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भारतीय कृषि अनुसंधान परिषद
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ENVIRONMENTAL FACTORS INFLUENCING THE GROWTH OF *GRACILARIA EDULIS* IN CULTURE *

In India seaweeds are mainly used as raw material for the production of phytochemicals namely agar and sodium alginate. At present the red seaweeds *Gelidiella acerosa, Gracilaria edulis* and *G. crassa* are used for the extraction of agar-agar and brown seaweeds *Sargassum* and *Turbinaria* for industries have come up in different maritime states of India namely Tamil Nadu, Gujarat, Karnataka, Kerala and Andhra Pradesh. All these seaweed based industries mostly depend on the seaweeds harvested from the south-east coast of Tamil Nadu from Mandapam to Kanyakumari. The resource of algin yielding seaweeds is quite sufficient to meet the raw material requirement of algin industries. But the availability of *Gelidiella acerosa* and *Gracilaria edulis* from natrual seaweed beds are inadequate to meet the raw material demand of agar industries. Hence cultivation of agar yielding seaweeds is necessary in order to maintain a continous supply without any paucity of raw material to the agar industries.

The cultivation of commercially important seaweeds on experimental scale is attempted by the Central Marine Fisheries Research Institute and Central Salt & Marine Chemicals Research Institute. Since 1972 the Central Marine Fisheries Research Institute is involved in the field cultivation of agar yielding seaweeds at different places in the nearshore areas of Gulf of Mannar and Palk Bay, Kanchirangudi estuary, Athankarai estuary, Pillaimadam lagoon and fish farm ponds by vegetative propagation method using long line coir ropes, coir rope nets, HDP rope nets, coir rope frames, monofilament nylon fishing lines, velon screen bags, coral stones, pens and cages.

In the Central Marine Fisheries Research Institute, culture experiments with *G. edulis* were conducted in the nearshore areas of Gulf of Mannar and Palk Bay during different seasons of the years from 1976 to 1985 continuously. Although there were variations with respect to quantity of seed material introduced, the yield rate showed fluctuations during certain seasons. In order to understand these variations, relevant environmental data were collected from the inshore waters where culture operations were carried out.

The environmental parameters such as surface water temperature, salinity, dissolved oxygen and nutrients (phosphate, silicate, nitrite and nitrate) during each culture operation were compared in relation to biomass increase and duration of culture period. It was observed that no single environmental parameter could be pin pointed as responsible for variation in production. At best it could be inferred that a complexity of environmental factors operating in a dynamic inshore area may be responsible for seasonal variation in the yield of seaweeds. The Gulf of Mannar and Palk Bay experience contrasting seasonal changes in wind velocity and direction and wave action. The solar radiation in the region, rainfall, transport of inorganic and organic material into the region are some of the factors other than those observed parameters.

Detailed investigations were undertaken again during the years 1986 to 1989 to know the effect of various environmental factors such as water temperature, water quality, water turbidity, light intensity, sedimentation, fouling organisms (epiphytes and epifauna) and predators which affect the growth of G.

Prepared by : N. Kaliaperumal, V. S. K. Chennubhotla *, S. Kalimuthu, J. R. Ramalingam and K. Muniyandi. Regional Centre of CMFRI, Marine Fisheries - 623 520, Tamil Nadu. * Minicoy Research Centre of CMFRI, Minicoy.

edulis by culturing it on 2x2 m size coir rope nets. These culture experiments were done in the nearshore areas at 1 m depth in Gulf of Mannar (near CMFRI jetty) from October to March and in Palk Bay (near CMFRI fish farm) from April to September during the calm seasons in both sides. Four kg of seed material of *G. edulis* was used for seeding each net. The harvest of the seaweed was made after 25 to 60 days growth when the plants reached harvestable size or when the sea conditions were unfavourable. The nets without growth of plants were removed after observing for a maximum period of 75 days.

