POND BASED GROW OUT SYSTEM OF *GRACILARIA VERRUCOSA*

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ABSTRACT

Gracilaria verrucosa was successfully cultivated in a pond based aquaculture system at Narakkal, Kerala, India. Daily growth rate of seaweed was found to be maximum (19.22%) during 60 days of introduction. The growth, pigment constituents and the yield of agar were influenced by the environmental parameters. Agar yield and photosynthetic pigments declined in the initial period up to 50 days due to acclimatization of the plants to new environment which was collected from Chennai, India and introduced in the pond at 'Narakkal. After 60 days, the algae started establishing in the bottom of the pond and an initial harvest of 230.25 kg was harvested after 90 days of culture period. Further regular harvest was made at every 10 days interval yielding 1015 kg of *G.verrucosa* during the culture period. The agar content ranged between 7-14.8% and bottom sample exhibited better yield of agar than the plants cultured in the floating raft.

Key words: *Seaweed culture, Pond culture, Gracilaria verrucosa, Shrimp*

The red algal genus *Gracilaria* is a group of warm water seaweeds distributed widely in every part of the world except the polar regions and is of considerable economic importance as an agarophyte. The genus has been harvested from naturally occuring stocks in a number of countries in the developing world. Due to over exploitation of the natural population, the need for a constant and reliable supply of raw materials can only be met through cultivation. *Gracilaria* spp. has been regarded as the most important agarophytes for cultivation due to their high regenerative capacity. It has been recorded not only in offshore islands where the salinity is high, but also in estuaries where the salinity is low and in the open sea as well as in enclosed pools and ponds. According to Trono (1988), *Gracilaria* can be cultivated in brackish water ponds with salinity range of 20 to 28 ppt. It was cultivated from fragments in long line, rope, net, broadcasting in ponds and raceways (Alveal *et al.*, 1997).

In the present study an attempt was made to culture the seaweed *Gracilaria verrucosa* in the ponds of Narakkal with a view to improve the water quality of aquaculture ponds.

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MATERIALS AND METHODS

Gracilaria verrucosa samples were collected from shallow pools in the Muthukadu Lake of Chennai. The fresh seaweeds were cleaned thoroughly and transported to Narakkal in Vypeen Island. Experiment was carried out in 0.1 ha size earthern ponds. Three numbers of floating rafts of 1.5 m^2 area were fabricated with PVC frame. Plastic netting was attached to the base and sides of the PVC frame. Initially 920g of *G.verrucosa* was introduced in each raft and evenly distributed. Daily exchange of water by tidal flow through sluice gates was carried out. Experiment was conducted during June to November. Initial sampling was done after 50 days of seaweed introduction. Thereafter regular sampling was carried out at every ten days interval upto 160 days of culture period. Growth of seaweeds was monitored during sampling period. Daily Growth rate (DGR) of seaweeds was calculated using the following equation:

$$(\ln W_2 - \ln W_1)/ t_2 - t_1$$

Where, W_1 = Weight of seaweeds introduced

W_2 = Weight of seaweeds harvested

$t_2 - t_1$ = Time interval

DGR values are expressed as percentage.

Excess seaweeds were harvested leaving the minimum quantity ranging from 850 g to1Kg in the rafts for further growth. Pigments such as chlorophyll a, phycoerythrin, phycocyanin and allophycocyanin were estimated following the method of Jeffrey and Humphrey (1975). Temperature, pH and salinity of water were recorded regularly by mercury thermometer, pH meter and hand refractometer respectively. Nutrients like NH_3-N, NO_3-N, NO_2-N and PO_4-P were analysed by standard procedure (Strickland and Parsons, 1972). Seaweeds from the rafts as well as those established in the pond bottom were cleaned thoroughly and sun dried. The samples were further washed and dried in a pre-heated oven before extraction of agar. Agar extraction was carried out by the method of Levy and Friedlander (1990).

RESULTS

As the experiment was conducted during the monsoon period, salinity in the pond ranged from 5-10 ppt, pH between 7.0 and 8.0 and temperature between 27°C and 30°C respectively.

