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PROSPECTS OF SEAWEEDS AS SOURCES OF BIOACTIVE PHYTOCHEMICALS: A SEARCH ALONG COASTAL BELTS OF KERALA

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ABSTRACT

Seaweeds are macroalgae adapted to inhabit marine ecosystem. They are sources of phytochemicals and reveal immense functional food applications. 10,000 species of algae have been reported across the world and their production is estimated to 6-7 million tones, of which nearly 90% comes from Asia-Pacific region. High diversity and growth of many species of seaweeds occur along the South east coast of Tamil nadu, Gujarat, Lakshadweep and Andaman-Nicobar Islands. 844 species of marine algae comprising Chlorophyta (216), Phaeophyta (191), Rhodophyta (434) and Xanthophyta (3) are reported from Indian coastal belt. They yield nutraceuticals, cosmetics, feed, pharmaceuticals, phycocolloids, fertilizer and biofuels. Sea weed derived compounds are an ample source of nutritionally and pharmaceutically active agents. The proven examples are *Gracilaria, Gelidiella, Gelidium* and *Pterocladia, Kappaphycus, Hypnea, Gigartina, Chondrus, Sargassum, Hormophysa, Laminaria, Turbinaria, Undaria, Cystoseria Macrocystis, Enteromorpha linza, Enteromorpha prolifera, Ulva, Caulerpa, Sargassum, Hypnea musciformis* and *Acanthophora.*. Functional ingredients derived from these algae can help fill the requirement for bioactive to treat chronic diseases like cancer, multiresistant microbial infections, inflammatory events and weight management risks. Future need included algae/seaweed industry comprising species selection, mass-production via photobioreactor productivity and yields, harvesting, and downstream processing.

KEYWORDS: Sea weeds, functional food, nutrients, phytochemical, pharmaceutical,

INTRODUCTION

Seaweed record states that Japan and China from 4th century BC onwards utilized *Laminaria* species as marine food.[1] Gupta and Abu-Ghannam[2] reported the therapeutical references in Traditional Chinese Medicine dates back. Meanwhile, the algal source and usage varies geographically. In East Asia, seaweed usage was mainly nutritional with scanty medicinal uses. *Unnidaria pinnifida* and *Laminaria japonica* popularized as Asian nutritional food for iodine and fiber sources. The Chinese Materia Medica narrates the ancient use for treating goiter, phlegm accumulation, and cleansing heat a key principle to restoring balance in Traditional Chinese Medicine.[3] Western countries documented dating back to the Greek and Roman empires, where mucilage was used to treat rashes, burns, scurvy treatment and parasite elimination.[4] Seaweeds are consumed as raw or cooked, fresh or dried food. Therapeutical applications ranges from physical application, to different solvent extractions/decoctions utilized for many ailments.[5]

Many studies have reported wide array of active molecules from the sea weeds. *Phaeophyceous* species in particular has combination of active lead molecules. These include phlorotannins, fucoxanthins, and fucoidan. The categorization of seaweed into brown brown, red or green algae is based on their photosynthetic pigments, reproductive method, micro and macro morphologies, and its phycopolymers. Seaweeds used cosmetics like body wraps, and baths, with the concept in blood circulation, detoxification, acne treatment, skin moisturizing, purification, exfoliation, or rejuvenating effects. Ethnic people has a feeling that 'The Sea washes away all of the ills of mankind. Furthermore, many medical experts in the current scenario are using topical seaweed body therapies to promote skin beauty and health. Seaweed body treatments are believed to provide surface minerals that can diffuse into the skin, and they provide relaxing stress free experiences when applied in the correct manner. In addition, these biomolecules constitute a focus of contemporary science of human nutrition. A wide range of food products offer variety of physiologically active compounds. Seaweeds and seaweed-derived products are underexploited bio-resources and source of such natural ingredients for functional foods. The present study is an attempt to explore sea weeds of Kerala utilized by local people for multipurpose.

MATERIALS AND METHODS

Study site

Kerala is located on the southwest coast of India between the Lat.8°20' N to 12°51' N and Long 74°53' to 77°30'E. Coastline length of Kerala is approximately 560 km. Sea weeds were collected randomly at each place from the intertidal and subtidal region upto 1.5.m depth. They were sorted out, identified and liquid specimens of all species preserved.

Local knowledge of marine algae was gathered mainly through individual interviews with selected informants using a semi-structured interview format from 2014 to 2015. Interviews were largely conducted in local language with the help of a local translator and responses were recorded in English. During interview with each informant, information regarding the type of ailments managed by locals against the reported ailments, the algae used, ways of remedy preparations, route of administration, precautions if any and dosage was gathered. Ethnobotanical data related to habitat and abundance, threat and local marketability of claimed medicinal plants as well cultivation practice were also collected. The information was also discussed with expertise in the localities to validate the claims as far as possible. Specimens for most of the reported sea weeds were collected, dried, properly identified and authenticated with the reference from CMFRI, Kochi.