The data collected on the growth and production of *G. edulis* cultured in Gulf of Mannar showed that although the period of good growth varied from year to year, November to February/March was found to be suitable for good growth. The yield of crop ranged from 1.7 to 5.2 fold increase and the rate of production varied from 14 to 77 g/day/m^2. There was no growth of *G. edulis* in the nets introduced at Palk Bay during the entire period of study. The environmental and hydrological data collected from the seaweed culture site in Gulf of Mannar during the months of good growth from 1986 to 1989 are given in Table 1.

The reasons for the failure of crop in certain months in Gulf of Mannar and Palk Bay were mainly due to attachment and growth of several other algae and animals on the nets and seedlings, high and low light intensity, high water temperature, water turbidity, sedimentation and grazing by fishes. The algae which hampered the growth of *G. edulis* by heavy attachment were *Ulva lactuca, Enteromorpha compressa, E. intestinalis, Chaetomorpha aerea, Cladophora fascicularis and Boergesenia forbesii* (green algae); *Jania rubens, Hypnea musciformis, Champia parvula* and *Acanthophora spicifera* (red algae). The animals found attached to the nets affecting the growth of *G. edulis* were *Aplysia*, sponges, ascidians, bryozoans and molluscan egg mass. The fishes found to graze on cultured *G. edulis* were *Siganus javus, S. canaliculatus* and *Psammoperca weigiensis*. The clear water without much sedimentation, optimum light intensity, slightly higher phosphate and nitrate contents in the water and absence of fouling organisms and predators accelerated the growth of *G. edulis*.

The present investigation indicates that *G. edulis* can be successfully cultivated on commercial scale in the nearshore areas of Gulf of Mannar during the five months period from November to March when the sea is calm. The shallow waters near CMFRI fish farm in Palk Bay are not suitable for *G. edulis* cultivation as the growth of the plant was affected by various environmental factors mentioned above. The culture experiments of *G. edulis* conducted earlier by the Central Marine Fisheries Research Institute in 3 - 4 m depth area at Palk Bay near CMFRI fish farm showed good growth of plants as there was less sedimentation, fouling organisms and predators. Hence *G. edulis* could be cultivated in deep waters in Palk Bay side and attempts may also be made to culture *G. edulis* in shallow waters at other areas of Palk Bay in order to select the suitable culture sites and period of good growth.

TABLE 1. *Enviromental and hydrological data collected from the seaweed culture site and Gulf of Mannar*

Month & year	Water clarity	Temperature (° C)		Salinity (‰)	Dissolved oxygen (ml/l)	Nutrients (µg at/l)				Sediment-ation (g/1/24 hr)
		A. T.	S. W. T.			Phosphate	Silicate	Nitrite	Nitrate	
November '86	Clear	29.5	28.7	34.19	3.88	0.26	22.75	-	0.6	1.415
December	Clear	29.2	28.2	30.53	4.46	0.17	30.30	-	2.50	1.220
January '87	Clear	29.7	27.2	30.22	4.73	0.12	43.40	0.84	1.00	1.179
Feburary	Turbid	31.2	28.5	30.30	4.42	0.23	33.70	0.21	0.58	4.031
November	Clear	28.0	27.7	32.83	4.60	0.17	28.33	0.06	1.00	1.496
December	Clear	27.1	27.6	29.50	5.42	0.10	12.50	0.08	1.34	1.190
January '88	Clear	27.2	26.3	28.00	6.20	0.10	24.66	0.15	2.13	1.494
February	Clear	28.1	27.6	29.50	6.6	0.22	14.50	0.06	3.00	3.168
March	Turbid	31.8	30.4	32.80	6.06	0.24	35.30	0.10	3.15	4.128
December	Clear	28.8	27.2	29.13	5.47	0.08	23.00	0.02	1.44	0.832
January '89	Clear	27.7	26.5	30.40	4.50	0.21	35.00	0.08	2.12	1.367
Feburary	Clear	29.1	27.1	32.00	5.01	0.18	22.22	0.05	1.94	1.461
March	Clear	32.6	28.4	32.17	4.41	0.19	42.50	0.22	2.25	1.948