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Open sea mariculture of Asian seabass *Lates calcarifer* (Bloch, 1790) in marine floating cage at Balasore, Odisha, north-east coast of India

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ABSTRACT

The present study was undertaken to evaluate the survival, growth rate and culture potential of sea bass, *Lates calcarifer* (Bloch, 1790) in an open sea floating cage at Balasore, Odisha in the north-east coast of India. A total number of 4357 juveniles of *L. calcarifer* weighing on an average of 25 g were stocked in HDPE cylindrical open sea floating cage of 6 m inner diameter with 6 m net bag depth in the middle of May, 2009. The fishes were fed @ 5-8 % of body weight thrice a day with chopped trash fish throughout the experimental period and were harvested in the middle of November, 2009 after 180 days of culture. Sea bass attained an average of 29.45 cm body length and 996.62 g in body weight at the time of harvest. Daily average increment in body length and body weight were 0.10 cm and 5.4 g respectively. Growth was allometric and average specific growth rate was 2.05. FCR was 1:6 and a survival rate of 79.6 % was recorded. The cost benefit ratio was 0.5. Open sea floating cage culture of seabass was much more advantageous than culturing in inshore waters as evidenced from their growth performance and survival.

Keywords: Balasore, Cage culture, Growth, *Lates calcarifer*, Seabass

Introduction

Odisha State has a coastline of 480 km (8% of the total coastline of India) spread over the districts of Balasore, Cuttack, Puri and Ganjam. Balasore is characterised by an extended continental shelf, tidal areas and extensive river deltas. Aquaculture of *Lates calcarifer*, commonly known as the Asian seabass, commenced in the 1970s in Thailand and rapidly spread throughout south-east Asia. In India also it is a sought after fish in many states for its delicacy. The grow-out phase involves the rearing of seabass from juvenile to marketable size. The marketable size requirement of seabass vary from country to country *e.g.*, in Malaysia, Thailand, Hong Kong and Singapore, the normally accepted marketable size is between 700–1200 g while in the Philippines, it is between 300–400 g. The culture period in grow-out phase also vary from 3–4 months (to produce 300–400 g size) to 8–12 months (for 600–900 g size). The success of marine cage culture of seabass and its economical viability have contributed significantly to large scale development of this aquaculture system in Australia. The production of seabass in Australia has steadily increased for the past 15 years and this trend is expected to continue (Boonyaratpalin and Williams, 2002; Thirunavukkarasu *et al.,* 2004). Seabass possesses fast growth rate, amenable for artificial feed or trash fish, and can be bred in captivity, thus making it a candidate species suitable for aquaculture (Dunstan, 1959; Sirikul, 1982; Davis and Kirkwood, 1984; Sakaras, 1987; Barlow *et al*., 1996; Boonyaratpalin *et al*., 1998; Singh, 2000). This species is generally cultured in sea cages located in river mouths or estuaries (Boonyaratpalin *et al*., 1989). During the present investigation, the growth performance of seabass was evaluated in a floating sea cage anchored at Balasore, Odisha, north-east coast of India.

Materials and methods

Site

Considering the local seed availability of Asian seabass *(L. calcarifer),* the Central Marine Fisheries Research Institute (CMFRI) has selected Balasore, Odisha as one of the potential location for demonstration of open sea cage culture, with funding from National Fisheries Development Board (NFDB), Hyderabad. The site selected was at Chaumukh, which is located around 70 km away from

Balasore Town. Underwater inspection was done for the selected site. The cage site was well protected from direct wave action and mooring was done at two sites, one in the open sea and another in the nearby lagoon. During rough weather, cage was de-linked from the mooring system and relocated in the protected lagoon.

Sea cage

The indigenous HDPE marine floating cage was developed and installed at Chaumukh (21^0 32' 639" N; 87^0 18' 223" E). The cage was designed based on the cost effectiveness and flexible properties of HDPE. The cage was very sturdy and withstood rough climatic condition of the sea. Entire cage site topography was studied before installation of the cage. The HDPE cage frame measuring 6 m inner and 8 m outer dia were provided with HDPE outer predator (braided 60 mm), inner grow out (25 mm) and bird nets (80 mm) with a net depth of 6 m. Cat-walk and hand rails were provided for the safety of the workers and routine cage maintenance. The bottom HDPE ballast was filled with 150 kg of black stone chips to keep the nets in intact shape and volume. Outer and inner nets were interconnected to avoid secondary ballast. A dynamic mooring system was developed to withstand the high fluctuation of waves, currents and wind speed. The mooring system included a cost effective 9 mm PP gabion box which can hold the breaking strength of 10 t in elongation, in place of expensive anchors and filled with about 3.5 t of stones to which the mooring chain (12 mm) was connected. The swivel connected to the chain rotated the entire cage by mooring only at a single point. Tension on mooring cable was maintained by HDPE floats connected with a shock absorber weight of 100 kg, which balanced the drag force generated by the currents and other oceanographic parameters between the floating cage net bag, mooring and anchoring system. Shock absorber also in turn resisted any pressure on the cage.

