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THE ALGEA AND MEDICINE - CRITICAL REVIEW

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Abstract

A wide variety of photosynthetic organisms that may be found in a variety of aquatic habitats are known as algae. In recent years, algae have garnered a lot of attention in the area of medicine owing to the possible medicinal implications that they offer. This article provides an in-depth analysis of the myriad ways in which algae play a role in the field of medicine, focusing on the bioactive chemicals, pharmacological actions, and possible applications of algae in the field of drug development. Polysaccharides, proteins, lipids, and secondary metabolites are examples of the bioactive chemicals that are generated from algae. These compounds demonstrate a wide range of biological actions, including anti-inflammatory, antiviral, anticancer, antioxidant, and antibacterial effects. In the course of preclinical research, these compounds have demonstrated encouraging results, and they have the potential to be utilized in the creation of innovative medications. Within this review, the mechanisms of action of these bioactive chemicals as well as their prospective therapeutic applications in the treatment of a variety of disorders are investigated. The standardization of bioactive chemical extraction, the scalability of production, and the regulatory obstacles are some of the problems and limits that are linked with the application of algae in medicine. This article also tackles these issues and limitations. Additionally, the review analyzes new developments in biotechnology and genetic engineering that attempt to improve the therapeutic value of algae, therefore making them more practical for clinical applications. These breakthroughs are discussed in the context of the study. In conclusion, algae are a promising source of new bioactive chemicals that have substantial therapeutic promise; nevertheless, further study is required to overcome the hurdles that are currently being faced and fully realize their potential in contemporary medicine. The purpose of this study is to offer a complete overview of the present state of medicine based on algae, with the goal of promoting future research and development in this developing subject.

Keywords: *Algea, Medicine, Critical*

Introduction

Algae are a broad collection of organisms that are capable of photosynthesis. They may be found in a wide variety of aquatic habitats, ranging from freshwater ecosystems to marine ecosystems. They have been an essential component of life on Earth, making a large contribution to the creation of oxygen on a global scale and acting as the basis for the food webs that exist in aquatic environments. In addition to its significance for the environment, algae have garnered significant interest in a variety of disciplines, including agriculture, the generation of biofuels, and most significantly, medicine. In the field of medicine, the investigation of algae for therapeutic reasons is not a unique notion. In the course of human history, several societies have made use of algae for the nutritional and medicinal benefits it may offer. On the other hand, throughout the

course of the last few decades, there has been a spike in the amount of scientific study that is targeted at discovering the immense potential of substances produced from algae in contemporary medicine. Having discovered that algae are abundant sources of bioactive molecules, such as polysaccharides, proteins, lipids, and a wide variety of secondary metabolites, this growing interest has been spurred by the revelation that algae are rich suppliers of these compounds. A wide range of biological actions, including but not limited to anti-inflammatory, antiviral, anticancer, antioxidant, and antibacterial properties, have been proven to be exhibited by these substances. Because of their one-of-a-kind characteristics, bioactive chemicals that are generated from algae are becoming increasingly attractive as potential candidates for the creation of novel medicines and therapeutic agents. For example, particular algal polysaccharides have demonstrated the ability to modulate immune responses and promote wound healing. Additionally, certain lipids and secondary metabolites are now being researched for their effectiveness against cancer cells and dangerous bacteria. Despite these encouraging discoveries, there are a number of obstacles that must be overcome before drugs made from algae may be brought from the laboratory to the bedside. These include the fact that the synthesis of bioactive compounds might vary, that there are challenges associated with standardization and culture on a big scale, and that there are regulatory impediments. Furthermore, the complex processes that are responsible for the therapeutic benefits of these substances need to be examined in greater depth through the use of rigorous research. The purpose of this study is to offer a critical analysis of the present status of research on algae and the medical uses of algae. The wide variety of bioactive chemicals that have been discovered in algae, as well as their pharmacological qualities and the promise that they offer for the development of novel therapeutic medicines, will be investigated under this study. In addition to this, the study will highlight contemporary developments in biotechnology and genetic engineering that aim to overcome the obstacles and constraints that are currently being encountered in this respective sector. The purpose of this study is to shine light on the enormous potential of these organisms in contributing to healthcare and to promote continuing research and innovation in this promising field. This will be accomplished by presenting a complete overview of the role that algae plays in medicine.