In the floating rafts, the percentage daily growth rate of the seaweed *G.verrucosa* was found to be increasing from the period of introduction and reached a maximum of 19.22% on 60 days. However, the growth showed an irregular pattern with peak values of 14.27% and 12.3% on 90 and 110 days of culture period respectively and thereafter a consistent pattern was observed till the end of the experiment. Of all the three rafts in the pond, raft III which was near to the sluice gate exhibited better growth of seaweed (Fig.1). It was observed that the seaweed *G.verrucosa* established itself on the bottom of the pond after 60 days of culture period and after 90 days,

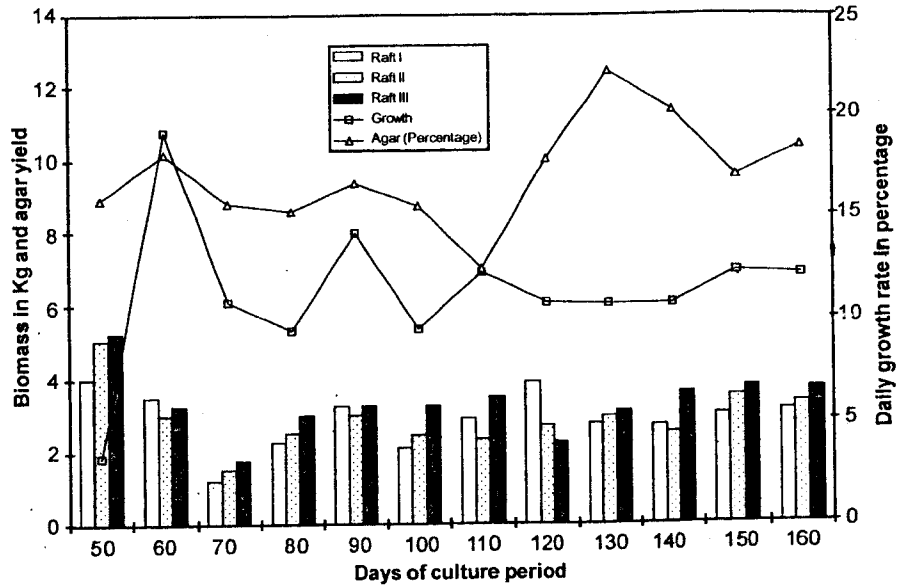

Figure 1. Growth and agar yield of *G.verrucosa* in the rafts of the pond culture system

230.25 Kg of *G.verrucosa* was harvested from the pond. Total quantity of 1015 Kg of the seaweed was harvested from the pond during the culture period. Succession of growth of *Enteromorpha* (green algae) was observed during low salinity and cloudy weather during 60th day of culture period.

The agar yield of *G.verrucosa* during introduction was 14.8%. In the rafts, the agar yield recorded maximum value of 10% on 50, 110 and 150 days. Minimum value of 7% was observed on 100 days of culture period (Fig.1). The yield of agar from the samples collected from the pond bottom was found to be higher than those cultured in the floating rafts. Maximum yield of 14.38% on 110 days and minimum of 9.36% on 90 days were recorded from the *G.verrucosa* grown on the pond bottom(Fig. 2).

The pigment concentration (chlorophyll 'a' and accessory pigments) declined upto 50 days of culture period. Thereafter, accessory pigments were found to follow a similar pattern throughout the culture period. Chlorophyll 'a' exhibited almost an inverse relationship with accessory pigments after 60 days. An increase in the pigment constituents was observed on 100 days (Fig. 3).

The concentration of nutrients except nitrate in water declined up to 50 days. At 60 days, there was a drastic increase in ammonia concentration which led to an enhancement of the total

