

Current Trends in Seaweed Research – Overview

Karthik B^{1*}, Vinoth Kumar R²

¹M.Sc. Botany, Periyar Institute of Distance Education (PRIDE), Salem – 636 011

²Division of Algal Biotechnology and Bionano Technology, PG and Research Dept of Botany, Pachaiyappa's College, Chennai – 600 030

Received: 10th Feb, 19; Revised 11th Jun, 19; Accepted 25th Jul, 19; Available Online: 25th Aug, 19

ABSTRACT

Depletion of non-renewable resources becomes unavoidable in this growing population to meet the need of its food supply requirements. The needs for the exploration of renewable, cost effective and non-toxic drugs are also increasing; this situation turns our focus towards the natural resources. One among such resource is seaweeds. They are macroscopic marine algae with global distribution. Recent research trends show the application of seaweeds in bio-fuel technology, wastewater treatment, therapeutic biomolecule identification, nutritious food source, bio-fertilizers and cosmetics, etc. Japan and China is using this valuable resource to meet their food supply demand from fourth and sixth centuries. The presence of commercial products like carrageenan, agar, etc. in seaweeds has increased their industrial application in a greater way for the human welfare. Here, we will discuss the recent trends in seaweed research and their various commercial applications.

Keywords: animal feed, bio-fertilizers, bio-fuel, renewable resource, seaweeds.

INTRODUCTION

Algae are easily accessible resources and are abundant in marine ecosystem. Marine ecosystem contains both micro-algae and macro-algae. Macro-algae are also known as seaweeds. They are salt-dwelling marine plants and are commercially valuable resources due to their nutritional richness. They usually grow on the rock surfaces, corals, pebbles and other solid substrates. Seaweeds contains high amount of carbohydrates, proteins, fats, essential minerals and bioactive secondary metabolites like phenols and terpenoids. Seaweeds are generally classified as green seaweeds (Chlorophyceae), red seaweeds (Rhodophyceae) and brown seaweeds (Phaeophyceae) based on their photosynthetic pigments¹. Marine macro algae or seaweeds are part of human diet from 600 to 800 BC. For a long period of time, seaweeds are used as a staple food in China and Japan. In Indian coastal system, seaweeds are one of the valuable marine resources which are less explored. The coastal area of Tamilnadu is rich in seaweed resources. In this overview, we will discuss the various applications of seaweeds and some of the commercial products derived from them.

As Animal Feed

Traditionally, seaweeds were utilized as animal feed by human society to meet the nutritional requirements of domestic animals. To reduce the usage of expensive feedstuffs, kelp meal was used in early days. Macro algae (seaweeds) also have prebiotic activity that improves the digestive health, boosts immune system and protects against pathogenic infection, thereby increases overall productivity. It also nourishes the beneficial (symbiotic) microorganisms in the digestive tract and improves the

digestive capacity. Application of health-promoting seaweeds will also reduce the application of antibiotics in animal farming industries².

In Medicine

Seaweeds were used in traditional medicine from 3000 B.C. due to the presence of their therapeutic properties. In Chinese Medicine, they are used in the treatment of endocrine diseases like goitre. In Rome, seaweeds are used for wound healing. Seaweeds are generally used to treat helminth infections, cough, and gastro-intestinal diseases, renal and urologic diseases^{3, 4, 5, 6, 7, 8}. An overview on therapeutic potential of seaweeds reveals the presence of various bioactive compounds that can be used to treat wide range of diseases. Various researches have been carried out till now, to study the antimicrobial, antineoplastic, antiparasitic and free-radical scavenging activity of seaweeds. But only few properties have been developed in to pharmaceutical products. *Pelvetia babingtonii* and *Ascophyllum nodosum* extracts possess alpha-glucosidase inhibiting activity and reduce glucose levels during hyperglycaemic conditions⁹. Few edible brown algal extracts contain insulin-like and insulin-secreting activity¹⁰. Peptides derived from *Undaria pinnatifida* and phlorotannins from *Eklonia stolonifera* are useful in the treatment of hypertension^{11, 12}. Alginates derived from *Lessonia trabeculata* and *Lessonia nigrescens* are used to produce bioactive gels, which are used as biomaterials in tissue engineering applications¹³. Few species of *Laminaria* were effectively used in intrauterine devices for contraceptive purpose¹⁴.

In Food Industry

*Author for Correspondence: karthikbalu121086@rediffmail.com

Seaweeds like *Porphyra*, *Gracilaria*, *Laurencia*, *Acanthophora*, *Enteromorpha*, *Caulerpa*, *Codium*, *Viva*, *Monostroma*, *Laminaria*, *Macrocystis* and *Sargassum* are rich in proteins. They are consumed in the form of salads, soup, jam, jelly, and pickle, chocolate and wafer^{15,16}. Hydrocolloids are polysaccharides present in the cell wall of seaweeds used as gelling agents, thickeners and stabilizers for emulsions. Examples of hydrocolloids include algin, agar-agar and carrageenan. They have broader applications in food, confectionary and dairy industries¹⁷. Carrageenan is used in the preparation of sausages, meat balls, poultry and seafood products, desserts, ice creams, chocolates, beverages, sauces, etc. Alginates are used in pastry products, syrups, puddings, pie fillings, salad preparations and flavoured sauces^{16,18}.