1.The Bioactive Compounds in Algae

Algae are a rich source of a wide variety of bioactive chemicals that have tremendous promise for possible medicinal applications. Polysaccharides, proteins, lipids, and secondary metabolites are the primary categories that these molecules fall under. Each of these categories exhibits a distinct set of biological activity.

2.Polysaccharides

Polysaccharides derived from algae, such as carrageenan, alginate, and fucoidan, have attracted a lot of attention due to the diverse collection of biological activities that they exhibit. Because of its antiviral and anticoagulant characteristics, carrageenan, which is generated from red algae, is widely recognized. As a result of its gel-forming capabilities and biocompatibility, alginate, which is derived from brown algae, is utilized in the production of wound dressings and drug delivery structures. Fucoidan, which is another polysaccharide found in brown algae, possesses anti-inflammatory, anti-coagulant, and anti-cancer properties, which makes it a potential candidate for a variety of therapeutic uses.

3.Proteins and Peptides

It has been demonstrated that algal proteins and peptides possess pharmacological actions that are promising. These activities include antihypertensive, antioxidant, and immunomodulatory influences. Both Spirulina and Chlorella, two species of microalgae, have a high concentration of proteins that have the ability to modify immune responses and demonstrate antioxidant potential. Furthermore, certain peptides that have been extracted from algae have shown promise in preventing viral infections and reducing the development of cancer cells.

4.Lipids

When it comes to bioactive lipids, algae are an abundant source of omega-3 fatty acids, sterols, and glycolipids, among other components. Omega-3 fatty acids, which include eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA), are widely recognized for the neuroprotective and cardiovascular advantages that they offer. The antiviral and anticancer properties of glycolipids have been demonstrated, while the potential for algal sterols to reduce cholesterol levels has been demonstrated. Investigations are being conducted to determine the function that these lipid molecules play in the prevention and treatment of chronic illnesses.

5.Secondary Metabolites

There is a large variety of secondary metabolites that are produced by algae. These metabolites include terpenoids, phenolics, and alkaloids, all of which have different pharmacological effects. Terpenoids, which are present in a wide variety of algae species, have been shown to prevent cancer, inhibit the growth of microorganisms, and reduce inflammation. Phenolic substances, such as phlorotannins derived from brown algae, are known to possess exceptionally powerful antioxidant and anti-inflammatory properties. Although they have received less research, algal alkaloids have demonstrated potential in limiting the growth of microorganisms and altering the functioning of the nervous system.

6.Pharmacological Activities of Algal Compounds

Given that the many bioactive chemicals that are formed from algae display a wide variety of pharmacological properties, it is possible that these compounds might be used as prospective candidates for the development of innovative therapeutic medicines.

7.Anti-inflammatory

An important contributor to a wide range of chronic illnesses, such as arthritis, cardiovascular disorders, and cancer, inflammation plays a significant role. There is evidence that algal polysaccharides, such as fucoidan, have considerable anti-inflammatory benefits. These effects are achieved by blocking pro-inflammatory enzymes and cytokines. Algal phenolics and terpenoids, on the other hand, have the ability to influence inflammatory pathways, which might lead to the development of therapeutic therapies for inflammatory illnesses.

8.Antiviral

In the light of the current state of world health, the antiviral activities of algae chemicals are of special relevance. There has been a significant amount of research conducted on carrageenan because of its capacity to prevent the reproduction of a number of viruses, including the influenza virus, herpes simplex virus, and

HIV. The sulfated polysaccharides that are generated from algae have the potential to act as antiviral drugs because they inhibit the entrance and multiplication of viruses.