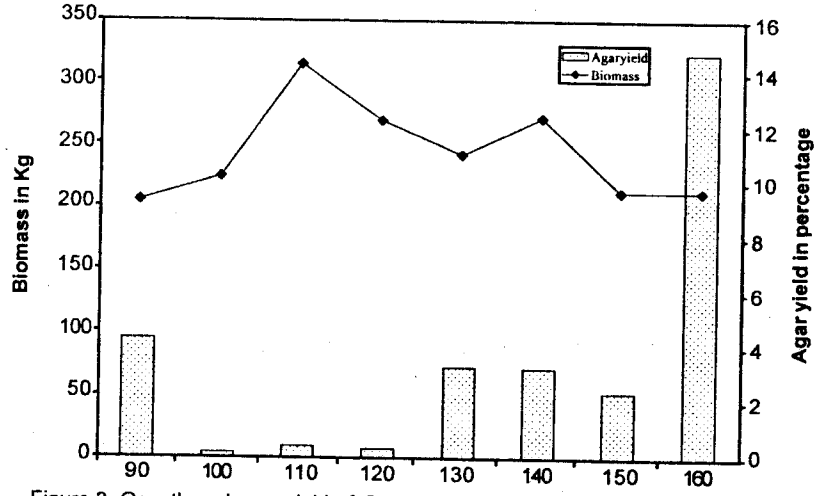

Figure 2. Growth and agar yield of *G.verrucosa* established on the pond bottom

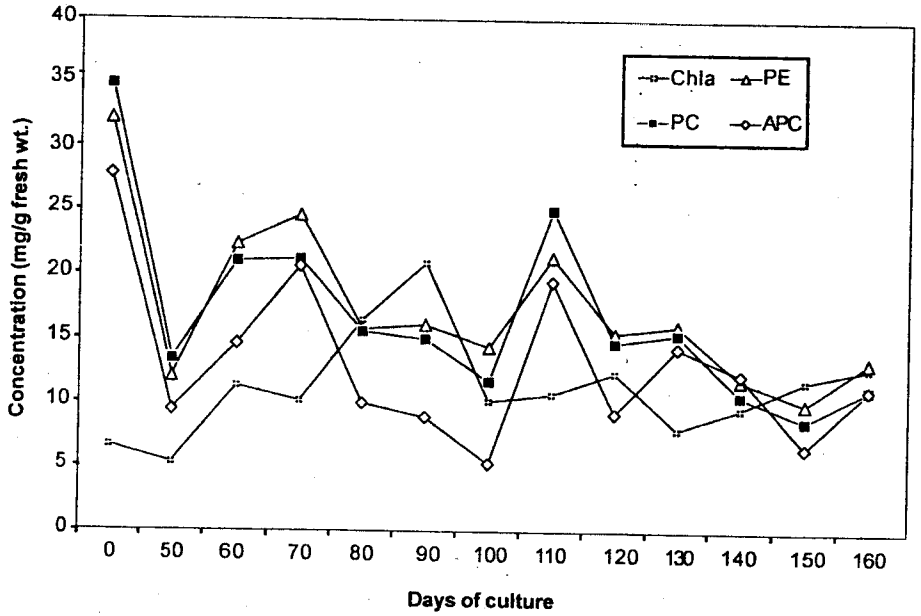

Figure 3. Pigment constituents of *G.verrucosa* in pond culture system

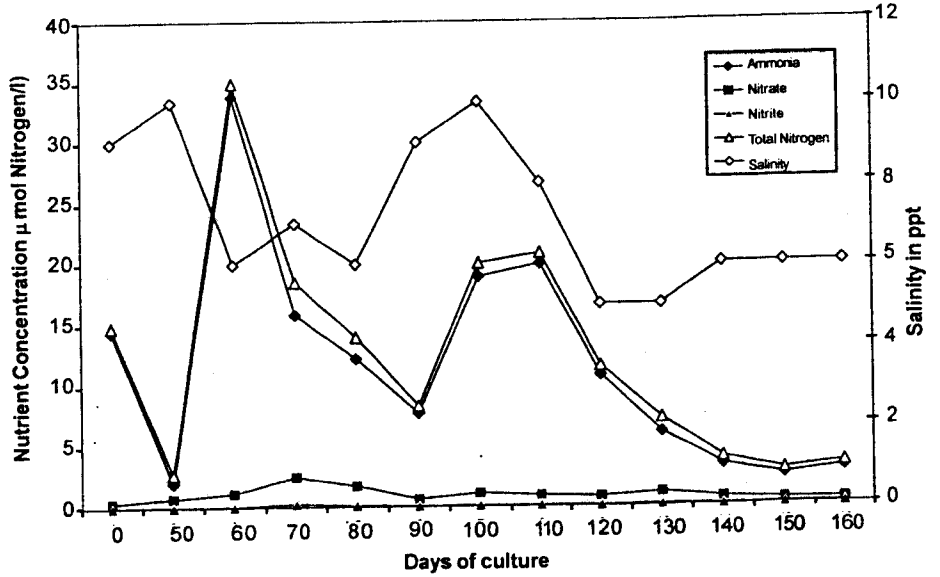

Figure 4. Water quality parameters in pond culture system of *G.verrucosa*

nitrogen content of the pond. This change was due to the introduction of shrimp seeds and *Enteromorpha* growth in the pond. The total nitrogen concentration declined gradually till 90 days of culture period. The concentration of all nutrients declined towards the end of the culture period (Fig. 4). The concentration of total nitrogen was found to have a negative correlation with growth ($r = -0.31$).

DISCUSSION

Macroalgae in many habitats have various physiological mechanisms for responding to environmental changes, and the ability to tolerate environmental disturbances often contributes to their success in marine communities. The decline in pigment constituents in the initial period of 50 days is due to the acclimatisation of the species to the new environment. The reduction in salinity from 10 to 6 ppt after 60 days of culture led to the establishment of *Enteromorpha* in the system. The sudden decline in the growth rate of *G.verrucosa* can be accounted for due to an overgrowth of the competing seaweed *Enteromorpha*. Similair results have been reported by Chiang (1981). The excellent growth of seaweed in the third raft near to the sluice gate can be accounted for by the utilization of the nutrients from the incoming water coupled with optimum sunlight available for the plant. The growth rate and chemical compositions of *Gracilaria* spp. in outdoor cultures have been reported as a function of salinity, temperature, irradiance, nitrogen and phosphate concentration, plant density, rate of water

