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Pilot scale field cultivation of the agarophyte *Gracilaria edulis* (Gmelin) Silva at Vadakadu (Rameswaram)

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ABSTRACT

Pilot scale field cultivation of the agar yielding red alga *Gracilaria edulis* was carried out at Vadakadu near Rameswaram from July, 2001 to July, 2002 involving the local fisher folk. The growth of plants during July, 2001 to January, 2002 was good and they reached harvestable size of 19.6 to 28.9 cm (mean length) after 60 to 80 days growth and harvests were made. The seed material introduced during March to July, 2002 degenerated due to turbid seawater, sedimentation and high seawater temperature. Data collected on environmental and hydrological parameters from the culture site at fortnightly intervals were correlated with the growth of cultured seaweed. The results obtained in this experiment revealed that commercial scale cultivation of *G. edulis* could be done successfully in the nearshore area of Vadakadu during the period July to January.

Introduction

Seaweeds are cultivated for the supply of raw material to the seaweed industries and for their use as human food. In India, seaweeds collected from the natural seaweed beds, mostly from south Tamilnadu coast, are used as raw material for the production of agar and alginates. About 25 agar and 10 algin industries are functioning at different places in the maritime states of Tamilnadu, Kerala and Karnataka. Annually about 5000 tons (dry wt) of alginophytes, *Sargassum* spp, *Turbinaria* spp and *Cystoserira trinodis* and 1000 tons (dry wt) of agarophytes, *Gelidiella acerosa, Gracilaria edulis, G. crassa* and *G. foliifera,* are used as raw materials by these industries. The agar yielding seaweeds are inadequate to meet the raw material requirements of Indian agar industries (Kalimuthu and Kaliaperumal, 1996). Hence commercial scale cultivation of agar yielding seaweeds is necessary to augment the resource and for uninterrupted supply of raw material to the industries.

With a view to develop suitable technology for commercial scale cultivation of agarophytes, attempts have been made on experimental field cultivation of agar yielding seaweed *Gracilaria edulis* by vegetative propagation method at different environments using various culture

techniques (Raju and Thomas, 1971; Umamaheswara Rao, 1973 and 1974; Krishnamurthy *et. al.*, 1975 and 1977; Chennubhotla *et. al.*, 1987 and 1992; Chennubhotla and Kaliaperumal, 1983; Paramasivam and Devadoss, 1987; Kaliaperumal *et. al.*, 1992, 1993 and 1994). To explore the possibility of commercial scale cultivation of *G. edulis* at Vadakadu (Palk Bay side) in Rameswaram Island, pilot scale culture was carried out from July, 2001 to July, 2002 using 2 x 2 m size coir rope nets. The fisherfolk of Vadakadu were involved in the seaweed culture activities under the project sponsored by the Department of Biotechnology, Govt. of India, New Delhi on "Transfer of technology of seaweed culture for rural development" with a view to transfer the proven technology developed for *G. edulis* farming by the Central Marine Fisheries Research Institute (Chennubhotla and Kaliaperumal, 1983) to them. Data on water clarity, sedimentation, wave action, epiphytes and predators were collected from the seaweed culture site. Data on hydrological parameters were also collected and the results obtained on all these aspects are presented in this paper.

Materials and Methods

Coir rope nets of 2x2 m size with 12 cm mesh fabricated with 1" thick coir rope were used for culture work. Young and healthy plants of *Gracilaria edulis* (Gmelin) Silva collected from Sangumal in Rameswaram island and transported to Vadakadu by road in plastic drums with seawater were used as seed mateial. Plants of *G. edulis* growing naturally near the culture site were also used for planting. Fragments of *G. edulis* (6.0 to 6.5 cm long) obtained from the mother plants were inserted in the twists of coir rope nets. In each net 4.0 to 6.8 kg of seed material were introduced and the seeded nets were tied tightly to the casuarina poles erected in 0.2 ha area at the culture site (Fig. 1) in such a way so that the nets were always submerged in seawater and 50 cm above the sea bottom. The number of nets and quantity of seed material introduced in each month from July, 2001 to July, 2002 are given in Table 1. Nets could not be

