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Seaweed Technology for India for the Twentyfirst Century

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ABSTRACT

Some of the concepts regarding seaweed technology which require particular attention for its effective utilization during the twentyfirst century are discussed. Major thrust areas would be application of different techniques like remote sensing, underwater diving, tissue culture, genetic engineering, molecular biology, improvisation in cultivation and processing of seaweeds, popularization and utilization of seaweeds for food, feed, fertilizers, drugs and other economically important products. To achieve these objectives, due care will have to be taken to generate appropriate technology and technical manpower in a systematic way.

INTRODUCTION

Man has overexploited various living and non-living resources on the earth. Due to change in the land use patterns, agriculture and forests are affected and ultimately degraded. Therefore, tapping of solar energy by land plants has reduced considerably. The ocean provides unlimited space for capturing this energy through photosynthesis by marine plants.

Seaweeds are one of the important sources for food, feed, fertilizers and also chemicals. These plants also form a major energy source. Although a lot of phycological research has been done in India, it is considered as fundamental research and marine algal utilization is still in infant stage.

India has a vast coastline of about 7000 km with the seaweed resources estimated at about 100,000 tonnes (wet wt./year), which can be harvested and used for various purposes. The status of seaweed research and development towards the end of the twentieth century and some concepts pertinent to the development of seaweed research and technology for the twentyfirst century are highlighted in this

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paper. This would perhaps enable us to utilise this highly productive and nutritive but neglected marine resource from the Indian coast in a sustainable manner in the future.

The global seaweed potential has been estimated to be about 1560 million tonnes wet wt. of brown algae and 261 million tonnes wet wt. of red algae [3]. The total annual seaweed production may be about 1821×10^4 tonnes wet wt., of which only 4.83% is being harvested from east and west Indian Ocean.

The most economically important industrial products are alginates, agar and carrageenan. The major seaweed species used by the industries are — for alginates: *Macrocystis*, *Nereocystis*, *Laminaria*, *Ascophyllum*, for agar *Gelidium*, *Gracilaria*, *Gigartina*, *Porphyra*, and for carrageenan: *Chondrus*, *Hypnea*, *Gigartina* and *Eucheuma*. The present annual world production of alginates, agar and carrageenan is about 15,000, 6,000 and 10,000 tonnes respectively.

MARINE ALGAL STATUS ALONG THE INDIAN COAST

Species distribution

Since the valuable contributions of Boergesen and Iyengar around 1940s, various phycologists have conducted extensive research on morphology, taxonomy and distribution of Indian marine algae. According to Untawale et al. [8], there are about 524 marine algal species of various groups. From the statewise distribution of seaweeds for different algal groups, it is reported that Tamilnadu coast has the maximum number of species (302) followed by Gujarat (202), Maharashtra (159), Lakshadweep Islands (89), Goa (82), Andhra Pradesh (79), Karnataka (66), Kerala (20) and West Bengal (6).

Resource survey

Considerable work has been done on different aspects, particularly on biology, ecology and chemistry of Indian seaweed, during the last two decades. However, no systematic data are available on the annual harvestable yield of Indian marine algae. Only certain areas like the Gulf of Kutch and Palk Bay were surveyed from the very beginning and Maharashtra, Goa and Karnataka recently. Some of the coastal areas of Kerala, Andhra Pradesh, Orissa, West Bengal, Andaman-Nicobar and Lakshadweep Islands still remain largely unexplored and scanty information is available from these places. From the available data, the annual harvestable yield is estimated to be about 100,000 tonnes wet wt. [7].

Exploitation of marine algae

Presently, seaweeds along the Indian coast are being exploited only for agar and alginates by small and large scale industries. Unfortunately, no statistics are available about how much raw material is harvested and supplied to these industries every year. Although seaweeds are known for their use as food, it is not

much popular among the people in India. The possibility of using some of the seaweeds as food is always there. Drifted seaweeds are often used as manure by coastal people for coconut plantations and paddy fields.

Seaweed industries of India

There are about 24 agar and 14 sodium alginate producing industries (including small and large) with annual installed capacity of 198 and 1623 tonnes in India [9]. Actually, the present annual production of agar and alginates by these industries is 55.7 and 735.5 tonnes, which is 28.13% and 45.32% respectively of their installed capacity. Such a decline in production is due to the paucity of raw material from natural resources as well as modern processing techniques [7].

