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Recent trends of useful algae and their role in food production, healthcare and pharmaceuticals products: A mini-review

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ABSTRACT

We use a variety of species in this fast-paced environment, and algae is one of them. Algae is valuable to humans in a variety of ways. They are useful bioactive compounds that develop autotrophically. Algae are used extensively in biotechnological and medicinal applications. The study of algae components and their actions has a lot of potential in biotechnology and pharmaceutics. Algae has an important part in biology. Algae's utility has gradually expanded in recent years. It plays a significant role in the industrial and pharmaceutical sectors as a new food product, medicine, and so on. Microalgae are commonly utilised in the manufacturing of medicinal and industrial products. Microalgae's pharmaceutical and industrial goods are worth billions of dollars. As well as being used in healthcare items. Usually, it's amyotrophic algae. And it can be found all over the planet. Algae contain a wide range of features that can be used to make synthetic medications.

Keywords: Algae; Bioactive compounds; Pharmaceutical products; Food products.

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INTRODUCTION

Algae have chlorophyll and use photosynthesis to manufacture their own sustenance. Algae are a varied category of aquatic creatures that have chlorophyll, which allows them to perform photosynthesis. Algae come in a variety of forms, including cyanobacteria, green algae, red algae, and brown algae. Algae have a growing number of industrial and traditional applications in human society due to their diverse range of varieties. Algae is derived from the Latin word "algae," which means "slimy green material." It is a nonflowering plant that grows in water and has no roots, stems, or leaves. It is a type of seaweed that floats on the water. Non-vascular organisms live in plants that possess chlorophyll. Most algae with polyphyletic origins, such as green, yellow-green brown, and occasionally red algae, are classified as eukaryotes, while cyanobacteria are classified as prokaryotes. (Plaza et al., 2010).

Algae are vital to life on Earth because they employ the photosynthesis process to produce chemical molecules that we need for food, feed, medication, and even energy. They can grow on the surface of other organisms in the soil or on rocks, or they can live on their own. These are critical because they provide humans and other terrestrial creatures with 30-50 percent of the net world oxygen for respiration. Algae belong to the protist family and come in a variety of sizes and environments. They can withstand a wide range of temperatures and are commonly found in moist areas or near water bodies. They catch light energy through photosynthesis and use it to transform inorganic chemicals into simple sugars (Herrero et al., 2013). They are similar to photosynthetic bacteria in that they form an aquatic food web that supports many animals. They also exhibit mutually beneficial partnerships with other organisms, such as blue green algae living with fungi to form lichens-plant coordinate relationships that provide oxygen and complex nutrients to their partner in exchange for protection and simple nutrients (Bhagavathy, et al., 2011, Priyadarshani and Rath, 2012).

Many countries have explored and used macroalgae to treat illnesses such as cough, gout, gallstones, hypertensions, goitre, and diarrhoea by creating antifungal, antiviral, antibacterial, antioxidant, and anti-inflammatory properties. It has also been discovered that algae can be used not only for medicinal purposes, but also as a source of algal biofuels in future cars and in numerous power plants for carbon dioxide sequestration (Volk et al., 2008; Harun et al., 2010).

HISTORY OF ALGAE USES

China and Korea: Five percent green algae, 66.5 percent brown algae, and 33 percent red algae were ingested daily in the diet for nutritional purposes in China and Korea. Vitamins, polyphenols, colours, minerals, beers, and polysaccharides are just a few of the beneficial nutritional bioactive substances found in them. They're also low in fat and have a low-calorie count, but they're high in important fatty acids and amino acids. China's algae sector is collaborating with certain industries such as NABB, NMSU, SOLIX, and ENN to create some interests in photobioreactors-based carbon sequestration systems, as well as the enormous development stage of biofuels and bio goods. Japan has primarily dealt with microalgae for food sources and actively involved in the development of new species of algae, but they are most interested in "Butyraceous brainier" research, which is concentrated at the University of Tsukuba.