Experimental animals

A total of 4500 seabass seeds were collected from natural source around the Chowmukh area and initially reared in an estuarine shrimp pond. After completion of collection, seeds were shifted to cage culture site at Balasore during May 2009. The fishes were conditioned on the previous day of transportation without any feeding. Seeds were acclimatised to the rearing conditions by keeping them in fresh seawater in 200 l tanks for about 30 min followed by slow addition of fresh seawater collected from the cage site.

Before stocking, the data on total length and body weight of random samples of animals were recorded. The cages were stocked with 4357 nos. of seabass weighing 25 g on an average. The fishes were fed @ 5-8 % of body weight thrice a day with chopped trash fish throughout the nursery period. The feeding regime followed was: 8% of body weight at 20 to 100 g size range, 6% at 100 - 300 g size and 3-5% at 300 - 500 g. The cage was inspected at every 10 days interval by underwater diving. The quantity of feed required was determined by regular examination of the quantity of feed consumed by the fishes and the feed quantity was adjusted accordingly. Periodical sampling of fishes were also carried out once in every 15 days to ascertain the health status and growth of seabass stocked in cages. The nets were cleaned at weekly intervals to remove the unconsumed feed, clogged silt and fouling by barnacles. Clogging and fouling of net material restricts water flow and also adds to the weight on the net in due course. The fishes were harvested from cage in November, 2009 after 6 months of culture.

Important parameters *viz*., weight and length gain (%), weight and length increment per day (g) and specific growth rate (SGR) were estimated using following formulae:

Weight gain (%) = [(Final mean body weight-Initial mean body weight)/ Initial mean body weight] x 100

Length gain (%) = [(Final mean body length-Initial mean body length)/ Initial mean body length] x 100

Weight increment per day (g) = (Final mean body weight - Initial body weight)/Number of days

Length increment per day (g) = (Final mean body length - Initial body length)/Number of days

SGR = [(*ln* final mean body weight - *ln* initial mean body weight)/ Number of days] x 100

Results and discussion

The cage structure used in the present study was found to be sturdy, durable, highly flexible to open sea climatic conditions and suitable for seabass culture. Similar floating net cages (6 m diameter and 4 m depth) were used for rearing sea bass at Vizhinjam Bay (Anil *et al*., 2010). Juveniles of seabass having mean length of 12.3 cm and mean weight of 25 g after stocking in cages reached on an average 14.75 cm in length and 53.6 g in weight after one month. At the end of 2nd, 3rd, 4th, 5th and 6th month, the mean lengths attained were 17.24, 20.67, 22.5, 25.93 and 29.45 cm respectively (Fig. 1). The corresponding body weights at the end of each month were 88.86, 204.57, 370.25, 720.59 and 996.62 g, respectively (Fig. 2). The survival rate at the end of the culture period was 79.6% and average production was 3456.5 kg. A food coversion ratio (FCR) of 1:6 was recorded. The total cost of production was Rs. 94.24 kg^{-1} and price realised was Rs. 189.89 kg^{-1}.

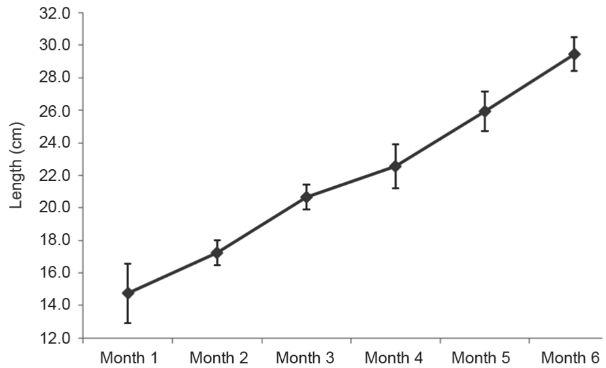

Fig. 1. Length (mean±SD) of seabass recorded at the end of each month of culture in cages

