PROCEEDINGS OF THE SYMPOSIUM ON COASTAL AQUACULTURE

Held at Cochin

From January 12 to 18, 1980

PART 4: CULTURE OF OTHER ORGANISMS, ENVIRONMENTAL STUDIES, TRAINING, EXTENSION AND LEGAL ASPECTS

(Issued in December 1986)

MARINE BIOLOGICAL ASSOCIATION OF INDIA

POST BOX NO. 1023, COCHIN-682 031, INDIA

Price : Rs. 400.00

SYMPOSIUM SERIES 6

Abbreviation

Proc. Symp. Coastal Aquaculture, Pt. 4.

PRINTED IN INDIA BY A. D. THOMAS STEPHEN AT THE DIOCESAN PRESS, MADRAS 7 AND PUBLISHED BY E. G. SILAS ON BEHALF OF THE MARINE BIOLOGICAL ASSOCIATION OF INDIA, COCHIN-682 031

Proc. Symp. Coastal Aquaculture, 1986, **4** : 1206-1209

SEAWEED CULTURE — ITS FEASIBILITY AND INDUSTRIAL UTILIZATION

V. S. KRISHNAMURTY CHENNUBHOTLA, S. KALIMUTHU AND M. SELVARAJ

Central Marine Fisheries Research Institute, Cochin-682 031

ABSTRACT

Culture of seaweeds is practiced since ages in countries such as Japan, China and Korea. Seaweed cultivation is an industry in Japan as a part-time avocation for land farmers and fishermen. The seaweeds cultured mainly in these countries are *Porphyra, Undaria, Laminaria, Enteromorpha* and *Monostroma*. In India seaweed culture is yet to develop on commercial lines. While the demand for these seaweeds is for food purposes in foreign countries, their demand in India is for the extraction of two phytochemicals namely agar-agar and algin. In recent years many factories manufacturing these chemicals have come up in India as a consequence of which the demand for the agarophytes and alginophytes has gone up. In order to maintain a continuous supply of this raw material to the industry, methods to augment the supplies through culture practices have to be developed.

In recent years the Central Marine Fisheries Research Institute has been engaged in the cultivation of several economically important seaweeds such as *Sargassum wightii, Turbinaria* spp., *Gracilaria edulis, G. corticata* and *Gelidiella acerosa* which indicated great scope for cultivation. The production rate has been found to be 4.4 kg/m^2 in the case of *G. edulis* and 3 kg/m^2 in the case of *G. acerosa* in about 80 days for 0.30 kg and 1 kg of seed material introduced respectively. In the case of alginophytes the growth was not encouraging. These culture experiments were conducted by introducing small fragments of the seaweed into the twists of the coir ropes fabricated in the form of a 5×2 m net and tied to fixed poles in inshore waters. In the case of *G. acerosa*, the substratum along with the plant fragments was tied to the ropes.

The agarophytes thus grown can be processed further for extraction of agar-agar. The extraction could be done by a simple cottage industry method not involving any costly equipment. In the case of *Gelidiella* agar, freezing and thawing are required to remove the insoluble chemicals. A total of 90 tonnes of *G. edulis* can be obtained from 3 harvests in a year from a hectare area.

INTRODUCTION

CULTURE of seaweeds is practiced since ancient days in countries such as Japan, China and Korea. In Japan, cultivation of marine algae especially *Porphyra* has been in vogue on large scale which probably originated in 17th century. Seaweed industry is an industry in Japan mostly as a part-time avocation for land farmers and fishermen. Species of *Enteromorpha, Monostroma, Laminaria* and *Undaria pinnatifida* are intensively cultivated in Japan. *Porphyra* is cultivated in Korea also. Raft culture of *Laminaria japonica* using wooden frames has yielded very good results in China though the sea floor culture is still prevalent in Japan and Korea.

In India seaweed culture is yet to develop on commercial lines. The Central Marine Fisheries Research Institute has been working to evolve methods of culturing commercially important seaweeds such as the agar yielding *Gelidiella acerosa*, species of *Gracilaria* and the algin yielding *Sargassum* spp, and *Turbinaria* spp. There is heavy demand for the two phycocolloids agar-agar and algin extracted from these seaweeds since they are used in

textiles, ice-cream, confectionary, film, rubber, liquor, varnish and paint industries. Many factories manufacturing these phytochemicals have come up in recent years and hence the demand for raw material also increased.

The standing crop of *Gelidiella acerosa* and *Gracilaria edulis* in the natural environment is declining every year due to indiscriminate harvesting by fishermen throughout the year without observing any periodicity and removal of plants alongwith their holdfast. Over-exploitation of these algae from their natural beds leads to decline in population in the subsequent year while the demand for these seaweeds increases every year. In order to meet this ever increasing demand by the agar industries, their supply is to be augmented by adopting culture practices.

CULTURE

The necessity for and the principles and problems connected with seaweed culture have been discussed by Krishnamurty (1965). Edwyn Isaac (1956) has shown that fragments of *Gracilaria confervoides* can propogate vegetatively.

