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The Role of Algae in Pharmaceutical Development

Aditya T[1]*, Bitu G[1] and Mercy Eleanor G[2]

[1]KIIT School of Biotechnology, Kalinga Institute of Industrial Technology University, Bhubaneswar, India
[2]Vignan Institute of Pharmacentical Technology, Jawaharlal Nehru Technological University Kakinada, Andhra Pradesh, India

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*For Correspondence

Aditya T, KIIT School of Biotechnology, Kalinga Institute of Industrial Technology University, Bhubaneswar, India

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E-mail: adityacharan@ymail.com

ABSTRACT

Marine algae have received growing attention as sources of bioactive metabolites and considered for the pharmaceutical industry in drug development. Algae have many convincing properties to make it stand out in front of synthetic drugs. This review focuses specifically on the potentials, properties, medicinal uses, applications of algal molecules. This also focuses on the future aspects and challenges of algae in the pharmaceutical and nutraceutical area.

INTRODUCTION

Algae are a very simple chlorophyll-containing organism composed of one or group of cells together in colonies which are basically not much related to each other making it polyphyletic in nature [1-4]. Natural products from algae have been widely explored, since long time, for human use as food and as medical treatments. Many chemicals and products from algae have economic importance and are broadly used as it is a good source of fibre, minerals, antioxidants, vitamins, pigments, steroids, lectins, halogenated compounds, polysaccharides, proteins, polyunsaturated fatty acids and other lipids; thus, they are even consumed in many countries [5-8]. Algae are a rich and varied source of pharmacologically active natural products and nutraceuticals. Currently these products are very valuable in the market. Many products are now being commercialized such as carotenoids, phycobilins, fatty acids, polysaccharides, vitamins, and biologically active molecules for use in human and animal health [9-16]. Even marine algae which are catagerosied into micro/macro algae are being very beneficial to the pharmaceutical industries. Marine algae are potential sources of highly bioactive secondary metabolites that might represent useful leads in the development of new pharmaceutical requirements [17-22]. Many studies are now being carried out on the chemicals which are being extracted from marine algae for human benefits and welfare. After biofuel many researchers are working on production of biologic drugs by coaxing therapeutic pharmaceuticals to replace expensive drugs[18,19].

Algae as a Source of Pharmaceuticals

The global market of pharmaceutical industries is on a huge rise. In India 70% to 80% of the market is dominated by pharmaceutical industries, the market size is growing every year. Algae always had the potential to be beneficial to mankind; especially the use of cyanobacteria (blue-green algae), for antibiotics and pharmacologically active compounds has received ever increasing interest. Large ranges of products are being derived from algae which include; Antimicrobials, Antivirals, Therapeutic proteins, drugs, Antifungals and many more[23-28].

Mostly the bases of these are dependent on the properties of algae such as the antioxidant properties, anticancer activity, and antiviral properties[29,30]

- **Antioxidant properties:** The most powerful water soluble antioxidants found in algae are polyphenols, phycobiliproteins and vitamins. Antioxidants help in the inhibition of cancer growth by causing regression of premalignant lesions[31-36]. A study has found out that many algal species have helped in prevention of oxidative damage by the process of scavenging free radicals and active oxygen which helps in cancer prevention. Antioxidants are the key to fight out various diseases including chronic disorders, cardiovascular diseases, and inflammations. Polyphenols found mostly in marine algae are having good antioxidant properties, also known as pholorotannins. The sulphate polysaccharides which are isolated from marine algae release radical scavenging activities [37-41]. Several methods of extraction are designed out by researches for this. Filamentous green algae have great antioxidant properties. Seaweeds contain a wide variety of bioactive compounds, which has this property and is very well used commercially worldwide [42-47].

- **Anticancer activity:** Mostly marine algae are involved in this as it has wide range of properties. They have good antibiotic properties which are inhibiting many dangerous diseases. Oral cancers can be treated by the use of algae which exhibits antioxidant properties such as β- carotenes, floral compounds of algae are being used as therapeutics for cancer. This section is under vigorous study by researchers and people from pharmaceutical industries [48-55].