Egypt: Seaweeds such as green *Ulva fascinata* of Chlorophyta, brown *Sargassum linoleum* of Phaeophyta, and red *Corallina officinalis* of Rhodophyta were collected form Mediterranean coast, dried, and stored for further analysis for chlorophyll a, chlorophyll b, carotenoids, protein, and carbohydrate estimation

India: Due to its wealth of diverse freshwater and marine algae containing seaweeds, India can play a big role in algal farming. Because algae is important for a variety of reasons, India has the potential to become a world leader in this field. Algae may thrive on marginal and cropland and in brackish or dirty water, thus they don't need freshwater. Microalgae absorb carbon dioxide and release oxygen, reducing overall carbon dioxide emissions. India is a booming market for algae such as spirulina, which is used in pharmaceutical products. India and the United States worked together to generate financial options for biofuel development. The objective is to introduce algal biofuels in collaboration with "NAABB partnership with Reliance Industries Limited," which is one of the world's leading petrochemical corporations and is based in India.

United States: The Algal Foundation, established in the United States, works to encourage the growth of algae for human wellbeing as they are a vital source of energy, nutrition, and pollution management. Algae may thrive in a number of climates and production methods, from ponds to photobioreactors, resulting in a wide range of work prospects in the United States, ranging from research to engineering, building to farming, marketing to finance.

Taiwan: Taiwan is very similar to China. A huge steel company in southern Taiwan, one of the world's largest, has constructed a photobioreactor sequestration system to minimise pollution. The Industrial Technology Research Institute worked on topics like algae transformation, photobioreactors, belt screen harvesting, and supercritical extraction. It's a big job for a little country.

Australia: Australia has a few small algal industries. Aurora Algae is in demand in Karratha, according to MBD Energy. The University of Sydney is researching on several technologies for converting biomass into oils, including hydrothermal liquefaction, and is extending its biofuels research to work with airlines like Qantas and Virgin Air; all of this indicates a high level of development.

Europe: The EU finances several algae efforts, some situated in Spain. Repsol is a major Spanish petrochemical company engaged in biofuels. Strain selection, photobioreactor design, and fuel conversion are all being explored. Even if Greece and Italy are attempting to develop algae (http://www.bioflora.com/benefits-of-algae/), Spain remains the clear leader.

BIOACTIVE COMPOUNDS (ALGAL MACROMOLECULES) AND THEIR EFFECT

The bioactive molecule is a substance that has both physiological and functional properties. Carotenoids, fatty acids, and other bioactive substances or bio compounds are created by companies. The idea of producing bio chemicals or bioactive compounds from microalgae or algae has recently gained traction. These algae are a natural source of bioactive chemicals with positive health effects. Algae can be found in almost every environment on the planet. Bioactive substances are unique metabolites with particular capabilities found in these algae. Although there are numerous species in the world, only about 20% to 30% of algal species have been discovered. These bioactive chemicals obtained from microalgae, such as polysaccharides, proteins, and fatty acids, are efficient.

Bioactive compounds

Fatty acids, vitamins, polysaccharides, and pigments are among the active chemicals present in algae. These have a variety of pharmacological effects, including antifungal, antiviral, and antibiotic capabilities. Algae also include small components like linolenic acid, oleic acid, palmitoleic acid, and vitamin E. Antimicrobial, antioxidant, and anti-inflammatory effects are all present in these components.

ALGAE IN FOOD PRODUCTION

Protein, fatty acids, polysaccharides, and vitamins are all found in the biomass of algae as a food source. These algae foods have a pleasant, natural flavour and are free of contaminants. Chlorella algae, for example, is employed as a protein source (Rehder, 2014). Spirulina algae contains easily digestible polysaccharides. In industrial production, Spirulina platensis and Spirulina maxima are used (Table. 1).

Table 1. Uses of algae in food production

Sl. No.	Algal species	Product	Action/Use
1.	*Ascophyllan, Darville*	Alginic acid	It is used as a stabilizing Agent in the Ice cream
2.	*Ecklonia*	Sodium alginate	Beer foam
3.	*Sargassum*	Calcium alginate	Dairy products
		Propylene glycol (PEG)	As a gelling agent Used for plastic making
4.	*Agar*	*Gelidium*	90% of the production of agar is used as food in worldwide.
		Gracilaria	Used as a stabilizing and thickness agent in jellies and candies.
		Gladiellôa	Used as culture media in biotechnology. Used as smooth laxative in pharmaceuticals
5.	*Eucheuma denticulatum*	Carrageenan	Food use as seaweed
6.	*Betaphycus gelatinum*		Used in stabilizing and thickness of dairy products

		and coffee etc.
7.	*Chondrus crispus*	Used as gelling agent in jellies and poultry products.
8.	*Gigartina skottsbergii*	Used as air freshener at home.