RESULTS AND DISCUSSION

Seaweeds have been documented to contain many phytochemicals such as antioxidants and microbicidal molecules such as polyphenols, protein, amino acids and polysaccharides, Carrageenans and alginate can function as antibiotics, laxatives, anticoagulants, anti-tumor, anti-ulcer products and suspending agents in radiological preparations and have been used for centuries in therapy and pharmacy. Fibers perform varied range of anti-mutagenic roles and also function in modification of lipid metabolism in the human body. Chemists and biologists pay attention to the constituents of the algae; if their natural products are explored, they may lead to an efficient way open to of new drug molecules against several pathogens causing infectious diseases.[6] The present field analysis document the following macro algae used along the coast of Kerala for many uses. The major macroalgae are.

1. *Enteromorpha* - may be used to treat hemorrhoids, parasitic disease, goiter, asthma, coughing and bronchitis; they reduce fever and ease pain.
2. *Ulva lactuca, U. reticulata* - can be used to treat goiter; reduce fever, ease pain, induce urination

3. *Codium*- was used to treat urinary diseases, treat edema, expel ascarid; is an ecbolic.
4. *Acetabularia* - used to treat urinary diseases and edema.
5. *Ishige* - to treat cervical lymphadenitis, to diminish inflammation and to induce urination.
6. *Laminaria* - to treat goiter, urinary diseases; is an ecbolic; contains iodine and potassium.
7. *Endarachne* - used to treat urinary diseases, edema, gastric diseases and hemorrhoids.
8. *Sargassum tenerrimum* - to treat cervical lymphadenitis, edema; diminishes inflammation; reduces fever; induces urination; contains iodine and potassium.
9. *Porphyra* - to treat goiter, bronchitis, tonsillitis and cough.
10. *Gelidium* - laxative; can be used to treat tracheitis, gastric diseases and hemorrhoids; can be used to extract agar.
11. *Pterocladiella* - laxative; can be used to treat tracheitis, gastric disease and hemorrhoids; can be used as an agar extract; can be used to make coating for pills.
12. *Corallina elongata* – parasiticide, antiviral potentialities.
13. *Gracilaria* - Can be used to treat goiter, edema, urinary diseases, can prevent ulcer; can be used to as an agar extract and make coating for pills.
14. *Hypnea musciformis* - to treat bronchitis, gastric diseases and hemorrhoids; can be used to make carragenate.
15. *Chondrus* - to treat bronchitis, tonsillitis, gastric diseases, asthma and cough; is an adhesive, can be used to make carragenate. Presence of antioxidants like carotenoids.
16. *Chondria* – ascaricide. Species like Chondria atropurpurea have antiviral activity.
17. *Gloeopeltis* - to treat goitre, tonsillitis and bronchitis; prevents high blood pressure and scurvy.
18. *Caulerpa racemosa, Caulerpa scalpelliformis, Caulerpa sertularioides , Caulerpa verticillata* - against skin disorders. Uncharacterised polysaccharide fractions obtained from Caulerpa sp., also have high antiviral activity against HSV types 1 and 2 while maintaining low levels of cytotoxicity.
19. *Acrosiphonia* – Used in the treatment of Vibriosis and was reported in "Penaeus monodon".
20. *Acanthophora spicifera* - edible, Industrial (Agaroid), in vivo antitumor effect, antibacterial activity, the sulfated polysaccharide showed high antihyperlipidemic activity in rats.
21. *Cladophora fascicularis* - Food, animal feed and agricultural, antibacterial activity, human food.
22. *Bryopsis plumose* - treatment of lung cancer, tumours and AIDS antioxidant activity.