Aqueous extracts of algae show anticancer activities, cyanobacteria S. platensis shows the highest antioxidants which leads to anticancer efficiency, phyllocobili proteins are another example, sargassum species [56-60].

Antiviral properties: When limitations arose on vaccines it led way to many synthetic antiviral compounds for the treatment of active herpetic infections, but this was too unsuccessful [61,62]. Researches then found out the antiviral property in brown algae, as it has a wide spectrum of activity which completely inhibits virus. This discovery has led to antiviral chemotherapy [63-66]. Algal polysaccharides are are derived which are used against particular viruses;

- Carragren from red algae used against Influenza virus, DENV, HSV-1, HSV-2, HPV, HRV, HIV
- Galactan from Red algae, *Callophyllis variegate*, Agardhiella tenera used against HSV-1, HSV-2, HIV-1, HIV-2, DENV, HAV
- Alginate from Brown algae against HIV, IAV, HBV
- Nostaflan from Blue-green alga, *Nostoc flagelliforme* against HSV-1, HSV-2, influenza A virus, human cytomegalovirus
- Fucan from Brown algae, *Ascophyllum nodosum, Macrocystis pyrifera* against HIV, IAV, HBV [67-76]

Algae as nutraceuticals

The current value of algal nutraceuticals is very high in the market. Though the expansion of strains is very small, basic nutraceuticals from algae include food supplements, dietary supplements, value-added processed foods as well as non-food supplements such as tablets, and soft gels [77-82]. The major products derived from algae are Omega 3 polyunsaturated fatty acids (PUFA), β-Carotene, Astaxanthin, Carotenoids etc.

- **Carotenoids:** Microalgae is being widely used for nutraceutical supplements, species of cholorella, Dunaliella, *Haematococcus*, Spirulina, *Aphanizomenon*, are widely evaluated by researchers for its potential. It generally depends on the protein content of the species which determines its credibility towards nutraceutical development. Extracts of cholorella, Spirulina have good antioxidant, anti-inflammatory, anti-tumor properties. *Haematococcus* has many vitamins in it which makes it more interesting towards nutraceutical development. *Aphanizomenon* plays a huge role in cholestral controlling, stimulation of liver functions and also is a cure for many dermatological problems [83,84].
- **Astaxanthin:** Natural Algae Astaxanthin Association (NAXA), is playing a major role in determining the benefits and value of astaxanthin. It is laying stress on differences between natural algal astaxanthin and other synthetic sources. Astaxanthins are built from carbon precursors, its high lipid soluble pigment, it's basically an antioxidant with slightly low activity but has good free radical terminating of each carotenoid. Astaxanthins are used as food supplements [85-90].
- **Omega 3 polyunsaturated fatty acids:** PUFA is very important for body metabolisim in humans. Chlorophyts, Bryophyta algae are used for the extraction of these healthy and essential fatty acids. N-6 PUFA is a diet

rich fatty acid which is derived from the above. The fatty acid content in algae makes it a well-known bioactive compound which is very useful in the pharmaceutical industry.

Algal Drugs

Algae could be used to make complex, targeted cancer drugs, their photosynthetic organelles, chloroplasts make it more helpful. Researches and scientists are working vigoursly on genetically engineered tiny algae. These are helpful in killing harmful cancer cells, leading to tumour treatments. This is a major outbreak in the development of cancer drug therapy. Algae have a great ability of folding proteins into complex three dimensional structures. In San Diego human antibodies were successfully produced by algae, human therapeutic drugs, such as human vascular endothelial growth factor, were used to treat patients suffering from pulmonary emphysema [71-77].

Laboratories were interested in fusion of algal proteins which help in antibody formation, these was produced in the chloroplast of algae (**Figure 1**).