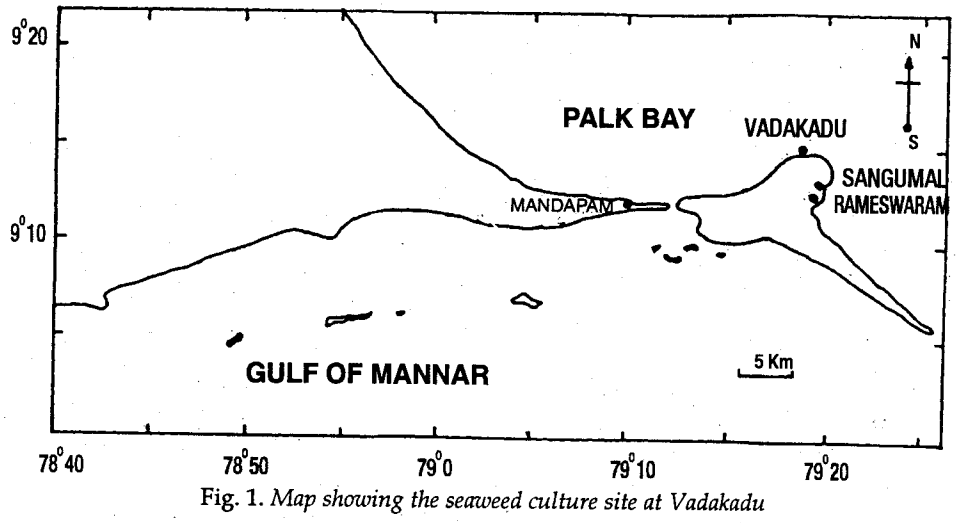

Fig. 1. *Map showing the seaweed culture site at Vadakadu*

introduced in October, 2001, February and May, 2002. Observations were made regularly and data were collected at fortnightly intervals on the growth of plants, sedimentation on nets, other algal growth, attachment of animals, grazing by fishes and sea conditions.

Data on environmental factors such as water clarity, water temperature and sedimentation were collected from the culture site at 15 days intervals. Water samples were also collected fortnightly and analysed for pH, salinity, dissolved oxygen and nutrients such as phosphate, silicate, nitrite and nitrate following the methods given by Strickland and Parson (1968). The method described by Kaliaperumal *et. al.* (1993) was followed for collection of data on sedimentation.

Results

The growth of seed material introduced on nets during July, 2001 to January, 2002 was good due to clear water without sedimentation and attachment of organisms. During this period the plants grew to harvestable size after 60 to 80 days with mean length of 19.6 to 28.9 cm and maximum length of 29.0 to 41.5 cm (Table 1). Though the plants reached harvestable size, the biomass of crops harvested during the period September, 2001 to January 2002 was less than the quantities of seed material introduced in the nets. It was due to heavy epiphytic growth of other algae such as *Padina boergesenii, Jania rubens, Acanthophora spicifera, Amphiroa fragilissima, Hypnea musciformis, H. valentiae, Cladophora* sp., *Chaetomorpha aerea* and *Enteromorpha compressa* on the culture nets. The crops harvested in March, 2002 from the nets introduced in December, 2001 and January, 2002 were found to be 4.2 to 4.9 fold increase over the quantities of seed material introduced. Maximum increase in yield of 8.9 fold was obtained from the nets introduced in January and harvested in March 2002 after 70 days of culture period. The attachment of animals on the nets and grazing by fishes were not observaed during the entire period of investigation.

The seed material introduced during March, April, June and July, 2002degenerated after 7 to 15 days due to heavy sedimentation all over the surface of seedlings affecting the photosynthetic activity and in turn the growth of plants. The low light intensity due to the turbulent condition of the sea caused low photosynthetic activity in cultured plants leading to its gradual degeneration. The failure of crop may also be due to high seawater temperature.

Data collected on environmental and hydrological parameters from the seaweed culture site from July, 2001 to July, 2002 are given in Table 2. The water was clear (96 to 99% clarity) from July, 2001 to February, 2002 and turbid (76 to 79% clarity) during March to July, 2002. The values for sedimentation varied from 0.167 in February to 3.564 g/l/24 hrs. The atomospheric and bottom temperature ranged from 28.5 to 34.5°C and from 28.0 to 33.8°C respectively. In the bottom water, the pH values varied from 8.1 to 8.7. The salinity and dissolved oxygen content of the water ranged from 31.43 to 35.70‰ and 4.09 to 5.12 ml/l respectively. The phosphate content varied from 0.06 to 0.25 µg at/l, silicate from 5.50 to 18.00 µg at/l, nitrite from 0.06 to 0.14 µg at/l and nitrate from 1.25 to 2.13 µg at/l in the culture site.