23. *Dictyopteris bartayresiana* – human food, animal feed, manure, industrial use, alginates, antitumor properties.
24. *Lobophora variegate* - anti-oxidative, anti-inflammatory, and anti-cancer properties. Sulfated galactofucan from Lobophora variegate have anticoagulant and anti-inflammatory properties.
25. *Padina tetrastromatica* - Anti Hepatitis B Virus (HBV) activity, edible, rich in amino acids, vitamins and fatty acids.
26. *Asparagopsis taxiformis* – edible, antifungal activity, used for controlling goiter, condiment, used in the traditional raw fish preparation known as "poke." Remarkable antiprotozoal activity effective against Leishmania and other parasitic or disease-causing protozoans.
27. *Spyridia hypnoides* - antischistosomal activity.
28. *Gelidiopsis intricate* – industrial, animal feed.
29. *Turbinaria ornata*- as edible and industrial, antioxidant and antimicrobial activity, high antioxidant properties.
30. *Amphiroa anceps* – free radical scavenging properties, antibacterial activity.
31. *Chondracanthus acicularis* – high carrageen content, high dietary fibre, proteins and vitamins.
32. *Champia compressa* – antibacterial activity against two gram negative bacteria, antifungal activity.
33. *Ceramium cruciatum*- microbicidal property.
34. *Dictyota dichotoma* – have antitumoral activity, Dietary antioxidants are present involved in peroxynitrate inhibition and are pharmaceutically important.

The importance and uses of seaweeds as food in the form of recipes, salads, soups, jellies and vinegar dishes is well known in many Indo-Pacific countries since long ago. However, in Indian context, the uses of seaweeds in the form of food are still very limited. Sobha[7] studied six species of seaweeds (*Ulva fasciata, U. reticulata, Caulerpa racemosa, Padina tetrastromatica, Sargassum wightii* and *Gracilaria corticata*) collected from the southern Kerala coast, as food products in the form of ulva toffy, ulva squash.

Arun kumar et al.,[8] evaluated 16 red and 7 green seaweeds as a source of nutraceutical values like dietary fiber, pigments, carbohydrates, protein and amino acids supplements in the food and fodder. *Gracilaria verrucosa, G. corticata var. corticata, Acanthophora spicifera*

and *Chaetomorpha linum* are potential food. Algal products have been used in the food, cosmetic and pharmaceutical industries. An expanding market for these products is a fact and is facing a new challenge of growing algae on a large scale without harming any further the marine environment. Micro and macroalgae are essential to the development of aquaculture since they provide the main micronutrients to many aquatic organisms, including vitamins, nitrogen-containing compounds, sterols, specific fatty acids. Use of macroalgae as fuel and its thermochemical behavior were studied by Ross et al. they reported that marine macroalgae is one such source of aquatic biomass and potentially represents a significant source of renewable energy.

The prospects for marine algal extracts are promising because of public awareness, health care, functional food, clean environment. Also farmers are looking for ways to replace synthetic chemicals and mineral fertilizers by new natural preparations for plants and animals, which will minimize the environmental impacts.

Canciyal et al.,[9] surveyed the coastal belts of Thuthukodi and revealed the importance of sea weeds. Rebours et al.,[10] evaluated seaweed wealth and sustainable livelihood for coastal communities in Europe, Canada, and Latin American industries with sustainable harvesting of natural resources. Reports of nutrient and nutraceutical potentials of seaweed biomass of *Ulva lactuca* and *Kappaphycus alvarezii* was significant.[11] Kasimala et al.,[12] reviewed on biochemical composition and nutritional aspects of seaweeds in terms of ash, high fibers, low protein and fatty acids. They reported red algae contain high protein content (32%), where as green algae contain highest carbohydrate content (35%). The most common edible seaweeds in Asian countries are *Porphyra Spp., Padina Spp., Undaria Spp.,* and *Laminaria Spp*. Gupta [13] screened medicinal and therapeutic uses of red algae. Hayashi and Reis[14] screened pharmacological potential of *Kappaphycus alvarezii*. Mohapatra et al.,[15] remarked seaweeds as health booster. Admassu et al.,[16] considered sea weeds as untouched Potential and alternative resource. Further, pharmacological importance of Seaweeds was narrated in detail .[17-22]

The present study can enhance awareness of the fisher folks to protect the coastal resources particularly, the seaweeds from destructive fishing practices thereby promoting a strong sense of community ownership. It can propose additional income of fisher folks from seaweed gathering and processing and development of a livelihood program in the locality.

Processing and utilization of seaweed and seaweed products centers not only on the known commercial products but also on the development of non-technical ones.

CONCLUSION

Sea weed exploration presented in this work reveals the medicinal and nutritional properties of algae. Seaweeds have immense application in pharmaceuticals, cosmetics, nutritional supplements. Meanwhile, the lead metabolites from algae have not been resolved completely. Food preparations of the seaweeds may be in the form of salad, vegetables for viand, dessert or pickles. Other local uses include medicine fertilizer and insect repellant. Development of other possible food products form seaweeds should be encouraged to the seaweed gatherers to consumers for a livelihood. Present study adds scope for the pharmacological significant products and metabolites from seaweeds in the coming era. Based on the result of the social aspect and the presence of potential species of seaweed in Kerala, there is a need to develop food products for the gatherers to meet their basic needs in life.

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