



## **Exploitation of marine algae in Indo-Pacific region**

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### **ABSTRACT**

Marine algae are harvested from the coastal waters of numerous countries of Indo-Pacific region due to their value as food, feed for animals, fertilizers and a source of various minerals, trace elements and phycocolloids. Out of 20,000 species of marine algae in the world, 145 are used for food and 101 for extraction of phycocolloids. The Indo – Pacific region encompasses approximately 75% of the world's coral reefs and provides ideal habitat for marine algae and various other organisms. According to FAO Fisheries Statistics, 2006, the total estimated marine algal production in the world is more than 15.8 million tonnes and that of Indo–Pacific region is of the order of 13 million tonnes. The global production of edible marine algae has been assessed as four million tonnes (wet wt.). The Indo- Pacific region produced 2,60,00,00 tonnes wet weight. In India, the annual production of marine algae has been estimated as 3, 01,646 tonnes. The bulk production comes from Tamil Nadu coast and Andaman-Nicobar Islands amounting to 60 %. Information on global production of useful marine algae, important edible species, harvesting, industrial exploitation and culture of Indian resources is given in this paper. The marine algal industry has grown in leaps and bounds in other countries increasing the employment potential and gainful economic returns for them. There is an urgency in improving the culture and exploitation of our marine algal resources to face competition in the world markets.

### **Introduction**

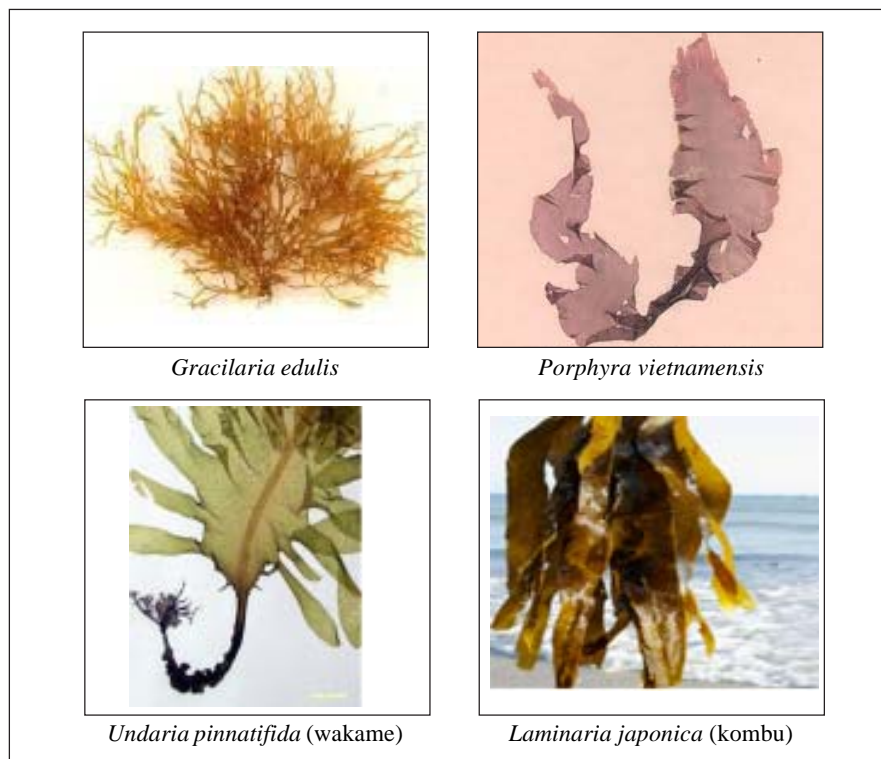
Out of 20,000 species of marine algae in the world, 145 are used for food and 101 for extraction of phycocolloids. The Indo – Pacific region encompasses approximately 75% of the world's coral reefs and provides ideal habitat for marine algae and various other organisms. According to FAO Fisheries Statistics, 2006, the total estimated marine algal production in the world is more than 15.8 million tonnes and

that of Indo–Pacific region is of the order of 13 million tonnes (Table-1).

