

# Opportunities of seaweed value addition and quality control requirements in India

Niladri S. Chatterjee\*, Lekshmi R. G. Kumar, C. N. Ravishankar  
and Suseela Mathew

ICAR-Central Institute of Fisheries Technology, Cochin-29

\*niladri.chatterjee@icar.gov.in

## Introduction

Seaweeds has long documented history of uses as food in different parts of the world. Now, backed by recent research, seaweeds are perceived as superfood, rich in protein, micronutrients, vitamins, and health promoting phytochemicals. Globally, seaweeds are traded as ready to eat food and functional food products with a premium price tag. Besides, the global seaweed trade is also driven by the prominent seaweed hydrocolloids, namely Agar, Alginate, and Carrageenan. Markets for seaweed-based cosmetics, animal feed ingredients, fertilizers, soil conditioners are relatively small but rapidly growing. Dried seaweeds as raw materials in various industries are also traded but fetches comparatively lower price. Hence, besides ramping up seaweed production, judicious and focused investment for establishing post-harvest infrastructure and value chain is essential.

The Indian coastline of 8100 km and EEZ of 2.17 million km<sup>2</sup> support luxuriant growth of diverse seaweed resources belonging to 700 species. Of these, nearly 60 species are economically important. Approximately 20,000 t (wet weight) of these resources are harvested annually, while the actual harvest potential is close to 870,000 t. The major species harvested are *Gracilaria edulis*, *Gelidiella acerosa*, and *Kappaphycus alvarezii* among red algae; *Sargassum wightii*, *Turbinaria conoides*, and *Cystoseira spp.* among brown algae and *Ulva lactuca*, *Enteromorpha sp.*, *Caulerpa spp.* among green algae. The state-wise distribution of number of seaweed species in the country are, Gujarat 202; Maharashtra 152; Goa 75; Karnataka 39; Kerala 20; Lakshadweep 89; Tamil Nadu 302; Andhra Pradesh 78; Orissa 1; West Bengal 6 and Andaman & Nicobar Islands 34. These rich resources of seaweed in India could potentially

serve and benefit the functional food, pharmaceuticals, textiles, fertilizers, and animal feed industries.

## Market potential

The global seaweed industry is valued at approximately US\$ 5.5 – 6 billion, out of which products intended as food contribute about US\$ 5 billion (FAO, 2018). China, the European Union, Japan, and the USA are the major importers of seaweed products. In 2016, top 35 seaweed importing countries traded in seaweed products worth USD 2 billion. Carrageenan and edible seaweed products were the major imported items with a share of 37% and 30% respectively. The market analysis indicates that besides seaweed hydrocolloids, market for edible seaweed products is equally lucrative. The market for high value seaweed nutraceuticals such as fucoidan and fucoxanthin is rapidly growing. Fucoidan is a bioactive sulphated polysaccharide found in brown seaweed. Many research reports noted the anti-inflammatory, anti-viral, and anti-cancer activities of fucoidan. Fucoxanthin is a carotenoid found in brown seaweed. The carotenoid has proven anti-diabetic and anti-obesogenic properties. A recent market research suggests that the value of global “Fucoidan Market” in 2020 is 30 million USD and growing at a compound annual growth rate (CAGR) of 3.8%. While, the global “Fucoxanthin market” is valued at 95 million USD in 2020, growing at a CAGR of 2.6%.

## Quality control of seaweed raw material for food and feed purpose

The seaweed raw materials used for food and feed purposes need to be tested for Iodine and Mercury. In 2006, the European Union (EU) for Scientific Committee on Food (SCF) established an upper limit of 600 µg/day for iodine intake for adults and 200

µg/day for children of 1-3 years of age. For mercury in algae and prokaryotic organisms, a maximum residue level of 0.01 mg/kg is established according to Regulation (EC) No 396/2005. For arsenic, lead, cadmium, and mercury, the maximum levels in the feed are established under EU Directive 2002/32/EC of the European Parliament and the Council. Metal content in seaweed is important from animal health care and food safety point of view as many seaweed species are used as animal feed or feed ingredient. As per this EU directive 2002/32/EC Aldrin, Dieldrin, Toxaphene, Chlordane, DDT, Endosulfan, Endrin, Heptachlor, Hexachlorobenzene, and Hexachlorocyclohexane needs to be tested. The regulatory limits for feed material/ ingredients are presented in Table 1.

For polycyclic aromatic hydrocarbons and polychlorinated biphenyls such regulatory limits are not available. However, the presence of these organic pollutants is a possibility in seaweeds and should be monitored. In this case, a default regulatory limit of 0.01 ppm can be considered (Regulation (EC) No 396/2005).

