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Growth performance of a Seaweed, *Kappaphycus alvarezii* under lined earthen pond condition in Tharuvaikulam of Thoothukudi coast, South East of India

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Abstract

The potential for using seaweed by rearing in floating bamboo cage moored at farm unit of Department of Coastal Aquaculture, Tharuvaikulam village of Tamil Nadu coast, South East of India was assessed under lined pond conditions. Seaweed, Kappaphycus alvarezii was grown for 35 days of cultivation in order to evaluate their growth performance in lined pond. Young seaweeds with average weight of 150g was tied in each seeding twine and grown to an average weight of 1350 g in 35 days with average wet weight gain of 1200g. A total wet weight of 259.200 kg / bamboo cage (10 x 10 feet size) was obtained at the end of the 35 days. This result clearly indicates that floating bamboo cage has considerable potential for the cultivation of seaweed in lined ponds, but, requires the careful management of nutrient inputs supply in to the cultivation ponds.

Keywords: Seaweed–Growth performance - Lined earthen pond condition.

Introduction

In general, seaweeds are macroscopic marine algae attached to solid substratum and growing in the shallow waters of sea. Seaweeds are comes under the primitive group of Thallophyta and are classified into three major Classes viz. Chlorophyceae (green algae), Phaeophyceae (brown algae) and Rhodophyceae (red algae). Seaweeds forms important marine resources and exploited for their commercial value such as agar, agarose, algin and carrageenan, besides their use as food, source of enzymes, dyes, drugs, growth promoters, etc.

In India, seaweeds are harvested from the natural beds along the Tamil Nadu and Gujarat coasts since 1966. Seaweed resources exploited in Indian coastal waters are inadequate to meet the growing demand for the supply of raw materials to the seaweed industries. Thus, there is the need to cultivate commercially important seaweeds to augment the supply of raw materials to the existing industries and for their sustenance.

In India, the introduction and culture of carrageenan yielding seaweed, *Kappaphycus striatus* was initiated by Central Salt and Marine Chemicals Research Institute (CSMCRI), which was considered as a boon to seaweed cultivation. Presently this species is acclimatized and cultivated extensively along the Mandapam coast (east coast) and on Diu coast (west coast) of India.

In the last 30 years, commercial production of eucheumatoid species has increased from less than 1000 dry weight mt to over 100,000 mt that are produced annually by about 40,000-50,000 families worldwide[1]. Therefore, numerous tropical countries with coastlines are searching for seaweed cultivation as a sustainable alternative livelihood for coastal villagers, particularly as part of coastal management. Today, seaweed farming is a viable alternative source of income for small-scale fishermen[2,3].

In India, seaweed cultivation methods are reviewed by various authors[4,5]. Raju and Thomas (1971) *Gracillaria edulis* was cultivated by using a long line rope method in a sandy lagoon in Krusadai Island, India[6]. In India, the Central Marine Fisheries Research Institute (CMFRI) developed a technology using for the cultivation of *Gracilaria edulis* by vegetative method[7]. The same methods were tried by using rope nets in place of long lines and variations were observed[7,8]. Experimental cultivation of *Gelidiella acerosa* was attempted by bottom culture using coral stones as substrates on open shore cultivation[7,9]. This cultivation method has also been adopted in India for *Gracilaria edulis*[6,4,7]. The cultivation of *Hypnea musciformis* was done in the lagoon of Krusadai Island, Gulf of Mannar of India[10]. In India, CMFRI has developed a viable technology in 1983 for commercial cultivation of agar yielding seaweed using coir rope nets[11,8]. The field cultivation was done in Pamban area, Gulf of Mannar of India[12]. *H. valentiae* on rope culture was done at Krusadi Island, Gulf of Mannar of India[13].