exchange, aeration, pH and inorganic carbon supply (Lapointe and Ryther, 1979; Lapointe 1981, 1987; Friedlander *et al.*, 1991; Gonan *et al.*, 1993). Much lower or higher salinity is unfavourable for growth. Hagland and Pedersen (1993); Jimenez del Rio *et al.*(1996) and Yamasaki *et al.* (1997) have reported positive correlations between growth rates and nitrogen content in outdoor cultivation tanks of other *Gracilaria* species.

Temperature range of 25–30°C is considered to be the most favorable for maximum growth and production of the red seaweed (Mac Lachlan and Bird, 1986; Hurtado- Ponce and Umezaki, 1987). The pH of seawater may seriously affect the growth of *Gracilaria*. The pH value should be kept stably above 7.0. The optimum value is above 8.0. It has been reported that *Gracilaria* will begin to deteriorate and finally disintegrate when the pH is below 6.5 (Liu, 1987).

Pond cultivation of *Gracilaria* is less labour intensive than rope farming and has been quite successful. It has been understood that agar extracted from *Gracilaria* cultured in ponds is often of low gel strength and can attract food grade agar industry. It was understood that the pond cultivation of *G.verrucosa* can yield 1.5 - 2 ton dried seaweeds per ha per year with an average of 300 Kg per ha per crop. This finding is at par with the results reported by FAO (1989, 1990), where 3-4 tons of dried seaweeds per ha per year with an average of 450 Kg per ha per crop was obtained from pond system.

As *G.verrucosa* was found to be an euryhaline species, it can be cultivated successfully in the brackishwater ponds and backwaters of Kerala. The agar extracted from *G.verrucosa* can be used in cottage industry for making jam, jelly and other food items.

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REFERENCES

Alveal, K., Romo, H., Werlinger, C. and Oliveira, E. C. (1997). Massive cultivation of the agar producing alga *Gracilaria* (Rhodophyta) from spores. *Aquaculture*. **148** (2-3) : 77-83.

Chiang, Y. M. (1981). Cultivation of *Gracilaria* (Rhodophycophyta, Gigartinales) in Taiwan. In: Proceedings of *Xth International Seaweed Symposium*. Berlin T. Levring (ed.) Walter de Gruyter & Co., **10**:569-574.

