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Culture of Asian seabass (*Lates calcarifer*, Bloch) in open sea floating net cages off Karwar, South India

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ABSTRACT

Cage farming of marine finfish is an alternative to meet increasing demand for food fish. Culture of Asian seabass in open sea floating net cages made of either HDPE or GI pipes, has been successfully demonstrated off Karwar, south India. Fish were fed with chopped oilsardine. Various growth parameters like average daily growth rate (ADGR), survival rate (SR), specific growth rate (SGR) and biomass index (BI) were estimated. Mean weight and length at the end of the 150 days experimental period was 1.02 kg and 412.05 mm respectively with a SR of 68.8%. The economics of cage farming was also worked out. The need to standardise stocking densities and feeding rate has been emphasised.

Keywords: Cage culture, Karwar, *Lates calcarifer*, Seabass

Introduction

Globally, marine fish cage farming has proved to be a promising productive sector of industrial economy. In India, culture of marine finfish in open sea net cages is being promoted on a large scale due to increasing demand for quality fish and diminished production from capture fisheries. Cage culture is preferred over ponds for rearing Asian seebass (Boonyaratpalin and Williams, 2002). While nursery rearing of cultivable finfish like Asian seabass has been perfected in India (Philipose *et al*., 2010), research is now being focused on economically viable cage design and improved mooring systems.

In this paper we report the culture of Asian seabass in circular floating cages made of either high density poly ethylene (HDPE) or galvanised iron (GI) pipes, in the open sea off Karwar, south India, with an objective to understand the feasibility and economic viability of the culture. The coastline of Karwar, with a number of protected bays, is ideal for cage culture without affecting traditional fishing operations.

Materials and methods

Cages

For culture of seabass, circular cages of 6 m diameter made of either HDPE or 'B' class epoxy painted GI pipes were used. While HDPE cages were floated by inserting thermocol inside the pipes, GI cages were floated by providing eight pressurised fiber barrels containing 30 pounds air. Each cage was moored with concrete blocks weighing 3 t. The depth of the water column was 12 m and 10 m during high and low tides respectively, with mud-sandy bottom. The cages were tied with HDPE inner net of 4.5 m depth and a braided outer net of 5 m depth. Both the nets were kept in circular shape by providing a ballast pipe of 2" dia, at the bottom of each net, inserted with an iron rope (1.5" dia). The outer net had a mesh size of 60 mm. The mesh size of the inner net employed during the first 75 days of rearing period was 14 mm, which was replaced with a net of 28 mm mesh size for the rest of the culture period.

Source and maintenance of fish

Ten thousand hatchery produced Asian seabass juveniles (9±0.6 cm) reared in indoor cement tanks were transported to the marine farm site of the Central Marine Fisheries Research Institute (CMFRI), off Karwar, Karnataka, south India (lat 14^0 49' 914" N; long 74^0 06' 002" E) and stocked in four cages @ 2500 numbers per cage. The marine farm is naturally protected from strong winds, waves and current. The site is also free from domestic, industrial and agricultural wastes and other environmental hazards.

Feeding regime

The fish were fed with fresh or frozen chopped oilsardines (*Sardinella longiceps*) at the rate of approximately 5% of the biomass. Frozen feed was thawed before feeding. Fish were demand fed four times daily at 06.00, 12.00, 17.00 and 00.00 hrs.

Water quality parameters

Water quality parameters such as temperature, pH, salinity and dissolved oxygen (DO) were monitored daily using portable instruments, while critical parameters such as unionised ammonia (NH_3) and nitrite (NO_2) were estimated fortnightly, following titration methods as per APHA (1980).

Fish sampling and growth study

Representative numbers of fish were collected at monthly intervals as well as at final harvest and length and weight measurements were recorded. The fish were harvested at the end of 150 days of culture (March to July). The following growth parameters were enumerated as per the methods described by Salama and Al-Harbi (2007):

Average daily growth rate (ADGR g day^{-1}) = W_2-W_1/d

where, W_1 = Initial mean weight (during first/previous sampling), W_2 = final mean weight (during subsequent sampling) and 'd' = number of days between samplings

Specific growth rate (SGR) = lnW_2-lnW_1/d X 100

Survival rate (SR %) = N_2/N_1 X 100

where, N_1 = initial number of fish and N_2 = number of fish harvested.

Biomass increase (BI) was calculated as the difference in the biomass (in kg) between sampling.

Results

Various environmental parameters recorded dring the culture period are presented in Table 1. Salinity between 30.6 to 34.8 ‰ (mean: 32.4 ‰); temperature ranged between 33 to 27.60 °C (mean: 30.97 °C); dissolved oxygen level varied between 4.56 to 2.83 mg l^{-1} (mean: 3.85 mg l^{-1}). ammonia level ranged between 0.0011 and 0.0083 mg l^{-1} (mean: 0.0044 mg l^{-1}) and nitrite level varied between 0.01 to 0.02 mg l^{-1} (mean: 0.016 mg l^{-1}).

