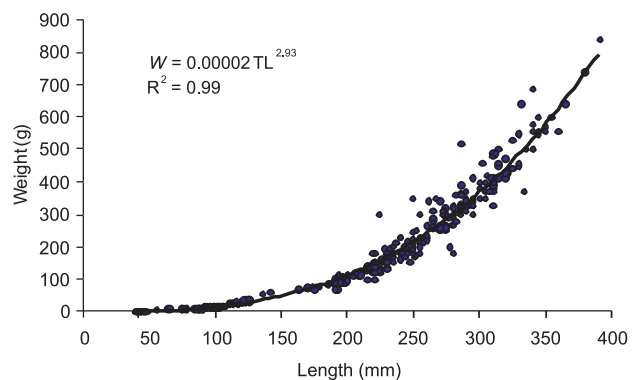

Fig. 2b. Length-weight relationship of Asian seabass grown under trash fish feeding system (T-II ponds)

is called isometric and when it is less or greater than 3 it is allometric. Wootton (1992) more specifically stated the growth to be positive allometric when animal weight increases more than length ($b>3$) and negative allometric when length increases more than weight ($b<3$). Of the two treatments studied here, although b was close to 3 for T-II, growth was negative allometric, which means weight was not symmetrical with length (Fig. 2b). Slope less than 3 indicates density and/or feeding problems in a culture system (Murphy *et al.*, 1991). Though significant differences between the treatments were not found in the length-weight relationship (LWR) curves, in which slope values were less in live prey fed individuals than trash fish fed ones, but the higher b value (2.93) in the latter group highlighted that fishes in this treatment had a good LWR and were therefore in good condition compared to the other group. Despite being allometric, the T-II with trash fish feeding is apparently more appropriate under the brackishwater tide-fed pond culture system because it produced significantly greater growth and survival rates.

The condition factor value (1.40) as higher in T-II compared to T-I (1.28) with no significant difference (p>0.05) (Table 2). Condition factor is used to compare the 'condition', 'fatness' or 'well being' of fish and are based on the hypothesis that the heavier fish of a given length are in better condition. Condition factor data can be useful for proper management of culture systems as it provides the culturist with an indication of the conditions under which the organisms are growing. The lower condition factor value in T-I indicated worse poor culture conditions than T-II in terms of availability of food material. Condition factor values for both the treatments were higher than the relative condition factor value (0.95) of seabass captured from south east coast of India (Rajkumar *et al.*, 2006). Examination of the K value (>1) in the present study indicated that the species exhibited healthy and robust condition showing good compatibility with the environment. The study also revealed that improper feed management strategy can affect the isometry and lead to more allometry in growing organisms.

This study concludes that the trash fish feeding system could produce Asian seabass with higher growth, survival and optimum length-weight relationship and condition state, as this system better meets up the feed requirement of the growing fish compared to live prey feeding system. Further research needs to be undertaken to devise proper feeding strategy for improvement of prey system considering the bottleneck in trash fish availability.

Acknowledgements

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