In India, as of now, there is no regulatory limit for heavy metals and persistent organic pollutants in seaweed for food supplement and feed purpose. The Food Safety and Standards (Contaminants, Toxins, and Residues) Regulations, 2011 mentions a regulatory limit for Mercury in non-specified food as 1 mg/kg and Methyl mercury in all food staff at 0.25 mg/kg. The same should be applied to seaweed-based food and supplements. More importantly, the Gazette of India Notification No. 465 on Food Safety and Standards (Health Supplements, Nutraceuticals, Food for Special Dietary Use, Food for Special Medical Purpose, Functional Food and Novel Food) Regulations, 2016 mentions only “Kelp” as an approved nutraceutical or supplement ingredient in India. No other edible Indian seaweeds are listed. This Gazette notification should be amended to include Indian edible seaweed species to legally market seaweed-based supplements and nutraceuticals in India. The probable enforcing agency for seaweed-based food and supplements may be the FSSAI. Whereas for seaweed-based feed the Ministry of Agriculture and Farmers Welfare may be the enforcing agency.

**Table 1.** Regulatory limits for feed material/ ingredients (Source: EU Directive 2002/32/EC)

Parameter	Tolerance limit (mg/kg at moisture of 12%)
Arsenic	2.00
Lead	10.00
Mercury	0.10
Cadmium	1.00
Aldrin and Dieldrin (Single or combined)	0.01
Toxaphene	0.10
Chlordane	0.02
DDT	0.05
Endosulfan	0.10
Endrin	0.01
Heptachlor	0.01
Hexachlorobenzene	0.01
α-HCH	0.02
β-HCH	0.01
γ-HCH	0.20

### High-value food additives from seaweeds

Regulatory limits for heavy metals have been mentioned in European Commission Regulation (EU) No 231/2012 of 9 March 2012 for high-value food additives from seaweed. Formaldehyde (50 mg/kg), Arsenic (3 mg/kg), Lead (2 mg/kg), Mercury (1 mg/kg), and Cadmium (1 mg/kg) should be monitored. The values in parenthesis indicate maximum permissible limits. *E. Coli* should be absent in 5 g, and *Salmonella sp.* should be absent in 10 g. In India, the Food Safety and Standards (Food Products Standards and Food Additives) Regulation, 2011 mentions regulatory limits for Agar, Alginates, and Carrageenan. For Agar and Alginate, the Lead and Arsenic content should be no more than 5 and 3 mg/Kg respectively. For Carrageenan, regulatory limits of Cadmium (1.5 mg/Kg), Mercury (1 mg/Kg), Arsenic (3 mg/Kg), and Lead (5 mg/Kg) have been specified. *E. Coli* and *Salmonella sp.* Should be absent. The probable enforcing agency may be the FSSAI for high-value food additives from seaweed.

### Quality control of seaweed fertilizer and plant growth regulators

Levels of heavy metals and pesticides in seaweed-based bio-stimulants should be monitored as per the Gazette of India Notification No.812 (CG-DL-E-24022021-225410) of the Ministry of Agriculture and farmers welfare. The gazette notification specifies maximum permissible levels of Cadmium, Chromium VI, Copper, Zinc, Lead, and Arsenic as 5 mg/kg, 50 mg/kg, 300 mg/kg, 1000 mg/kg, 100

mg/kg, and 10 mg/kg respectively. For pesticides and other organic pollutants, the permissible limit is 0.01 ppm. Seaweed-based plant growth regulators contain micronutrients, amino acids, and plant growth regulators (auxins, cytokinins, polyamines, gibberellins, abscisic acid, and brassinosteroids), phloroglucinol and eckol, etc. Label claims for these constituents should be there and the products should be analyzed to verify the label claim. The probable enforcing agency may be under the Fertilizer Control Order. State Governments are responsible for enforcing the fertilizer control order. Central Fertilizer Quality Control & Training Institute and its three Regional Laboratories, State fertilizer testing laboratories should be responsible. ICAR institutes may extend support for quality analysis of seaweed bio-stimulants.

### Conclusion

ICAR-CIFT has developed several technologies for value added products and nutraceuticals from seaweed. Five of the technologies have been transferred to industries and commercial production has started for four of them. ICAR-CIFT is the national reference laboratory of FSSAI for fish and fisheries products and will have important role to play for quality control of seaweed and seaweed products. The institute has pilot plant facility for process demonstration and have transferred the technology for solar dryers for hygienic drying of fish and fish products. However, a conducive policy environment needs to be formulated for achieving the true potential of seaweed value addition and processing in India.