Mean weight, mean length, ADGR and SGR of the seabass juveniles reared in cages, at 30 days interval are shown in Table 2. ADGR and SGR on termination of the experimental period were 16.58 g and 3.01, respectively. SR and BI at the end of the culture period were 68.8% and 6.94 t, respectively. Fish were fed with approximately 2.2 t of feed during the culture period. The economics worked out is shown in Table 3.

Discussion

The study successfully demonstrated the feasibility of rearing Asian seabass in open sea floating net cages off Karwar. Further, it was also demonstrated that Asian seabass fed on oilsardine showed better values of different growth parameters like ADGR, SR and SGR when compared to earlier studies.

Three important issues in cage culture system are the biological, engineering and socio-economic aspects, which go hand-in-hand in development (Fredriksson *et al*., 1999). The cage design and mooring system adopted in the present study could withstand rough sea conditions during the

Table 1. Water quality parameters recorded during cage culture of *L. calcarifer*

Days	Temperature (°C ± SE)	pH (± SE)	Salinity (‰ ± SE)	DO (mg^{-1} ± SE)	NO_2 (mg l^{-1} ± SE)	NH_3 (mg^{-1} ± SE))
0 day	29.2± 0.2	7.2±0.1	32.6±0.4	5.5±0.58	0.015±0.002	0.02±0.002
30 day	30±0.2	7.4±0.2	33.2±0.5	6.0±1.26	0.020±0.004	0.02±0.004
90 day	30.4±0.3	7.2±0.1	33.4±0.2	5.5±0.86	0.015±0.008	0.03±0.002
120 day	28.6±0.2	7.2±0.1	29.6±0.2	5.5±0.14	0.015±0.002	0.02±0.002
150 day	28.8±0.2	7.4±0.1	28.6±0.2	5.5±0.14	0.025±0.002	0.02±0.002

SE: Standard Error

Table 2. Mean growth, ADGR and SGR of *L. calcarifer* at monthly intervals

Days	Mean weight (± SE) (g)	Mean length (± SE) (cm)	ADGR (g)	SGR
30 days	13.49 ±2.80	106.00±8.52	0.042	5.38
60 days	82.125±32.90	180.86±23.31	2.22	80.05
90 days	No sampling			
120 days	528.00±117.77	336.00±30.02	14.38	80.81
150 days	1025.42±329.67	412.05±46.66	16.58	28.82

SE: Standard Error

Table 3. Economics of cage farming (one GI cage; 2500 fish) of *L. calcarifer* off Karwar, South India

Details of costs and returns	Amount (₹)
Initial investment for a 6 m diameter cage	100000
Fixed cost (for crop duration of five months)	
a) Depreciation	20000
b) Insurance (2% on investment)	-
c) Interest on fixed capital (12%)	12000
d) Administrative expenses	3000
Total fixed cost (A)	35000
Operating cost	
a) Cost of seed (2500 nos.)	35000
b) Labour charges including cost of feeding	48000
c) Interest on working capital (6%)	4980
Total operating cost (B)	87980
Total cost of production (5 months)	122980
Yield of seabass (kg)	1764
Gross revenue from 1764 kg	441000
Net income (8)-(6)	318020
Cost of production (₹ kg^{-1}) (6)/(7)	69.71
Price realised (₹ kg^{-1}) (8)/(7)	250
Capital productivity (Operating ratio; (5)/(8))	0.20

culture period. Our study demonstrated that the GI cages floated on pressurised barrels were more stable than HDPE cages.

In the present experiment, fish were stocked at a density of 25 fish m^{-3}. In cage culture, optimum stocking densities and carrying capacities vary with species, size of fish, size of cages, rate of water exchange and length of growing season (Kilambi *et al*., 1977). Rowland *et al*. (2006) observed that stocking density did not affect final weight, SGR or absolute growth rate, but did affect the FCR and production when silver perch fingerlings were stocked at different densities in cages in an aerated earthen pond. Mortensen *et al*. (2007) found that the growth was similar when spotted wolffish were reared in tanks on land and in a flat-bottom sea cage at the same stocking density and water temperature. The depth, area and speed of the water current at the culture grounds determine the culture density of finfish species. Maximum stocking density of fish will only be achieved if environmental conditions are favourable (Mortensen *et al*., 2007).

Since oilsardine was regularly available in large quantity during March to July in Karwar at a reasonably cheap price (₹ 5 kg^{-1}), fish were fed with oilsardines during the present experiment. Trash fish was used as an economical way of feeding finfish in culture by earlier workers (Chou and Lee, 1997). As feed accounts for the major portion of rearing costs, nutritional adequacy and cost-effectiveness is critical to the aquaculture industry (Boonyaratpaline, 1997). In our experiments, fish were demand fed four times daily. However, Clark *et al.* (1990) observed that under demand feeding, growth and feed conversion were not significantly different than those fed *ad libitum*. Kadri *et al*. (1991) suggested that feeding efficiency could be improved markedly if feed delivery was tailored to daily rhythms in appetite. Since, accurate quantity of feed consumed was not available, actual feed conversion ratio could not be worked out.

Production strategies often involve manipulation of densities by harvesting, grading and transferring fish to larger-mesh cages during the culture period (Campbell, 1985). Further research is needed to standardise the stocking densities and feeding rate specific to the location, since an optimum density and proper feeding rate are mandatory for economical production.

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