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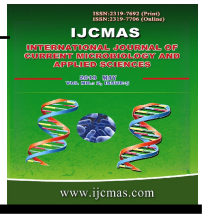

Review Article

Biological importance of Marine Algae- An overview

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A B S T R A C T

Marine algae are ecologically important and have been used as food and medicines for centuries. Various species of marine algae provide not only food but also produce extracts are used in numerous food, dairy, pharmaceutical, cosmetic, and industrial applications. Algae can be used to make Biodiesel, Bioethanol, biobutanol and Hydrogen gases. Naturally growing seaweeds are an important source of food, especially in Asia. They provide source of carbohydrate, protein enzymes, fiber, vitamins including: A,B_1, B_2, B_6, niacin and C, and are rich in iodine, potassium, iron, magnesium and calcium. Algae culture on a large scale is an important type of aquaculture in some places for the production of bioactive compounds. Industrial utilization is at present largely confined to extraction for phycocolloids, industrial gums classified as agars, and alginates. Alginates are derivatives of alginic acid extracted from large brown algae such as *Laminaria*. They are used in printers' inks, paints, cosmetics, insecticides, and pharmaceutical preparations. In the USA, alginates are used as stabilizers in ice cream and also as a suspending agent in milk shakes. In 1995, the estimated value of international seaweed gums market was $560 million dollars

Keywords

Seaweeds; *Nostoc ellipsosporum;* Cyanovirin; *Laminari;* Marine algae; omega -3 fatty acids; Antioxidant.

Introduction

The world's oceans, covering more than 70% of the earth's surface, represent an enormous resource for the discovery of potential therapeutic agents. During the last decades, numerous novel compounds have been found from marine organisms with interesting pharmaceutical activities. Therefore, marine organisms are believed to be a potential source to provide not only novel biologically active substances for the development of pharmaceuticals. cyanobacteria and marine algae have been discovered by screening programs. Many of these chemical compounds are diverse range of biological activities and chemical structure which are used by bio pharmaceutical companies. The medicinal value of cyanobacteria was monitored as early as 1500 BC, when Nostoc was used to treat gout and several form of cancer. More than 40 different Nostocales has been reported as producer of 120 different

metabolites having activity of anti HIV, antifungal, anticancer, antimalarial and antimicrobial. Cyanovirin a 101 amino acid protein extracted from *Nostoc ellipsosporum* was found to have potent activity against all humen immunodeficiency viruses such as HIV-1 (Burja *et al.*, 2001). Phytoplankton, seaweeds and symbiotic dinoflagellates (unicellular, biflagellate organisms) in corals and sea anemones are marine algae. Seaweeds are classified as Green algae (Chlorophyta), Brown algae (Phaeophyta), Red algae (Rhodophyta) and some filamentous Blue-green algae (Cyanobacteria).

Most of the seaweeds are red (6000 species) and the rest known are brown (2000 species) or green (1200 species). Seaweeds are used in many maritime countries as a source of food, for industrial applications and as a fertilizer. Nori (*Porphyra spp.*), a Japanese red seaweed, is very popular in the Japanese diet, has a high protein content (25-35% of dry weight), vitamins (e.g. vitamin C) and mineral salts, especially iodine. Microalgae biomass has a chemical composition which varies depending on the algae used. It can be rich in proteins or rich in lipids or have a balanced composition of lipids, sugars and proteins (Table 1).

Antioxidant property of marine algae

Antioxidants play an important role in the later stages of cancer development. There is increasing evidence that oxidative processes promote carcinogenesis. Recent years, several algal species also have been reported to prevent oxidative damage by scavenging free radicals and active oxygen and hence able to prevent the occurrence of cancer cell formation (Richardson, 1993). Among the most relevant compounds found in the algae, antioxidants are probably the substances that have attracted major interest. Antioxidants are considered key-compounds in the fight against various diseases (e.g. cancer, chronic inflammation, atherosclerosis and cardiovascular disorder) and ageing processes (Kohen and Nyska, 2002). Polyphenols in marine brown algae are called phlorotannins and known to act as potential antioxidants.

Phlorotannins are formed by the polymerization of phloroglucinol (1,3,5-trihydroxybenzene) monomer units and synthesized in the acetate–malonate pathway in marine alga. Furthermore, sulfated polysaccharides isolated from marine alga also have been shown to exert radical scavenging activities in vitro and in vivo. However, biochemical scientists have several techniques to extract bio-active compounds from algal biomass (Athukorala *et al.,* 2006).