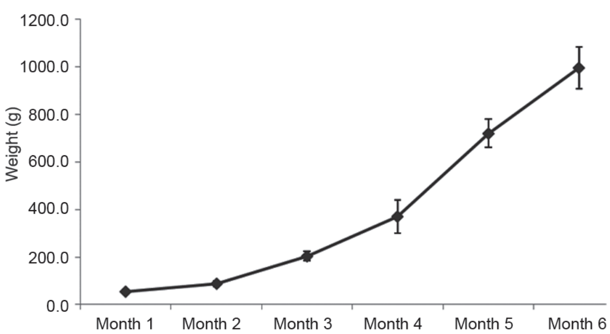

Fig. 2. Weight (mean±SD) of seabass recorded at the end of each month of culture in cages

A net income of Rs. 2.9 lakhs were obtained from this culture. Kailasam *et al*. (2001) observed a survival rate of 65% in higher stocking densities of 20 and 30 nos l^{-1} in experimental conditions at CIBA, Chennai. Anil *et al*. (2010) reported a juvenile survival of 60% in seabass stocked in cages at Vizhinjam Bay. The main reason for mortality is high rate of cannibalism in the early stages of seabass. Seabass fry is highly carnivorous and voracious feeder, and fast-growing individuals (shooters) drastically reduce the survival rate through cannibalism (Kailasam *et al*., 2002). During the present study, weekly grading was carried out to remove the shooters to avoid cannibalism. The monthly details of growth performance are presented in Table 1. The average gain in body length and body weight during the culture period was 139.43% and 3886.48% respectively. The daily average increment in body length and body weight during 180 days of culture was 0.10 cm and 5.4 g respectively. Specific growth rate at the end of culture duration was 2.05. Daily increment in weight and SGR recorded in the present study are consistent with earlier reports of seabass culture in cages (Sakaras, 1987; Eusebio and Coloso, 2000; Katersky and Carter, 2005; Anil *et al*., 2010). The gain in body length and body weight as well as SGR was maximum (2.78%) in the 3rd month of culture. However, daily increment in weight and length were highest (94.63 and 14.99 respectively) in the 5th month of culture. SGR decreased in successive months with increase in weight of fish. Jobling (1994) established an inverse relationship between SGR and fish weight, which is in full agreement to the present study. Seabass fed on trash fish very well and shoaling behaviour was noticed during feeding which justifies the high growth rate obtained in cages. Average body weight of 996.62 g recorded after six months of culture is superior when compared to that reported earlier from cages by Anil *et al.* (2010) and Schipp *et al.* (2007). The average operating (cost: benefit) ratio for seabass reared in the cage at Balasore was 0.5. The combined length-weight relationship derived from seabass in cage is:

$$\log W = -2.8645 + 3.9732 \log L \ (r^2 – 0.9)$$

The slope of the regression relation for the pooled population was significantly different from the isometric value of 3 indicating allometric growth. The b value recorded in the present study was much higher than those reported from natural waters by Ganguly *et al*. (1959), Patnaik and Jena (1976), Rodgers (1996) and Volvich and Appelbaum (2001). This difference is possible because of the favourable ecosystem available, energy conservation due to limited movement and lack of competition for food. The higher slope value for the length-weight regression relation indicates significantly higher weight increment in open sea floating cages. During rough weather, cage was de-linked from the mooring system and relocated in the protected lagoon.

Table 1. Monthly growth performance of *L. calcarifer* recorded in the cages

Holding system	Body weight gain (%)	Total length gain (%)	Weight increase per day (g)	Length increase per day (cm)	SGR (%)
Month 0 - 1	114.4	19.92	0.95	0.08	2.54
Month 1 - 2	65.78	16.86	1.18	0.08	1.68
Month 2 - 3	130.21	19.94	3.86	0.11	2.78
Month 3 - 4	80.98	9.08	5.52	0.06	1.98
Month 4 - 5	94.63	14.99	11.68	0.11	2.22
Month 5 - 6	38.31	13.56	9.20	0.12	1.08

The present study indicated that open sea floating cage culture of seabass is much more advantageous than inshore culture with respect to its higher growth performance and survival. There was no incidence of disease in cages during the entire experimental period. The higher growth performance and survival of seabass in sea cages may be attributed to the supplementary source of nutrition obtained from the biofoulers which were found to get settled on the cage structures like net and frame during the course of culture, reduced stress, natural light levels and photoperiod. An important role of cage in sea is that it can function effectively as a fish aggregating device. During the present study at Balasore, it was observed that the fish and crustacean population around the cage increased, feeding on the feed that escape from the cage, adding to the richness of the area. Algae, barnacles, bryozoans, ascidians, sponges, polychaetes, pearl oysters, brown mussels and seaweeds were the main biofouling organisms on the net of the cage. Additionally, brachyuran crabs and ornamental fishes were also found associated with the net cage.

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