The importance of marine algae as food is well known in many countries of Indo-Pacific region. They are used in salads, soups, jellies and vinegar dishes because of the presence of vitamins A, B and B-12 in higher quantities as compared to many land plants and vegetables consumed as food. However, in spite of having very rich marine algal resources, the consumption of seaweeds are very minimal in many parts of the world.

Table-1. The species of marine algae cultured and quantities harvested in (million tonnes) in Indo-Pacific region

Name of the marine algae	Countries cultivated	Utilization	Quantities harvested (Million tonnes)
<i>Laminaria japonica</i> (Kombu)	China, Japan, North Korea and South Korea	Food	4.8
<i>Undaria pinmatifida</i> (Wakame)	China, Japan, North Korea and South Korea	Food	1.8
<i>Gracilaria verrucosa</i>	China, Taiwan	Food and Phycocolloid	1.15
<i>Gracilaria</i> spp.	Indonesia, Korea, Philippines, Vietnam	Food and Phycocolloid	0.25
<i>Kappaphycus alvarezii</i>	Malaysia, Myanmar, Philippines, India	Food and mainly Phycocolloid	0.24
<i>Euचेuma</i> spp	China, Fiji Island, and Indonesia	Food and Phycocolloid	2.0
<i>Euचेuma cottonii</i>	Philippines	Food and Phycocolloid	1.5
<i>Euचेuma denticulatum</i>	Malaysia and Philippines	Food and Phycocolloid	0.1
<i>Porphyra tenera</i>	Taiwan, Japan, North Korea and South Korea	Food	0.57
<i>Porphyra</i> spp	China	Food	0.82
<i>Enteromorpha clathrata</i>	China	Food	0.12
<i>Gelidium amansii</i>		Agar	1200 (tonnes)
<i>Monostroma nitidum</i>	South Korea	Food	0.80
<i>Caulerpa lentellifera</i>	Philippines	Food	0.43
<i>Codium fragilis</i>	South Korea	Food	0.12
<i>Hizikia fusiformis</i>	Japan and South Korea	Food	N/A
<i>Kappaphycus alvarezii</i>	India	Phycocolloid and Liquid Fertilizer	1500 (tonnes)



It may be due to lack of awareness about the importance of marine algae (Qasim, 2003).

#### **Global production of algae used for human consumption**

The global production of economically important marine algae has been assessed as four million tonnes (wet). As per the data available, the highest production (1million) is from China followed by Japan (700,000 tonnes) and Korea (400,000 tonnes). The lowest yield is in New Zealand (50 tonnes). Marine algae used as food mainly are produced and marketed in Japan, China and Korea, although they are popular in other countries too, due to the presence of Asian communities or because the cuisine is popular as in United States of America where there is a very good market for algal recipes. The marine

algae used for food and phycocolloids extraction and the quantities harvested in Indo-Pacific region are given in Table-1. The values quoted for the total consumption of edible marine algae vary from 400 000 tonnes (dry weight) or 2 million tonnes wet weight per year (Richards Rajadurai, 1990) to 454,730 tonnes dry weight (Mc Hugh, 1991). Almost 94% of edible marine algae are produced through farming (Table-2) and the cost of production is met by a very high market price for the end product.

As per the FAO report on the State of World Fisheries and Aquaculture, 2010, Indo-Pacific Region countries dominate marine algal culture production (82% by quantity in 2008). Trade figures indicate the Republic of Korea to be the highest exporter and Japan to be the

Table-2. Aquaculture production in Indo-Pacific countries

Name of the country	Aquaculture production % in the world.
China	62.8
Indonesia	13.7
Philippines	10.6
South Korea	5.9
Japan	2.9
North Korea	2.8
India (since 2002)	0.075 (production of 1500 t. of <i>Kappaphycus alvarezii</i> (dry weight))