Preliminary culture experiments carried out in India with some of the economically important seaweeds such as *Sargassum cinctum*, *S. plagiophyllum*, *Gracilaria edulis* and *Gelidiella acerosa* (Thivy, 1964; Raju and Thomas, 1971; Umamaheswara Rao, 1974; Chennubhotla, 1976; Chennubhotla *et al.*, 1977) indicated that there is great scope for the cultivation of these species. These culture experiments were conducted by introducing fragments of the seaweed (along with holdfast in the case of alginophytes) into the twists of the coir ropes which in some cases were fabricated in the form of nets of different sizes woven round supporting side frames of wooden poles or G.I. pipes. These ropes and nets were tied to wooden poles fixed in the coastal waters. In the case of experiments with *Gelidiella acerosa* a portion of the plant along with substratum was tied to the coir ropes.

In the cultivation of *G. edulis* carried out near Mandapam, it was found that a total of three harvests could be made within one year and the annual yield has been calculated as 3.5 kg of fresh seaweed per metre of coir rope (Raju and Thomas, 1971). Umamaheswara Rao (1974) reported an yield of 4.4 kg of fresh seaweed of *Gracilaria edulis* per square metre of coir net within 80 days for an initial seed material of 0.3 kg. Chennubhotla (1976) reported an yield of 2 kg of fresh *G. edulis* per square metre of coir net within 45 days for an initial seed material of 0.35 kg. *G. edulis* cultured in Athankarai Estuary showed slight bleaching as compared to that cultured in inshore waters. Lower salinity near the estuary mouth during monsoon enhanced the development of the half dead fragments of *G. edulis* and fresh growth started with new shoots springing up. Low salinities giving encouraging results of the growth of seaweeds has been reported by Krishnamurty (1954) and Kurogi (1963). *Gelidiella acerosa* has a slow growth and yielded a harvest of 3 kg from an initial seed material of 1 kg after 77 days growth (Chennubhotla *et al.*, 1977) In *Sargassum plagiophyllum*, Raju and Venugopal (1971) observed a period of 9-10 months for it to settle on artificial substrata such as concrete cylinders after which rapid growth was observed and near mature plants were seen within nine months. Thivy (1964) reported a growth of 37-52 cm for an initial height of 10 cm in *Sargassum cinctum* within 40 days. The trial experiments with *Gracilaria corticata*, *Sargassum wightii* and *Turbinaria decurrens* have shown that these species have got the capacity to regenerate from the vegetative fragments.

Recently, cultivation of *G. edulis* near Central Marine Fisheries Research Institute Jetty at

Mandapam Camp was carried out in 0.2 hectare area using 5×2 m size coir nets without wooden or G.I. pipe supporting frames. This has brought down the cost of production as the cost of G.I. pipe or wooden frame was eliminated. In these experiments the crop was harvested after 60 days without waiting for 80 days as in the earlier occasions as the chances of the fully grown seaweed being washed away after breaking due to wave action or winds and grazing by fish could be avoided. An average yield of 30 kg for an initial seed material of 10 kg/net was obtained. It was found that there was no appreciable difference in the yield of agar-agar between the 60 days grown and 80 days grown plants except for the gel strength (Thomas and Krishnamurty, 1976), but the gel strength could be improved according to the requirements by blending with other agarophytes such as *Gelidiella acerosa* having higher gel strength.

In this paper the details regarding the cultivation of *G. edulis* based on the above result, the possibilities of extraction of agar-agar from the harvested seaweed and the economics of culture operations in relation to agar extraction are discussed. Full information on the cultivation of other economically important seaweeds is not yet available.

An alternate method of culturing seaweeds is to collect sporophytic plants, liberate the spores in the laboratory, rear them and allow to settle and germinate on suitable substrata like coral stones, transfer them to the sea for growing in to adult plants. But the methods by using fragments is easier and the growth is quicker.

Feasibility and Industrial Utilization

In one hectare area, 1,000 coir nets of 5×2 m size could be introduced with *G. edulis*. At the rate of 30 kg per net, 30 tonnes of fresh *G. edulis* could be harvested after 60 days. Three harvests could be made in a year and the total harvest would be 90 tonnes of fresh weed. The dry weight of this weed will be 1/8th of the fresh weight. The yield of agar from the dry weed will be 15% by weight. Thus 1.687 tonnes of agar-agar could be extracted from the harvested material from one hectare in a year which may fetch a price of Rs. 100 per kg.