Most of the seaweed industries in India are engaged in the production of only agar and alginate. The annual seaweed requirement for agar and algin by these industries at full capacity is about 1840 and 12,880 tonnes dry wt. respectively. But estimated harvestable quantities of agarophytes (*Gelidiella* and *Gracilaria*) and alginophytes (*Sargassum* and *Turbinaria*) from natural seaweed beds along the Indian coast are about 3,600 and 31,600 tonnes wet wt. annually. From this data, one can visualise how far these resources will be able to feed industries. To keep these existing industries alive, it is necessary to tap other non-conventional resources which are readily available in large quantities besides cultivating the conventional algae on a large scale.

Our present knowledge regarding seaweed farming is very limited. Uptodate information in the form of seaweed calendars would be necessary to know about the reproductive phase like spore formation, release, establishment and growth of these spores. Efforts would be required to collect these spores on different media from natural conditions and also to produce these spores under controlled conditions, ready for transplantation in the field.

In view of large scale seaweed farming, projected for the future, it would be necessary to know about the pests and diseases caused by various marine organisms, and also suitable remedies to prevent or control these incidences. Application of different fertilizers, use of micronutrients, trace metals and growth hormones may also be needed for ensuring good growth and higher yields. Open ocean seaweed farming as a source of energy and the relevant offshore technology for the same may also be needed in the forthcoming century. Apart from the agarophytes and alginophytes, there would be a need for edible seaweed species which grow in the estuarine region or ponds and also along the open coast.

Tissue culture and genetic engineering

Once the seaweed farming techniques are perfected, there would be demand for the species with the desired characteristics. For this purpose, biotechnological methods involving molecular biology, genetical engineering and tissue culture would be of great significance. This may open new vistas in seaweed research in

the next century. At present, limited information is available on these aspects. However, these techniques may be applied to obtain high yielding species for agar, alginate, carrageenan, protein or of any desired quality.

Application of these techniques might be of value in producing kelp species like *Macrocystis* or *Laminaria* which can be grown in the tropical Indian Ocean. *Laminaria japonica* is one such example. Through these techniques, intensive inbreeding and selection, X-ray induced mutations and production of new and improved strains would be possible [1,6].

Introduction of new species

Another important aspect for the future development of the industrial potential of seaweed will be introduction of some new economically important marine algal species in suitable coastal waters. Particularly, species like *Eucheuma*, which is being cultivated in Philippines, Indonesia and USA, on a large scale and is a very good source of κ -carrageenan, may be an ideal seaweed for Indian tropical conditions. However, such novel introduction of foreign species must be preceded by research and development work.

Energy from biomass

Of late, there has been considerable work on assessment of the potential of seaweeds as fuel through anaerobic digestion to methane. Ryther and Hanisak [5] have demonstrated the production of biogas from marine algae through biotechnology and proposed *Gracilaria* as a possible "energy crop". Both gas production (60%) and bioconversion efficiency (50%) of organic matter in these experiments compared favourably with those of the biomass substrates [2]. It is now technically feasible to develop and cultivate a particular clone with specific characteristics through tissue culture techniques. For instance, a particular clone of *Gracilaria tikvahiae* has a capacity to propagate vegetatively for long periods without changes in its genetic makeup. Thus, utilization of such seaweeds as an "energy crop" may play a role as part of man's solution to the present energy crisis.

Algae as food

Seaweeds in India are being exploited only for the production of agar and alginates. The possibility of utilising seaweeds as food has been emphasised by the work of Lewis and Gonzalves. Although species like *Porphyra*, *Monostroma* and *Ulva* are known for their use as nutritive food in China, Japan, Korea and other south east Asian countries, such foods have not yet been among people in India. According to WHO(Tech. Rep. No. 522) the mortality pattern in infants in south Asia is largely due to protein deficiency. In such cases, protein deficiency can be overcome by the addition of protein-rich marine algae in their diet. However, a detailed seasonal variation in nutritively important products is necessary for proper and efficient utilisation. Keeping in view its importance as food, it is

necessary to create awareness among the people and food industrialists about the scope offered by our marine natural resources.

Marine algal chemistry and biochemistry

Seaweeds are a potential source of different types of phycocolloids like agar, alginate, carrageenan, mannitol, fucoidin, etc., bioactive substances, proteins, carbohydrates, lipids, vitamins, growth hormones, trace metals and micro-nutrients, which are of great importance to the marine ecosystem and also to man. In view of this, it is of immense importance to study the chemistry and biochemistry of these special groups of plants [4]. In addition, different physiological processes, structure and composition of various pigments and their functions are of great scientific interest. Not much work has been done on these aspects in India. It is hoped that before the advent of the twentyfirst century, a lot of interest would have been generated about the seaweed importance in India.

The ever-growing tempo of basic and applied research on marine algae promises to enhance further our ability to manage this highly productive and renewable resource. Much of the information being acquired will prove helpful in cultivation, conservation and utilization.

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