Pilot scale cultivation of some economically important seaweed adopted in has been done at Vellar estuary od south east of India[14]. During 1995, the first attempt at cultivation of a *K.*

striatum was reported[15]. In south east of India, a detailed report on the experimental cultivation of *K. alvarezii* was done[16]. Recently, large scale *K. alvarezii* cultivation has begun in Tamil Nadu coast of India[16]. The pilot scale cultivation of *K. alvarezii* has been successfully carried out in Vizhinjam bay of India[17]. In India, the demand from phycocolloid industry is great but the present production from natural habitat is very low and insufficient to cater the needs for local industry. This gap between the demand and supply can be bridged through mariculture practices of seaweeds by cultivating the useful species on commercial scale. There are several reports on the experimental field cultivation of economically important seaweeds in different maritime states of India[14,15,16]. Vegetative propagation method at different environments using various culture techniques have been reported from India[6], Shoreline cultivation of *Kappaphycus* has been successfully established along the Gulf of Mannar and Palk Bay coast of Tamil Nadu India[16] and similar cultivation is being organized along the Saurashtra coast in Gujarat of India in recent times. Though much works available on cultivation seaweeds in open sea and to some extent in earthen pond environment condition, there is paucity of information available on cultivation of seaweeds under lined earthen pond condition. The present investigation was undertaken to assess the growth performance of *Kappaphycus alvarezii* in lined earthen pond condition by using the known techniques of bamboo floating raft method.

Material and methods

The study was conducted in farm unit of Department of Coastal Aquaculture, Tharuvaikulam of south east of India. The *K. alvarezii* seed materials were collected from Mandapam, Gulf of Mannar, south east coast of India. The seed materials were transferred to culture site. The live material has been transported in jute sacks and wetted with water to prevent desiccation.

The good floating nature of one raft (having size of 10 x 10 feet) bamboo poles serving as mainframe with 10 feet length each. Each corner of the bamboo raft was tied with small bamboo pole (each 2.5 feet) used as additional frames. The poles were fixed by tying with 6 mm thick nylon ropes. Anchors (5 kg on one side of the raft) were made of concrete blocks that were made especially for marine environment, i.e., with extra cement and rock pebbles. The anchors were fitted to the rafts using 8 mm thick nylon ropes which are strong against pond waves. Fish nets were tied under the raft to avoid the grazing.

Well branched with good quality seed materials weighed with an average weight of 150g (purchased from farmers) was inserted in single braid knot (16 braid knots / single rope); thus 192 seed materials were seeded out of 12 ropes in a single bamboo raft. Approximately, 28.800 kg of seed materials were inserted in a single raft. The distance between each tied rope was 15cm.

The study was conducted for a period of 35 days. The Daily growth rate was calculated every 15 days interval. The Daily Growth Rate (DGR) or specific growth rate (SGR) % was calculated using the following formula[18].

$$DGR\ \% = \ln(Wf / Wo) / t \times 100$$

Wf is the final fresh weight (g) at t day.
Wo is the initial fresh weight (g),
t is the number of culture days.

Similarly, the average daily growth was calculated by the following formula:

$$\text{Average Daily Growth (ADG)} = \frac{\text{Weight gain}}{\text{Number of days}}$$

Results and Discussion

The calculated growth performance of seaweed under lined earthen pond condition along with seeding details is given in Table 1. The Average daily growth (ADG) and Specific Growth rate recorded in this study are 25.71 g / day and 4.11 % / day respectively. The relative growth rates (RGR) of K. alvarezii have already been well reported[19,16]. The water quality parameters recorded in the present study is given in Table 2. In the present study, young seaweeds with average weight of 150g was tied in each seeding twine and grown to an average weight of 1350 g in 35 days with average wet weight gain of 1200g. A total wet weight of 235.200 kg / bamboo cage (10 x 10 feet size) was obtained at the end of the 35 days. The final harvest of seaweeds in raft is depicted in Figure 1.

