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Outdoor culture of agar yielding red alga *Gracilaria edulis* (Gmelin) Silva

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ABSTRACT

Agar yielding red alga *Gracilaria edulis* was successfully cultured in fibreglass tanks with running seawater at out door environment. The biomass of cultured seaweed showed a crop growth rate ranging between 3.9 - 8.0 g/day after different days of culture. The tanks stocked with lesser quantity of seed material showed better growth rate. Experiments were also conducted by providing the seed material with different quantities of NPK, Urea, Ammonium sulphate + Sodium phosphate and Potassium nitrate + Phosphate + EDTA at weekly intervals. Higher crop growth rates (CGR) of 4.3 g/day with 700 mg NPK and 5.2 g/day with 80 mg urea were attained respectively. The growth rate recorded was 3.6 g/day in the tanks provided with Ammonium sulphate + Sodium phosphate and 3.7 g/day in the tank provided with Potassium nitrate + Phosphate + EDTA. Data on the environmental and hydrological parameters from seaweed culture tanks were recorded.

Introduction

Seaweeds are cultivated in the Far East for supply of raw materials to seaweed industries and for their use as human food. They can be cultured either in the sea or in onshore ponds and tanks by vegetative propagation method using fragments and by reproductive method using different kinds of spores. The advantage in the onshore cultivation lies in preventing the grazing of cultured seaweeds by fishes. Further, environmental and hydrological parameters can be monitored for consistent crop yield throughout the year in this method. Commercial scale cultivation of economically important seaweeds such as *Porphyra, Undaria, Laminaria, Eucheuma, Kappaphycus* and *Gracilaria* has been practised in countries like Japan, China, Philippines in widely different environments. Out door culture of *Chondrus crispus* (Saito, 1979), *Gigartina* and *Hypnea* (Neish, 1979; Guist *et. al.*, 1982) was achieved in different countries.

In India, experimental cultivation of commercially important seaweeds *Gelidiella acerosa, Gracilaria edulis, Hypnea musciformis and Acanthophora spicifera* was realised in different environments of the

sea (Raju and Thomas, 1971 : Umamaheswara Rao, 1974; Subbaramaiah *et.al.*, 1975; Krishnamurthy *et.al.*, 1975 and 1977; Chennubhotla *et al*, 1978; Rama Rao *et al.*, 1985; Rama Rao and Subbaramaiah, 1986; Patel *et al.*, 1986; Kaliaperumal *et al.*,1986, 1992, 1993 and 1996). But the cultivation of seaweeds in the onshore conditions needs to be studied. Hence, the present work on the outdoor culture of food grade agar yielding red alga *Gracilaria edulis* was undertaken with various stocking density of seed material in fibreglass tanks provided with running seawater system.

Materials and Methods

Culture of *Gracilaria edulis* (Gmelin) Silva was carried out in 250 l capacity fibreglass tanks (75 x 50 x 50 cm size) arranged in 3 tiers at different heights vertically. The tanks were kept under shade and provided with continuous running seawater by gravitational flow system. Healthy plants of *G.edulis* collected from subtidal region of Thonithurai near Mandapam were used as seed materials. Three sets of experiments were conducted in the present study. In the first set of experiments conducted, different stocking densities of seed material i.e. 100, 250, 500, 750 and 1000 g were used in order to find out the exact densities from which maximum biomass could be obtained. In the second set of experiments, the growth and biomass of cultured seaweed were recorded by using only 100 g of seed material. In the third set of experiments, the growth of seed materials was followed using different quantities of fertilizers such as NPK (100, 200, 300, 400, 500, 600, 700 and 800 mg), Urea (20, 40, 60, 80 and 100 mg), Ammonium sulphate (500 mg) + Sodium phosphate (50 mg) and Potassium nitrate (2.4 g) + Phophate (1.2 g) + EDTA (1.2 g) provided at weekly intervals by putting them in slotted polythene bags and suspending in the tanks. The seawater level in all tanks was maintained at 43 cm.

Results

The biomass of cultured seaweed *G.edulis* was found to be more in the tanks stocked with less quantity of seed material (100 g) showing 47% increase in yield after 12 days of culture period with CGR of 3.9 g/day (Table-1). In the experiment conducted with 100 g seed material, maximum increase in yield of 32.0% and 8.0 g/day growth rate were obtained after 40 days of the culture period (Table 2).

The growth and biomass data of *G.edulis* supplemented with different quantities of NPK are given in Table 3. During maximum growth rate of 4.3 g/day an increase in yield of 90% was recorded in the tanks provided with 700 mg of NPK after 21 days of culture period. When provided with different quantities of Urea, Ammonium sulphate + Sodium phosphate and Potassium nitrate + Phosphate + EDTA, at maximum crop growth rate of 5.2 g/day with 57% increase in yield was observed in the tanks provided with 80 mg of Urea after 11 days of culture period. However, higher yields of 155% with 3.6 g/day growth rate in the tanks provided with Ammonium sulphate + Sodium phosphate after 43 days and 63% yield with 3.7 g/day growth rate in the tanks provided with Potassium nitrate + Phosphate + EDTA after 17 days were recorded (Table 4).