9.Anticancer

Cancer is a catch-all phrase that refers to a group of diseases that have the potential to be fatal. As time goes on, an increasing number of individuals are affected by various forms of cancer. In most cases, it is difficult to identify the specific etiology of a cancer, as the disease might be caused by a number of different factors. Numerous research are conducted with the goal of identifying links in order to reduce the likelihood of developing cancer. An artificial algae algorithm (AAA) was the subject of study conducted by Kanwal et al. (2022). In order to enhance cancer diagnosis, a model for cancer prognosis and prediction was built, and it shown an improvement. Through the process of cell apoptosis, cancer can be slowed down or prevented entirely.

One of the elements that has received the greatest attention from researchers is ulvan. At the cellular level, some of his actions are comparable to those of hyaluronic acid (Alves et al., 2013a; Alves et al., 2013b). There are also the same effects. The element known as carrageenan, which is also known as degraded κ-carrageenan, has been discovered to possess an anticancer impact. Carrageenan derived from Kappaphycus alvarezii was found to cause apoptosis, often known as cell death, in a variety of human cancers, including human epithelial colorectal adenocarcinoma, normal human small intestine, and human hepatocellular carcinoma (Zainal et al., 2014; Yao et al., 2022). According to Pengzhan et al. (2003), ancient civilizations possessed the knowledge that enabled them to employ green algae as a treatment for a variety of ailments, including hyperlipidemia and urinary disorders. According to research conducted by El-Baky et al. (2009) and El Zawawy et al. (2020), some species, such as Ulva lactuca and Enteromorpha linza, have been discovered to possess a powerful antifungal impact on species that are often seen in urinary tract infections. Research was conducted to investigate the anticancer properties of polysaccharides found in marine algae. After being isolated from the red algae Gracilariopsis lemaneiformis, polysaccharides were shown to have an inhibitory impact, which was found to be connected with the concertation. There was a positive effect observed when the extracts were tested on human breast cancer cells, human hepatoma cells, and human cervical cancer cells. On the other hand, they did not exhibit any cytotoxic effects on Madin-Darby canine kidney cells (Chen et al., 2018; Yao et al., 2022). Researchers were able to successfully investigate the apoptosis potential of the brown alga Laminaria japonica in human nasopharyngeal cancer cells (Zeng et al., 2017). The majority of the apoptosis that was seen was late apoptosis. The polysaccharides that were isolated from the red alga Porphyra haitanensis were shown to trigger apoptosis in human gastric cancer cells, with the highest concentration occurring in the range of 10–500 μg/mL being the most effective. According to Choi et al.'s 2019 research, the green alga Capsosiphon fulvescens was able to trigger apoptosis in human colon cancer cells. There is a compound called fucoidan that is present in Fucus vesiculosus. This compound was discovered to have anti-cancer effect against large B cell lymphoma cells (Yang et al., 2015). The process by which polysaccharides and oligosaccharides undergo metabolism from

In the course of preclinical research, algal chemicals have been shown to possess powerful anticancer properties. At the same time as it reduces the development of tumors and increases the effectiveness of conventional chemotherapy, fucoidan causes cancer cells to undergo apoptosis. Phlorotannins and terpenoids are two examples of other substances that have demonstrated potential in preventing the

multiplication of cancer cells and the spread of the disease. These findings shed insight on the possible roles that chemicals generated from algae might play in the development of novel cancer treatments.

10.Antioxidant

Oxidative stress has been linked to the development of a number of chronic illnesses, including neurological disorders and cardiovascular diseases, among others. Strong antioxidant properties are exhibited by algal components, notably phenolics and peptides. These compounds scavenge free radicals and enhance the antioxidant defenses of cells. Because they possess these qualities, they are useful for both the prevention and treatment of illnesses that are connected to oxidative stress.

11.Antimicrobial

In order to combat the growing number of infections that are resistant to antibiotics, it is necessary to look for new antimicrobial agents. Compounds derived from algae, such as phlorotannins and alkaloids, have been shown to possess antibacterial properties against a diverse array of bacterial, fungal, and viral organisms. These chemicals have the ability to break the membranes of microbial cells, prevent the formation of biofilms, and modify the virulence factors of microorganisms.