FAO. (1989). *Gracilaria* culture in China. *NACA-SF/WP/89/12*. June 1989 www.fao.org/docrep/field/003/AC263E/AC263E00.htm.

FAO. (1990). Properties, manufacture and application of seaweed polysaccharides - agar, carrageenan and algin. *In: Training Manual on Gracilaria Culture and Seaweed Processing in China. FAO Doc Rep.*, August 1990.

Friedlander, M., Krom, M. D. and Ben-Amotz, A.(1991). The effect of light and ammonium on growth, epiphytes and chemical constituents of *Gracilaria conferta* in outdoor cultures. *Bot. Mar.* **34**: 161- 166.

Gonan, Y., Kimmel, E. and Friedlander, M. (1993). Effect of relative water motion on photosynthetic rate of the red alga *Gracilaria conferta*. *Hydrobiol.* **260/261**: 493-498.

Haglund, K. and Pedersen, M. (1993). Outdoor pond cultivation of the subtropical marine red alga *Gracilaria tenuistipitata* in brackish water in Sweden. Growth, nutrient uptake, co-cultivation with rainbow trout and epiphyte control. *J. Appl. Phycol.* **5**: 271-284.

Hurtado-Ponce, A.Q. and Umezaki, I. (1987). Growth rate studies of *Gracilaria verrucosa* (Gigartinales, Rhodophyta). *Bot. Mar.* **30**: 223-226.

Jeffrey, S.W. and Humphrey, G. F. (1975). New spectrophotometric equations for determining chlorophyll a, b, c and C2 in higher plants, algae and natural phytoplankton. *Biochem. Physiol. Pflanz.* **167**:191-194.

Jimenez del Rio, M., Zayin Ramazanovv and Guillermo, G. R. (1996). *Ulva rigida* (Ulvales, Chlorophyta) tank culture as biofilters for dissolved inorganic nitrogen from fish pond effluents. *Hydrobiol.* **326/327**: 61-66.

Lapointe, B. E. (1981). The effect of light and nitrogen on growth, pigment content, and biochemical composition of *Gracilaria folifera* v. *angustissima* (Gigartinales, Rhodophyta). *J. Phycol.* **17**: 90-95.

Lapointe, B. E. (1987). Phosphorus- and nitrogen-limited photosynthesis and growth of *Gracilaria tikvahiae* (Rhodophyceae) in the Florida Keys: an experimental field study. *Mar Biol.* **93**: 561–568.

Lapointe, B. E. and Ryther, J. H. (1979). Effects of temperature, light and salinity on growth in culture of *Chondrus crispus, Furcellaria lumbricalis, Gracilaria tikvahiae* (Gigartinales, Rhodophyta), and *Fucus serratus* (Fucales, Phaeophyta). *Bot. Mar.* **22** : 521-527.

Levy, I., Beer, S. and Friedlander, M. (1990). Growth, photosynthesis and agar in wild-type strains of *Gracilaria verrucosa* and *G.conferta* (Gracilariales, Rhodophyta) as a strain selection experiment. In: *Proc. Int. Seaweed Symp.* **13**: 381-387.

Liu , S. (1987). Study on the commercial cultivation of *Gracilaria* in South China. *Chinese J. Oceanol . Limnol.* **5**:281-283.

MacLachlan, J. and Bird, C. J. (1986). *Gracilaria* (Gigartinales, Rhodophyta) and productivity. *Aquat. Bot.* **26**: 27-49.

Strickland, J.D.H. and Parsons, T.R. (1972). A practical Handbook of Seawater Analysis. *Bull. Fish. Res. Board. Canada*. **167**, 310 pp.

Trono, G. C. Jr. (1988). *Review of the status of aquaculture in the Philippines*. Paper presented at the Seventh Session of the IPFC Working Party of Experts on Aquaculture, Bangkok, Thailand, 1-6 August 1988.

Yamasaki, S., Ali, F. and Hirata, H. (1997). Low water pollution rearing by means of polyculture of larvae kuruma prawn *Penaeus japonicus* with a sea lettuce *Ulva pertusa*. *Fish. Sci.* **63**:1046-1047.

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