Several epiphytes were found in the tanks during the culture period, namely *Chaetomorpha aerea, C.linoides, Cladophora* sp, *Rhizoclonium* sp,

Table 1. *Growth of* Gracilaria edulis *under different stocking densities during August, 2000 to February, 2001*

Quantity of seed material introduced (g)	Number of days of growth	Average yield (%)	% increase in yield	Growth (g/day)
100	12	147	47	3.9
250	11	283	13	1.2
500	7	565	13	1.9
750	7	840	12	1.7
1000	7	1058	6	0.9

Table 2. *Growth of* Gracilaria edulis *with stocking density of 100 g of seed material*

Culture period	Number of days of growth	Maximum yield (%)	% increase in yield	Growth (g/day)
February-March, 2001	40	420	320	8.0
April, 2001	15	200	100	6.6
May - July, 2001	70	575	475	6.8
July - August, 2001	37	310	210	5.7

Table 3. *Growth of* Gracilaria edulis *(stocking density of 100 g) provided with different quantities of NPK during September - December, 2001*

Quantity of NPK provided (mg)	Number of days of growth	Average yield (%)	% increase in yield	Growth (g/day)
Control	14	140	40	2.9
100	37	190	90	2.4
200	45	200	100	2.2
300	30	170	70	2.3
400	33	220	120	3.6
500	21	180	80	3.8
600	21	140	40	1.9
700	21	190	90	4.3
800	45	170	70	1.6

Table 4. *Growth of* Gracilaria edulis *(stocking density 100 g) provided with different fertilizers during September - December, 2001*

Fertilizer provided	Number of days of growth	Average yield (%)	% increase in yield	Growth (g/day)
Urea				
Control	14	135	35	2.5
20 mg	16	160	60	3.8
40 mg	19	167	67	3.5
60 mg	17	167	67	3.9
80 mg	11	157	57	5.2
100 mg	19	163	63	3.3
Control	37	210	110	3.0
Ammonium Sulphate (500 mg) + Sodium Phosphate (50 mg)	43	255	155	3.6
Control	15	125	25	1.7
Potassium Nitrate (2.4 g) Phosphate (1.2 g) EDTA (1.2 g)	17	163	63	3.7

Enteromorpha intestinalis, Ulva lactuca, Dictyota bartayresiana, Hypnea musciformis, Gracilaria crassa, Lyngbya majuscula and *Phormidium* sp. But the growth of the cultured seaweed remained unaffected as the epiphytes were periodically removed manually from the culture tanks. Variation in the environmental and hydrological parameters in the seaweed culture tanks during the study period is presented. (Table 5).

Table 5. *Data collected on environmental and hydrological parameters from the seaweed culture tanks during August, 2000 to December, 2001*

Parameters	Minimum value	Maximum value
Atmospheric temperature (°C)	28.1	35.6
Culture shed temperature (°C)	27.2	35.2
Water temperature in tanks (°C)	25.6	34.0
Light intensity (lux)	1,200	>50,000
Salinity (‰)	30.40	35.52
Dissolved oxygen (ml/l)	3.28	5.61
Nutrients (µg at/l)		
Phosphate	0.03	0.13
Silicate	3.00	32.00
Nitrite	0.02	0.10
Nitrate	0.50	1.88

Discussion

In the field cultivation of *G.edulis* carried out in the nearshore areas of Gulf of Mannar and Palk Bay, epiphytes, epifauna, sedimentation and grazing by fishes were found to hamper the growth resulting in failure of crop during some seasons (Kaliaperumal *et al.*, 1993). The present investigation revealed that these factors can be monitored in the outdoor culture and consistent crop could be obtained throughout the year. The present study also showed that application of fertilizer in optimal quantity promoted the growth and production of cultured seaweed. Pilot experiments in this line are necessary to perfect the technology of outdoor culture of seaweeds for commercial scale culture by the seaweed industry and private entrepreneurs. The growth and biomass obtained for *G.edulis* in the present outdoor culture can be equally compared with the results obtained in the field culture of this species in the lagoon of Krusadai Island (Raju and Thomas, 1971; Krishnamurthy *et al.*, 1975 and 1977), in the nearshore area of Mandapam (Umamaheswara Rao, 1974, Chennubhotla *et al.*, 1978) in Valinokkam Bay (Kaliaperumal *et al.*,1996) and in Minicoy lagoon (Kaliaperumal *et al.*; 1992; Chennubhotla *et al.*, 1992).

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