A growth rate of 3.5% per day is considered significant in commercial cultivation of *Eucheuma* spp[20,21]. The average growth rates of *Eucheuma denticulatum*, *Kappaphycus alvarezii,* and *Kappaphycus striatum* of about 3.5%[22]. A growth rate of 3% in unfertilized *E. denticulatum* cultivated in a land-based integrated system in Zanzibar was observed[23]. Higher growth rates on *K. alvarezii* were reported[24]. Lower stocking density results in higher growth rates than the high stocking density used by seaweed farmers in Tanzania. Further, higher nutrient levels have little effect on growth rates of both *E. denticulatum* and *K. alvarezii*, and, thus, do not add much to the seaweed farming industry. However, additional of nutrients would be necessary and beneficial in other set-ups such as land-based systems[25].

The economic feature of seaweed production in bamboo raft under lined earthen pond condition was also worked out and is given in Table 3. The cost of production / kg of seaweed (on dry weight basis) were calculated to the tune of Rs. 21.76 / kg. Similarly, the net profit / kg of seaweed are around Rs. 3.24. This cost of production for seaweed cultivation which is more or less closer to open seawater body condition.

Table-1
Seeding and growth performance of seaweed under lined pond

Seeding and Growth details		
1	Number of cage	01
2	Cage size	10 x 10 feet
3	Number of nylon rope (numbers)	12
4	Number of seeding twine in each nylon rope (numbers)	16
5	Total seeding twine in the raft (numbers)	192
6	Mean Initial Weight (g)	150
7	Total initial weight from whole bamboo raft (kg) seeded	28.800
8	Mean Final Weight (g)	1350
9	Mean Weight Gain (g)	1200
10	Total final weight from whole bamboo raft (kg)	259.20
11	Average daily growth (g / day)	25.71
12	Specific Growth rate (% / Day)	4.11
13	Seed source	Natural Collection
14	Days of culture	35

Table-2
Physico chemical parameters of seawater used seaweed production in Bamboo raft under lined earthen pond condition

Parameters	Seawater
1. Dissolved Oxygen (ppm)	6.3
Salinity (ppt)	36
PH	8.10
Temperature (^oC)	29.00
Alkalinity (ppm)	125
Dissolved free CO_2 (ppm)	Nil
NO_2 – N (µg at- NO_2-N / lit.)	0.18
NO_3 – N (µg at- NO_3-N / lit.)	0.85
NH_3-N (µg at- NH_3-N / lit.)	0.22
PO_4^- P (µg at- PO_4-P / lit.)	2.85

Table-3
Economic features of seaweed production in Bamboo raft under lined pond condition

A) Non - Recurring cost		
1	Cost of the cage (Rs.1,000 / cage	1,000.00
B) Recurring cost		
2	Seeding cost (28.800 kgs x Rs.5 per Kg)	144.00
3	Other expenses (transportation, labour, maintenance etc.	200.00
4	Depreciation (20 % of Non-recurring cost)	200.00
	Sub total	544.00
C) Harvest Details		
5	Total harvested weight of seaweeds (kgs) before drying	259.200
6	Total harvested weight of seaweeds (kgs) after drying	26.000
7	Selling price (Rs. 25 / Kg)	25.00
8	Total revenue (26.000 Kgs x Rs. 25 / Kg)	650.00
9	Net revenue (Rs. 650 – Rs. 544)	106.00
10	Cost of production / kg (Rs. 544 % 25 Kgs)	21.76
11	Net profit / Kg (Rs. 25 / Kg – Rs. 21.76 / Kg)	3.24

Figure-1
The final harvest of seaweeds in bamboo raft

Conclusion

Despite the good results observed in the present study for lined pond condition, these positive findings should be further investigated to test the effect of growing seaweed on the nutrient available in the pond condition. In addition, other beneficial effects should be examined closer, focusing on the natural bloom of pond with or without fertilizing schedule in the capacity of seaweed to absorb nutrients that are produced inside in the lined pond water condition. The results of the present study clearly demonstrated that floating bamboo raft in lined earthen pond condition offer a viable alternative for cultivating seaweed in open sea condition. Furthermore, polyculture of seaweed on fish warrants further investigation in lined earthen pond conditions.

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