APPLICATION OF ALGAE IN HEALTHCARE AND MEDICAL

Algae is a great Human Food Supplement

Asaf Tzachor, who leads global food security, says, "Our global food system fails on its most fundamental premise of providing people with healthy and food secure lives." Algae is a possible food source for both humans and animals. Microalgae has been consumed by humans for thousands of years (Ariyanti, et al. 2012). However, more lately, the focus has shifted to the nutritional benefits. While microalgae farming is not yet common, the case for algae as a food source in the future is compelling. Algae are often regarded as helpful dietary supplements with significant health benefits. Chlorella, Anthrospira, Dunaliella, Hematococcus, Scenedesmus, and others are examples (Da-Kui et al., 2014). Proteins, vitamins, pigments, and fatty acids are abundant in Chlorella and Arthrospira (Spirulina). They are utilised as food supplements by humans because they contain roughly 30% lipids. They are high in long-chain polyunsaturated fatty acids, particularly omega-6. Spirulina is a popular supplement all around the world. It's chock-full of minerals and antioxidants that are good for our bodies and minds. It has been consumed since ancient times and gained popularity after NASA hypothesised that astronauts could grow it in space (Bermejo et al., 2002).

Algae used as antioxidants

There is a lot of physical and mental stress in today's world, which leads to the generation of active free radicals like oxygen and non-oxygen free radicals in normal metabolism (Kim et al. 2012). Carotenoids are a type of antioxidant that is widely used. Carotenoids such as carotene, astaxanthin, and canthaxanthin are abundant in many algae. Astaxanthin is found in *Dunaliella salina*. Singh et al. (2014), reported antioxidant potential from brown algae such as *Sargassum* and *Laminaria.*

Algae as a source of Vitamins

According to Becker algae are high in vitamin A, B1, B2, B6, B12, C, and E (Amaro et al., 2011).

Algae used as anticancer and antitumour agents

Though cancer therapies can effectively kill malignant cells, their efficacy comes with negative effects, hence antioxidant supplementation is frequently recommended. It has the ability to slow the growth of cancer cells. Spirulina has been shown in animal studies to lower cancer occurrence and tumour size. (Smelcerovic et al., 2008).

Algae as a source of antibiotics, anti-inflammatory and anti-viral compounds

Spirulina has an antioxidant chemical called phycocyanin as an active component. Phycocyanin has powerful antioxidant and anti-inflammatory properties, fighting free radicals and inhibiting the synthesis of inflammatory signalling molecules.

Gloiopeltis; Used for the treatment of tonsils and goitres disease.

Grateloupia: It has the capability to lower blood sugar.

Corallina: It can be used as pesticides in agriculture.

Gelidium: Used for extracting agar.

Sargassum: Used for inflammation.

Acetabularia: Used for treatment of urinary disease (Raposo et al., 2014).

Enteromorpha: Used for treatment of goitre and parasite diseases.

Table 2. Utilization of algae in healthcare

Sl. no.	Source	Algal species	Product/ Compounds	Activity
1.	Red algae	*Laurencia papillosa*	Tetradecanoic acid	Antipathogenic
		Gelidiella acerosa	Saturated fatty acid	Antioxidant, Antimicrobial
		Gracilaria corticata	PUFAs	Antibacterial

		Ochtodes secundiramea	Fatty acids	Antiprotozoal
2.	Brown algae	*Lobophora variegata*	Fatty acids	Antibacterial
		Canistrocarpus	Fatty acids	Antiprotozoal
		Himanthalia elongata	Palmitic and oleic acid.	Antifungal
3.	Green algae	*Enteromorpha linza*	Stearidonic acid	Antimicrobial
		Ulva reticulata	Palmitic acid	Antibacterial
		Ulva fasciata	PUFAs	Antibacterial
		Anadyomene saldanha	Fatty acid	Antiprotozoal
4.	Microalgae	*haematococcus pluvialis*	Fatty acids	Antifungal

Source; Modified and updated from Stephens et al. (2013).