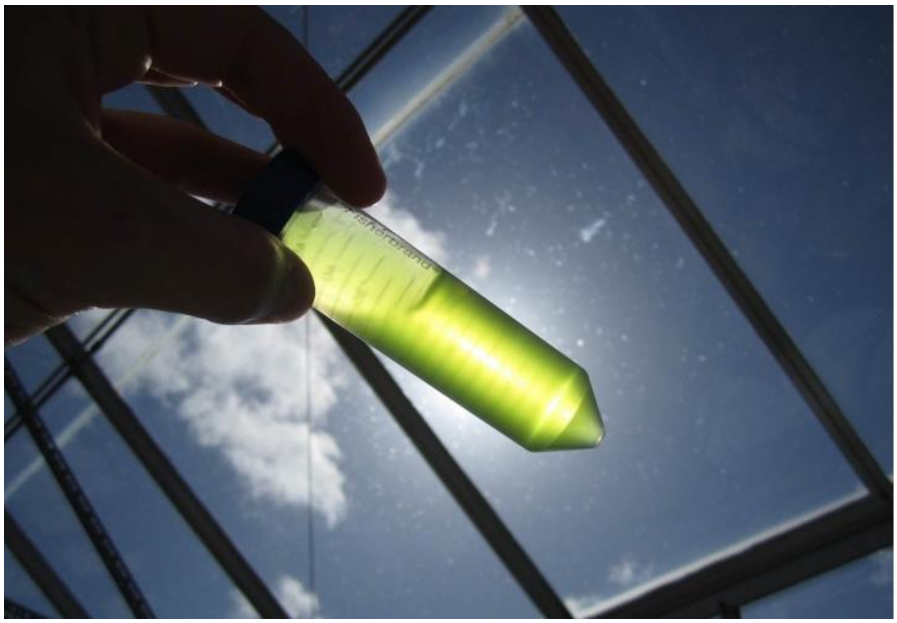

Figure 1: Algal engineered anti-cancer therapy.

Microalgae play a big role in development of anti-cancer drugs; a compound named cryptophycin has been isolated from the blue green algae which is a strong component for an anti-cancer drug development. They even produce alkaloidal neurotoxins such as saxitoxin and polyketide, having anti-inflammatory and anti-cancer properties [83-88].

Whereas, Macro algae contain alkaloids giving way to anti-cancer drugs

Medicinal uses of algae/algal drugs

Different types of algae have different medicinal properties making them unique from other. They are used for various treatments and below is a small list of such algae and their medicinal cures [91-96];

- *Enteromorpha:* It can be used to treat hemorrhoids, parasitic disease, goiter, coughing and bronchitis; fever reducyion capacity and ease pain.
- *Acetabularia:* This can be used to treat urinary diseases and edema.
- *Laminaria:* It can be used for thyroid problems and urinary diseases.
- *Sargassum:* It can be used to treat cervical lymphadenitis, edema; diminishes inflammation; induces urination; contains both iodine and potassium
- *Gelidium:* can be used to extract agar
- *Corallina:* It can be used as pesticides
- *Grateloupia:* Blood sugar lowing capability

- *Gloeopeltis:* Treatment for tonsils,goitre.

Applications and future of algal drugs

Algal drugs are having many applications which make it a new boon for the future in drug and pharmaceutical sector's. The applications include;

- High value oils
- Cosmetics
- Colorants
- Waste water treatment
- Food supplements
- Personalized drugs
- Fertilizers
- In forensic medicines

So, as scientists are looking for cheaper biological drugs, green algae have been the upcoming trend, and looking at the above applications it's becoming friendlier. Seeing the ability of bioactive compound production, especially by green algae is a boon to the pharmaceutical research [96-100].

CONCLUSION

The confirmation of scientists towards algal products has increased its sustainability in drug development field. The therapeutic drugs prepared from algae which exist on both sunlight and carbon dioxide in the air will be manufactured at one-thousandth of today's costs, which makes it cheaper. Yet the development of these drugs has few drawbacks which is creating hindrance. Many strains are really commercially useful. Using of bioreactors has been common and is being widely promoted.

Seeing the above studies and the on-going researches one can believe in the future and the improvement of algal drugs.

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