Table 1. *Data on the growth, culture period and other details on the cultivation of* G. edulis *at Vadakadu (Rameswaram) in Palk Bay side*

Month of planting	No. of coir rope nets (2x2 m size) introduced	Quantity of seed material used (in kg)	Month of harvest / Removal of nets	Growth/ culture period (days)	Quantity of crop harvested (in kg)	Mean length of seed material (cm)	Maximum lenght of harvested plants (cm)	Mean length of harvested plants (cm)	Remarks
July, 2001	51	325	September 2001	70	22	6.0	34.0	21.6	Plants reached harvestable size
August	25	100	October 2001	60	Nil	5.8	29.0	19.6	Plants reached harvestable size
September	48	300	November 2001	70	257	6.4	31.0	19.7	Plants reached harvestable size
October	-	-	-	-	-	-	-	-	Nets could not be introduced
November	45	300	January 2002	60	222	6.1	41.5	23.1	Plants reached harvestable size
December	22	150	March 2002	80	625	6.3	41.5	28.9	Plants reached harvestable size
January,02	47	200	March 2002	70	972	6.5	36.0	26.6	Plants reached harvestable size
February	-	-	-	-	-	-	-	-	Nets could not be introduced since the culture site is not approachable
March	50	325	April 2002	30	-	6.5	-	-	Seed material degenerated due to turbid seawater, sedimentation and high seawater temperature
April	50	325	May 2002	30	-	6.5	-	-	-do-
May	-	-	-	-	-	-	-	-	Nets could not be introduced due to non availability of seed material
June	60	400	July 2002	30	-	6.5	-	-	Seed material degenerated
July	60	400	July 2002	15	-	6.5	-	-	-do-

Table 2. *Environmental and hydrological data collected from the seaweed culture site at Vadakadu (Rameswaram)*

Month	Water clarity in the field	Water clarity (%)	Sedimentation g/l/24 hrs	Temperature (°C) AT	Temperature (°C) BWT	pH	Salinity (‰)	Dissolved oxygen (ml/l)	Nutrients (µg at/l) Phosphate	Silicate	Nitrite	Nitrate
July, 2001	Clear	99	1.439	30.8	30.1	8.2	31.43	4.20	0.19	5.50	0.09	2.13
August	Clear	99	2.133	29.0	28.5	8.1	32.36	4.39	0.06	5.95	0.07	1.44
September	Clear	99	1.989	29.6	29.6	8.7	33.77	4.36	0.10	7.83	0.07	1.75
October	Clear	99	1.500	28.5	28.0	8.5	35.70	4.18	0.18	14.50	0.14	1.75
November	Clear	96	1.203	30.0	29.5	8.4	34.65	4.18	0.16	12.00	0.06	1.88
December	Clear	96	1.360	28.5	28.5	8.2	34.13	4.63	0.15	12.00	0.06	1.88
January,02	Clear	98	0.390	32.0	31.8	8.2	33.52	4.45	0.24	10.50	0.12	1.88
February	Clear	98	0.167	33.0	32.6	8.1	33.30	4.33	0.16	11.50	0.06	1.88
March	Turbid	76	2.260	33.0	32.8	8.2	32.92	4.23	0.23	15.00	0.12	1.88
April	Turbid	78	2.250	34.5	34.2	8.4	33.62	4.09	0.25	12.50	0.11	1.88
May	Turbid	78	3.420	34.0	33.8	8.3	33.20	5.12	0.15	17.00	0.12	1.50
June	Turbid	78	3.564	33.3	33.0	8.3	33.68	4.91	0.18	25.50	0.12	1.25
July	Turbid	79	3.465	30.0	30.4	8.3	33.10	4.30	0.10	18.00	0.12	1.63

AT = Atomospheric temperature; BWT = Bottom water temperature

Discussion

The growth and production of cultured *G. edulis* at Vadakadu can be equally compared with the results obtained in the experimental field cultivation of this species carried out in the nearshore area of Mandapam (Umamaheswara Rao, 1974; Chennubhotla *et. al.*, 1978 and 1987; Kaliaperumal, 1993), Valinokkam (Kaliaperumal *et. al.*, 1994), lagoon of Krusadai island near Mandapam (Raju and Thomas, 1971; Krishnamurthy *et. al.*, 1975 and 1977) and Minicoy island of Lakshadweep (Kaliaperumal *et. al.*, 1992; Chennubhotla *et. al.*, 1992). The present study revealed that sedimentation, light intensity, water turbidity and water temperature are the factors affecting the growth of cultured *G. edulis*. This is in conformity with the earlier findings on the field cultivation of *G. edulis* (Chennubhotla et. al., 1987; Kaliaperumal *et. al.*, 1993 and 1994). In the experiments conducted earlier on the field culture of *G. edulis*, attachment of different animals such as Aplysia, sponges, ascidians, bryozoans, Sepia and other molluscan egg mass on culture nets and grazing by fishes affecting the growth and production of crops were recorded (James *et. al.*, 1986; Chennubhotla *et. al.*, 1987; Kaliaperumal *et.al.*, 1993). But in the present investigation these constraints were not faced during the entire period of the work. The present investigation shows that the period between July and January is suitable for large scale cultivation of *G. edulis* in the nearshore area at Vadakadu in the Palk Bay and for obtaining crops periodically when the water is clear with good light penetration and without sedimentation and attachment of animals. The periodical and regular harvests could be obtained by proper and daily maintenance of the seaweed farm.

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