The extraction of agar from *Gracilaria edulis* could be done by a simple cottage industry method evolved by the Central Marine Fisheries Research Institute (Thivy, 1960) not involving any costly set up. The process consists of cleaning the dry weed by repeated washings in fresh water and sun bleaching. The clean dried weed thus obtained is chopped to small bits, ground in grinder and soaked in soft water for 24 hours. Soaked seaweed is next ground into a paste which is leached in water for 24 hours. This process will leach out all water soluble minerals. This is dried again and boiled in soft water at 90°C for about one hour. The ratio of seaweed meal to soft water is 1 gm : 30 ml. The extraction of agar is good in acidic conditions and hence a lime fruit may be squeezed into the boiling water. During extraction the material is stirred well, after extraction is completed the vessel is kept insulated so that the sol will remain liquid for some hours during which time the suspended impurities will settle down ; when the sol has set into a firm gel the clear gel is removed leaving the sediment behind ; the gel is melted and poured into trays so that it can be cut into strips later. The gel strips are dried on plastic net supported on a galvanized wire cage ; it is best to dry the gel indoors to prevent dust settling on it ; drying being effected under an electric fan or in hot air at 60°C. After drying, the agar strips are collected and if necessary powdered by grinding in coffee grinder.

In the case of extraction of agar from *Gelidiella acerosa*, freezing technique is employ-

ed to retain the cold water soluble fraction of agar and since it is not possible to remove the impurities from the weed effectively as in the case of *Gracilaria edulis*.

Conclusion

Profit margin is assured only if the extraction of agar-agar is undertaken by the farmer himself. If the harvested fresh plants or dried plants are sold, it will be uneconomical since the cost of production per kg of fresh plants comes to Rs. 1.50 whereas the naturally collected pure material costs Rs. 0.25 per kg only. The farmer and his family members or some families jointly have to undertake on co-operative basis the cultivation of seaweeds and extract agar-agar by cottage industry method to bring down the cost of production. At present the cost of cultivated seaweed may be higher than that collected from natural environment, but in future when the denudation of natural vegetation occurs and the cost of collected material shoots up then the cost of both may become equal. Methods for cultivating seaweeds are developed and recommended to augment the supplies to the industries at present and to serve the future shortage in supply.

The coastal population have to attempt for cultivating seaweeds in a co-operative manner and extract the agar-agar in their villages. If soft water is not available in the village, demineralisation plants could be set up for getting soft water from the available hard water. The soft water could be obtained by installing solar stills or tube wells. At present, the seaweed industries are taking the major profit by paying lesser rate to the raw materials. If extraction of agar and algin is undertaken by the fishermen—farmers themselves, this profit also accrues to them.

The cultivation of seaweeds is beset with problems such as grazing by fish in the sea and hence sometimes the yield in the crop and thereby production may come down from the expected level.

In order to enable the fishermen or landless labour to undertake the seaweed cultivation the Government is offering certain credit facilities with subsidies under the programmes such as I.R.D.P., D.P.A.P., etc., which will be of immense use to them. These schemes are to be utilized for raising loans for strarting the seaweed culture.

References

Chennubhotla, V. S. K. 1976. Seaweed culture (Abstract) Symposium on coastal aquaculture, 63rd. Indian Science Congress Session, Waltair, January, 1976.

———, S. Kalimuthu, M. Najmudeen and M. Selvaraj 1977. Field Culture of *Gelidiella acerosa* (Forskal) Feldmann and Hamel. (Abstract—Supplementary) IX *Int. Seaweed Symp.* Santa—Barbara California, U.S.A.

Edwyn Issac, WM., 1956. The ecology of *Gracilaria confervoides* (L.) Grev. in South Africa with special reference to it's ecology in the Saldhanha-Langebaan Lagoon. *Second Int. Seaweed Symp.* Pergamon Press, London and New York. pp. 173-185.

Krishnamurthy, V. 1954. Biology and seasonal succession of the algal flora of a salt marsh at Madras. *J. Madras Univ. B.*, 24 : 161-178.

——— 1965. Marine algal cultivation—Necessity, Principles and Problems. *Proc. Seminar Sea, Salt and Plants*. C.S.M.C.R.I. Bhavanagar. pp. 327-333.

Kurogi, M. 1963. Recent layer cultivation in Japan. *Fish. News Int.*, (July-Sept.) pp. 1-3.

Raju, P. V. and P. C. Thomas 1971. Experimental field cultivation of *Gracilaria edulis* (Gmel.) Silva. *Bot. Mar.*, 14 : 71-75.

——— and R. Venugopal 1971. Appearance and growth of *Sargassum plagiophyllum* (Mert.) C.Ag. on a fresh substratum. *Ibid.*, 14 : 36-38.

Thivy, F. 1960. Seaweed utilization in India. *Proc. Symp. on Algology*, I.C.A.R., New Delhi. pp. 345-365.

——— 1964. Marine algal cultivation. *Salt. Res. Ind.*, 1 : 23-28.

Thomas, P. C. and V. Krishnamurty 1976. Agar from cultured *Gracilaria edulis* (Gmel.) Silva. *Bot. Mar.*, 19 : 115-117.

Umamaheswara Rao, M. 1974. On the cultivation of *Gracilaria edulis* in the nearshore areas around Mandapam. *Curr. Sci.*, 43 (20) : 660-661.