major importer (Richards Rajadurai, 1990). Prices for marine algae sold as food are always much higher than those used for extraction of phycocolloids. The whole sale price of brown algae used for food can vary from US\$ 7,500-10,000 per dry tonne where as material used for alginate extraction ranges from US\$ 150-500 per dry tonne (McHaugh, 1984). The Republic of Korea has the highest per capita consumption of marine algae in the world. 4,00,000 tonnes of marine algae producing 1,20,000 tonnes of product weight are consumed. Of this, 75% is Wakame, (*Undaria pinnatifida*) and 25% Nori (*Porphyra*). The Japanese consume 1,20,000 tonnes of dried marine algal products (7,00,000 tonnes of marine algae). Species of *Laminaria*, *Porphyra* and *Hizikia* are all marketed in dry form, while *Undaria pinnatifida* is sold in boiled or dried form. China consumes all of its domestic production of 1 million tonnes of wet marine algae equivalent to 150,000 tonnes of dried product. This total comprises to 80% *Laminaria* (Kombu), 12% of *Porphyra* (Nori) and 1.2 % of *Undaria pinnatifida* (Wakame) (Richards Rajadurai, 1990). The annual production of marine algae along Indian coast

has been estimated at 2,60,876 tonnes (Chennubhotla, 1992, 1999) and now revised to 3,01,646 t (Chennubhotla *et al.*, 2011). The bulk production comes from Tamil Nadu coast and Andaman-Nicobar Islands amounting to 60 %. The rest comes from Gujarat, Maharashtra, Goa and Kerala. In addition to above, 5% production comes through cultivation of *Kappaphycus alvarezii*.

In view of their value as food, feed for animals, fertilizers and a source of various minerals, trace elements and phycocolloids, the marine algae have been used as food for human beings. Nori (*Porphyra* sp.) a Japanese red alga, which is very popular in the Japanese diet, has high protein content (25-35% of dry weight), vitamins and mineral salts especially iodine. The bulk production of Japan consists of *Porphyra*, *Undaria*, *Laminaria*, *Monostroma*, *Enteromorpha* etc., that of China consists of *Porphyra* and *Laminaria*, that of Republic of Korea consists of *Porphyra*, *Laminaria* and *Undaria*, that of Taiwan consists of *Gracilaria*, some quantities of *Porphyra* and that of Philippines comprises of *Kappaphycus* and *Caulerpa lentillifera*. The produce is exported from Philippines and a significant amount of *Laminaria* produced in China is processed for alginates locally. The culture of *Kappaphycus alvarezii* (= *Eucheuma gelatinae*) was introduced to Hainan Island in 1660, while *Gracilaria verrucosa* was cultivated commercially in the late 1950's. The only marine algal species being used as food in India is *Gracilaria edulis*, which is consumed by coastal population in Tamil Nadu. In recent years, *Kappaphycus alvarezii* is being cultivated along the coast of Tamil Nadu for carrageenan and liquid fertilizer production. The coastal population use marine algae as manure for their coconut plantations in Tamil Nadu and Kerala. In Sri Lanka, Myanmar, Indonesia and Thailand,

*Gracilaria*, *Caulerpa* etc. are collected in small quantities for export purpose and in Indonesia and Vietnam, the coastal population consumes them as food and the culture operations in these countries are still in initial stages.

#### Status of seaweed utilization in India

At present algae are collected from south east coast of India, especially from Gulf of Mannar area as a means of livelihood. Since algal collection plays a major role in the livelihoods of small-scale fishing communities, 5,000 women are directly involved in algal collection from the fishing villages in the Rameswaram island and Kilakkarai area of the Gulf of Mannar. Another 5,000 people are dependent on seaweed-related activities and industries in the region and collect about 10-15 kg of seaweed per person. The price for the seaweeds varies from species to species—*Gelidiella acerosa* at Rs.4/- (US\$ 0.1) per kg, while *Sargassum* spp., at Rs.10/- (US\$0.25) per kg in wet form and Rs.15/- (US\$0.38) per kg in dried form. The species collected in large quantities are *Gelidiella acerosa*, *Gracilaria edulis* (agarophytes) and species of *Sargassum*, *Turbinaria* (alginophytes). These species grow in the shallow waters around the 21 islands in the Gulf of Mannar area. The collection is seasonal. For example, *Sargassum* spp. is available in harvestable size only during October to December. The peak collection season is from October to March, when the weather is not very windy. The women earn Rs. 100-150/- (US\$2.5-3.75) per day, when they sell the seaweeds in wet form and Rs.150-200/- (US\$3.75-5) per day in dry form. These seaweeds are sold to the agar processing industries located in Madurai, a city 150 km away from Ramanathapuram (Ramya Rajagopalan, 2008). It has also been noted that there is an overall decrease in the production of marine algae in Tamil Nadu from 5,800 tonnes (dry weight) in 1978 to 3,250 tonnes (dry