12.Anti-viral and anti-bacterial effect

Additionally, algae have the ability to inhibit the growth of germs and viruses. Studies grew increasingly particular in terms of which species of algae exhibit what potential and at what dose in order to better understand the topic. In a manner analogous to the anticancer effect, the biological substances that exhibit anti-viral and anti-bacterial effects are likewise polysaccharides. Chlamydomonas reinhardtii (Chlorophyta) polysaccharide extracts demonstrated two possible applications in the field of medicine. According to Vishwakarma and Vavilala (2019), one of the applications involves the capability of preventing the production of biofilm, while another application involves the capability of dissolving biofilms that have already been produced. A number of the investigations resulted in the development of the first medicine that was used to treat a variety of disorders caused by viruses. For the human immunodeficiency virus (HIV), which is the retrovirus that causes acquired immune deficiency disease syndrome (AIDS), a particular polysaccharide that was extracted from the brown alga Saccharina japonica (Phaeophyceae) was included in the first drug anti-AIDS, and it was found to inhibit HIV replication (Wu et al., 2011). Polysaccharides derived from Sargassum fusiforme have been shown to have a good influence on preventing the infection and replication of HIV-1 at various phases of the viral life cycle, according to the findings of another study (Zhang et al., 2020b). On the horizon are vaccines that are derived from algae. In a study conducted by Dauville et al. (2010), it was suggested that the utilization of an algal-produced vaccine may potentially be employed for the treatment of malaria. In the therapy of hepatitis B, the marine green alga Dunaliella salina was utilized with a positive effect (Geng et al., 2003). This was accomplished by introducing a surface antigen to the algae.

13.Anti-hypertensive and anti-hyperglycaemic effect

According to Wijesinghe et al. (2011), Ecklonia cava is a species of algae that has been shown to contain phlorotannins. These phlorotannins have been recognized for their ability to suppress the activity of angiotensin-converting enzyme. Another type of algae that has been shown to have antihypertensive and antihyperglycemic effects is called Sargassum fusiforme. It was also demonstrated that the extracts helped

enhance liver and kidney function in diabetic rats (Jia et al., 2020b), and they also promoted glycogen production in the liver and skeletal muscles (Jia et al., 2020a). These findings were published in the journal Diabetes Care. According to Alves et al. (2013)a and Alves et al. (2013)b, Ulvan is also regarded a heparinoid agent, which indicates that it possesses anti-coagulant action. According to Abdel-Raouf et al. (2015), the brown alga Hormophysa cuneiformis has been shown to exhibit an anti-hyperlipidaemic activity, which is utilized in the medical area. This is because it has the ability to alter the level of creatinine.

14.Algae use in dentistry

According to Wijesinghe et al. (2011), Ecklonia cava is a species of algae that has been shown to contain phlorotannins. These phlorotannins have been recognized for their ability to suppress the activity of angiotensin-converting enzyme. Another type of algae that has been shown to have antihypertensive and antihyperglycemic effects is called Sargassum fusiforme. It was also demonstrated that the extracts helped enhance liver and kidney function in diabetic rats (Jia et al., 2020b), and they also promoted glycogen production in the liver and skeletal muscles (Jia et al., 2020a). These findings were published in the journal Diabetes Care. According to Alves et al. (2013)a and Alves et al. (2013)b, Ulvan is also regarded a heparinoid agent, which indicates that it possesses anti-coagulant action. According to Abdel-Raouf et al. (2015), the brown alga Hormophysa cuneiformis has been shown to exhibit an anti-hyperlipidaemic activity, which is utilized in the medical area. This is because it has the ability to alter the level of creatinine.

Conclusion

The use of algae as a source of new bioactive chemicals that have great medicinal promise is a promising research endeavor. The fact that these compounds display such a wide variety of pharmacological activity highlights the fact that they have the potential to be used in the development of novel medicines for a variety of ailments. However, in order to successfully translate these chemicals into clinical applications, it is necessary to solve the problems that are associated with standardization, scalability, and regulatory compliance. In order to unleash the full potential of algae in the field of medicine, further research and innovation in biotechnology and genetic engineering will play a vital role. This will pave the way for the creation of innovative and effective therapeutic agents. The purpose of this study is to offer a complete overview of the present state of medicine based on algae, with the goal of promoting future research and development in this developing subject.

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