Anticancer activity of marine algae

Marine macroalgae are the most interesting algae group because of their broad spectrum of biological activities such as antimicrobial (Bouhlal *et al*., 2010), antiviral (Kim and Karadeniz, 2011), antifungal (De Felício *et al.*, 2010), anti-allergic (Na *et al.,* 2005), anticoagulant (Dayong *et al.,* 2008), anticancer (Kim *et al.,* 2011), antifouling and antioxidant activities (Devi *et al.,* 2011). They produce a wide variety of chemically active metabolites in their surroundings as an aid to protect themselves against other settling organisms (Bhadury and Wright, 2004). There are numerous reports of macroalgae derived chemical compounds that have a

broad range of biological activities, some of which have been used in pharmaceutical industries. Many marine algae produce antibiotic substances capable of inhibiting bacteria, viruses, fungi, and other pibionts. It appears that the antibiotic characteristic is dependent on many factors, including the particular alga, the microorganisms, the season, and the growth conditions (Centeno and Ballantine, 1999).

Several extractable compounds, such as cyclic polysulfides and halogenated compounds are toxic to microorganisms and therefore responsible for the antibiotic activity of some marine algae (Ohta, 1979). Studies indicated that released organic substances from juvenile forms of the red alga Chondrus crispus had an inhibitory effect on growth of adjacent diatoms (Khfaji and Boney, 1979)

Table.1 Chemical Composition of Selected Microalgae Expressed on a % Dry Matter Basis

Strain	Protein	Carbohydrates	Lipids
Scenedesmus obliquus	50 - 55	10 - 15	12 – 14
Scenedesmus quadricauda	40	12	1.9
Scenedesmus dimorphus	8 – 18	21 - 52	16 – 40
Chlamydomonas rheinhardii	48	17	21
Chlorella vulgaris	51 - 58	12 - 17	14 – 22
Chlorella pyrenoidosa	57	26	2
Spirogyra sp.	6 – 20	33 - 64	11 – 21
Dunaliella bioculata	49	4	8
Dunaliella salina	57	32	6
Euglena gracilis	39 – 61	14 - 18	14 – 20
Prymnesium parvum	28 - 45	25 – 33	22 - 38
Tetraselmis maculata	52	15	3
Porphyridium cruentum	28 - 39	40 - 57	9 – 14
Spirulina platensis	46 – 63	8 – 14	4 -9
Spirulina maxima	60 - 71	13 - 16	6 - 7
Synechoccus sp.	63	15	11
Anabaena cylindrical	43 – 56	25 – 30	4 – 7

Antiviral properties of marine algae

Considering the complications of this virus, some synthetic antiviral compounds were developed for treatment of active herpetic infections, but they are not effective for the treatment of latent infections (Naesens and De Clercq, 2001). On the other hand, the severe side effects and development of some resistant mutations of this virus, especially during long term medication with antiviral drugs, were reported (Malvey *et al.,* 2005). In many studies looking for novel antiviral agents, some plants and algae extracts were tested on different viruses including the herpes viruses (Serkedjieva, 2004). In some of these experiments different species of brown algae were tested for their antiviral activity. Extracts from several species of marine algae collected from the coast of California were reported by Deig and co-workers to possess antiviral properties (Ehresmann, 1977).

Algal metabolites in food and cosmetics

The oils from some algae have high levels of unsaturated fatty acids. For example, Parietochloris incisa is very high in arachidonic acid, where it reaches up to 47% of the triglyceride pool. Some varieties of algae favored by vegetarianism and veganism contain the long-chain, essential omega-3 fatty acids, Docosahexaenoic acid (DHA) and Eicosapentaenoic acid (EPA). The natural pigments produced by algae can be used as an alternative to chemical dyes and coloring agents (Bigogno et al., 2002).

Marine algae have been consumed in Asia since ancient times, but to a much lesser extent in the rest of the world. In recent years, many marine resources have attracted attention in the search for bioactive compounds to develop new drugs and health foods. Edible algae are a rich source of dietary fiber, minerals, and proteins (Kuda *et al.,* 2002). Marine algae are now being considered to be a rich source of antioxidants (Nagai and Yukimoto, 2003). Some active antioxidant compounds from brown algae were identified as phylopheophytin in *Eisenia bicyclis* (arame) (Cahyana *et al*., 1992) and fucoxantinein Hijikia fusiformis (hijiki) (Yan et al., 1999).

However, usually, these algae are boiled and/or steamed, dried and stored in process. (Jime´nez-Escri *et al*., 2001) reported that the radical scavenging activity of a brown alga Fucus was decreased by 98% after drying at 50^{o}C for 48 h. Furthermore, these dried products are soaked with 20–40 time volumes of water before being consumed. Agars, extracted from red seaweeds such as *Gracilaria* , are used in the food industry and in laboratory media culture. Carrageenans, extracted from red seaweeds such as *Chondrus*, *Gymnogongrus*, and *Eucheuma* among others, are used to provide particular gel qualities.

This review has highlighted the potential of Marine algae compounds based on the number of previous studies. With an increasing number of bacteria and fungi metabolites the marine algae hold great promise for novel medicine and industrial application and also found to be rich source of structurally novel and biologically active metabolites.

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