weight) in 2002 - 2003 (Subba Rao and Mantri, 2006). However, discussions are under way between GOMBRT (Gulf of Mannar Biosphere Reserve Trust) and various other research institutes for the culture of *G. acerosa* and *Gracilaria* spp., following a notification from the Government of Tamil Nadu, which prohibits the culture of the exotic *Kappaphycus alvarezii* in the Gulf of Mannar area. The culture of *Gelidiella* and *Gracilaria* has been carried out only on an experimental level and needs to be tried on a large scale. (Ramya Rajagopalan, 2008).

#### Industrial exploitation of Indian seaweeds

In the recent past, marine algae are also finding a place in integrated aquaculture systems. Some polysaccharides extracted from brown and red algae (agar, carrageenan and alginate) are employed in various industries especially for culturing microbial organisms and genetic engineering, in pharmaceutical and textile, food industry and in a host of other items. The agar extracted from Indian species is poor in gel strength and other physical characters. By improving the gel strength of these agars, high grade agars can be produced to compete with the world markets (Umamaheswara Rao, 2003; Kaladharan, 2003). In view of the shortage of food production in Indo-Pacific region, augmentation of marine algae through culture practices is of relevance and importance at the present juncture.

A potential harvest of 100,000 metric tonnes (wet weight) of marine algae is possible across Indian coast. (Dhargalkar and Pereira, 2005; Krishnamurthy and Subbaramaih, 2007; Ananthi *et al.*, 2010). However, the quantity of agarophytes exploited ranged from 248 to 1518 tonnes (dry weight) and alginophytes from 529 to 5537 tonnes (dry weight) during the years 1978 to 2005. During 2010, about 800 tons of agarophytes and 3500 tonnes of alginophytes were utilised for the production

of 80 tonnes of agar and 350 tonnes of algin. Since the above quantity of agarophytes are inadequate to meet the demand of agar industries, the required quantity of raw material of *Gelidiella* and *Gracilaria* were imported from few foreign countries. The natural stock of alginophytes in the natural sea beds along our coasts is quite adequate and only 50% of standing crop is exploited every year to produce alginates.

The carrageenan yielding red alga *Kappaphycus alvarezii* is cultivated on commercial scale since 2002 in Tamil Nadu and about 1500 tonnes of dry weed are produced per year, of which 250 tonnes are used for manufacture of carrageenan by the SNAP Natural & Alginate Products Pvt. Ltd., Ranipet, Tamil Nadu. The rest of the material is exported to foreign countries like Philippines and Malaysia. (Kaliaperumal, 2011). The marine algal industry has grown in leaps and bounds in other countries increasing the employment potential and gainful economic returns for them. There is an urgency in improving our marine algal species through biotechnological and biochemical means so that the products obtained from them can face competition in the world markets. It is also necessary to popularise the marine algae as food for combating food shortage.

Culture of protein rich algae like *Porphyra* spp., *Caulerpa* spp., *Acanthophora spicifera* and *Codium* spp will provide valuable nutritious diet to people suffering from malnutrition. Marine algal culture could be carried out profitably as a regular rural culture enterprise in a large number of suitable shallow coastal areas where fisherfolk as well as unemployed manpower are readily available. Spore culture of economically important species like *Gracilaria edulis* also proved successful and needs further studies to make it commercially viable (Reeta Jayasankar and Kaliaperumal, 1991; Reeta Jayasankar, 1992).

Thus, there is enormous potential to step up algal production through culture practices from the present level which will enable meeting ever rising demand in the various countries.

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