In Bio-fuel Production

In the recent days, the use of seaweeds for biofuel production as an alternative to petroleum-based fuel has received the attention of researchers and entrepreneurs. Seaweeds are considered to be an excellent source for biofuel production due to their high oil content. Due to low content of lignin in seaweeds, other carbohydrates like sulphated polysaccharides, mannitol, carrageenan, agar and alginic acid can be used for bioethanol production¹⁹. Polysaccharides from seaweeds can be hydrolysed by acid hydrolysis method for biofuel production²⁰. Since, brown algae contain high amount of carbohydrates compared to green and red algae, they are suitable resource for bioethanol production²¹.

In Wastewater Treatment

Wastewater purification is vital for the efficient management of water resources, protecting aquatic ecosystems from pollution and a sustainable method of improving water quality standards. Existing wastewater treatment approaches are very expensive and less effective to purify aquaculture effluents due to the presence of high suspended solids content²². Seaweed cultivation seems to be an effective, alternative method for wastewater treatment. They absorb and accumulate nitrogen and phosphorus from wastewater and store them in their tissues like a sponge. Seaweeds utilize these nutrients for their growth by storing them in the form of amino acids and photosynthetic pigments. Like other plants, macroalgae (seaweeds) consume carbon dioxide and release oxygen during wastewater treatment. They also use other metabolic wastes as fertilizers. The selection criteria of appropriate seaweed for phytoremediation includes nutrient storage potential, filtering capacity, life cycle data, adaptability to cultivation techniques and growth rate. Thus, seaweeds are an effective alternative approach for aquaculture-generated wastewater treatment to improve water quality and a revenue yielding business for farmers²³.

As Biofertilizers

The commercial application of seaweeds as fertilizer additives and their favourable outcome has been reported²⁴. Their effect on plant culture are also been documented. Seaweed extracts induce seed germination, seedling development, enhance stress tolerance^{25,26} and

promote plant growth rate and plant yield^{27,28,29,30}. Seaweeds are also used to enrich soil fertility³¹. Due to the presence of plant growth-promoting compounds like auxins, gibberellins, ethylene, etc, in seaweeds, they are used as biostimulants^{32,33,34,35,36}.

In Cosmetics

Nowadays, the focus of cosmetic industry is on bioactive ingredients, to reduce the usage of toxic chemicals and to gain consumer's trust. Marine ecosystem is a rich source of renewable resources and an abundant source of bioactive substances³⁷ with both pharmaceutical and cosmetic properties. Seaweeds are one such abundant resource that can be utilized for extracting biologically active chemicals. Carrageenan and alginate are derived from seaweeds used in cosmetic industry. *Fucus vesiculosus* extract contain algarol, which is used in the fragrance products³⁸. A seaweed carotenoid called astaxanthin being used in anti-aging products³⁹. Milled seaweeds are packed and sold as bath water additives along with essential oils. They are also commercially sold with bath salts⁴⁰. Hence, seaweeds are excellent source for cosmetic products.

Commercial Products

Agar

Agar is a gelling polysaccharide found in the cell wall inner matrix of red algae⁴¹. It has wide applications in baking and confectionary industries as stabilizers. Agar is used as laxatives, drug delivering biomaterials and in the preparation of culture medium for microbial cultures. Agar also utilized as finishing and sizing agents in garment and paper industries⁴².

Carrageenan

Carrageenans are family of linear sulphated polysaccharides present in red seaweeds. They are used in the preparation of cough syrups⁴³. They have broader applications in pharmaceutical and food industries. Carrageenans are used in baking food products, confectionaries, condiments, desserts, dairy products and syrups⁴².

Algin

Algin (alginic acid or alginate) is a mucilaginous substance extracted from brown seaweeds. Algin is used as emulsifiers, fillers and ointment bases in pharmaceutical products. It is used in weight reduction treatment as slimming agents. Algin is used as dispersing and thickening agents in pharmaceutical and cosmetic industries⁴².

Mannitol

Mannitol is a type of sugar alcohol present in the brown seaweeds. It is used in the pharmaceutical industry for tablet formulations. It is also used in the production of chewing gum, diabetic food, etc⁴².

Iodine

Brown seaweeds are used to extract iodine. Iodine is a micronutrient essential for the living organisms. They play a vital role in the synthesis of thyroid hormones. Dietary intake of seaweeds will also prevent iodine deficiency related diseases like goitre⁴².

CONCLUSION

Seaweeds are abundant in marine environment and are excellent renewable resources. Due to depletion of non-renewable coal fuels and the need for consistent food supply to the growing population, scientific society is searching for renewable natural resources to meet those needs. Nowadays, the focus is on sustainable development which will have minimal impact on natural environment and also lead the human community towards better living. Since, seaweeds are a good source for animal feeding, biopharmaceuticals, bio-fuels and various commercial products; thus, the need for seaweed research has been widely increased.

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