ALGAL PRODUCTS & PHARMACEUTICAL USES

***Chlorella*:** It is regarded as a superfood since it aids in detoxification and contains a high concentration of proteins, vitamins, and minerals. It is also used in the manufacturing of antibiotics. It's a freshwater plant. Mostly found in Japan, the United States, and Taiwan. It's manufactured into powder, pills, and liquid extracts in the pharmaceutical industry. It was used to cure ulcers, rashes from radiant therapy, and trichomoniasis (https://www.slideshare.net/sreeremyasasi/algae-as-drug-source). It is commonly used to treat constipation, hypertension, and respiratory issues. It also aids in the reduction of cholesterol and asthma attacks, the alleviation of premenstrual syndrome, the provision of energy, and the promotion of mental health. Nowadays, many researchers from algal chemistry have interested in order to develop new drugs (Parab & Vikas, 2012).

***Omega-3 fatty acids*:** Docosahexaenoic acid (DCA), a type of omega-3 fatty acid produced by algae, is important for the prevention and treatment of a several disorders (Steffens, et al. 2014). Depression, Asthma, ADHD, Alzheimer's disease, and Dementia can all be cured with it. It also aids for growth of children.

***Spirulina*:** Spirulina is a type of algae that is utilised as a dietary supplement for both humans and animals. Blue-green algae is a type of algae that can be found in high-salt tropical or subtropical waters. It is made composed of two cyanobacteria species (Arthrospira platensis, Arthrospira maxima). It's utilised for weight loss, high temperature, diabetes, stress, exhaustion, depression, and anxiety, among other things. It is mostly used to cure women's health difficulties such as attention deficit hyperactivity disorder, precancerous development, boost immune system, enhance memory, raise metabolism activity and lower cholesterol rate, prevent heart diseases, faster wood mending, and promote digestion and stool movement (de Morais et al., 2010).

Astaxanthin: Astaxanthin is a naturally occurring high-concentration carotenoid and it improves immune system function, which usually protects cells from injury, Alzheimer's disease, Parkinson's disease, and age-related macular degeneration (AMD, (Steffens et al. 2014).

***Phycoerythrin*:** A red algae that reflects red light while absorbing blue light. It used for cell labelling immunodiagnostic treatment, and cosmetics.

Beta-carotene: Beta-carotene is a collection of red, orange, and yellow pigments derived from the "Dunaliella salina" plant (Abdolsamad, et al., 2015). Beta carotene and alpha carotene are abundant in marine microalgae. It can also be found in vitamin A-rich vegetables, fruits, and whole grains. It helps to prevent cancer, heart disease, and cataracts, among other things (Nandi et al., 2015).

***Fucoxanthin*:** Fucoxanthin is a carotene-rich seaweed extract found in wakame and hijiki. It is usually found in brown seaweeds, although there are some red and green seaweeds as well, and it performs a limited kind of photosynthesis. Cancer, diabetes, and weight reduction are all treated with it.

***Alginates*:** Brown algae is found in the cell walls of alginates, which minimises the number of strong compounds including barium, tin, cadmium, manganese, zinc, and mercury. It's found in peel-off face masks, cholesterol and blood pressure medications, and throat lozenges (Sanmukh, et al. 2014).

CONCLUSION

As a result, it may be stated that algae play a significant role in food production, drugs, and healthcare. Several billions of dollars are spent on the marketing of algal biomass products. Food production relies heavily on agar-agar and chlorella. Algal medicines have been scientifically demonstrated to play a significant role in drug development. Bioactive molecules or algal macromolecules are bioactive molecules or algal macromolecules that are employed in the creation of pharmaceuticals, cosmetics, and food. There have been many studies on algal biomass efficiency, but there is still a need for greater research on the value of algae in pharmaceuticals, food items, and healthcare.

DISCLOSURE STATEMENT

No potential conflict of interest was reported by Authors.

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