

GREEN ALGAE: PHYTOCHEMICAL AND PHARMACOLOGICAL PROPERTIES

Abstract

Green Algae are aquatic organisms which scientific name is Chlorophyta belongs to family Chlorophyceae. Green Algae, like other plants, produce a variety of remarkable compounds collectively referred to as secondary metabolites. Flavonoids are some of the most precious phytochemicals, believed to be found largely in the earthbound plants. With the advancement of phytochemical research and marine bio prospecting, flavonoids have been reported by the research of microalgae and macro algae. This review offers an insight into the Phenolic compounds, flavonoids; polysaccharides and unsaturated fatty acids are some of the algal natural products which were reported to have variable biological activities including antioxidant activity, anticancer activity, anti-diabetic activity etc.

Keywords: Green algae, Flavonoids, antioxidant, anticancer, anti-diabetic.

Authors

Mr. Injamamul Haque

School of Pharmaceutical Sciences, USTM,
Meghalaya-793101

Ms. Arjina Mondal

School of Pharmaceutical Sciences, USTM,
Meghalaya-793101

Dr. Sudarshana Borah

School of Pharmaceutical Sciences, USTM,
Meghalaya-793101

Dr. Ruhul Amin

Faculty of Pharmaceutical Science,
Assam down town University, Panikhaiti,
Guwahati, Assam-781026.

I. INTRODUCTION

Green algae constitute the most heterogeneous group of photoautotrophic protists inhabiting the biosphere and show an enormously wide variability of shape, size, and habit. Even color may be highly variable and range from grass-green to orange and purple 1.

Green algae are thought to be the progenitors of the higher green plants. Green algae that may be unicellular, multi-cellular and colonial or coenocytes currently some debate on this point 2. Green algae, a diverse group of photosynthetic organisms commonly found in aquatic environments, have garnered increasing attention in recent years due to their promising pharmacological activities.

Marine organisms are offering a highly arrangement of pharmaceutically important natural products that can be used to treat different kinds of human diseases and disorder. The chemical structures of marine-derived bioactive compounds are unique and highly miscellaneous. Marine organisms manifest a novel molecular platform than the earthbound products 3. Marine microalgae are rich sources of pharmaceutically important bioactive compounds, like carotenoids, phenolic, flavonoids, fatty acids, alkaloids and other compounds. Microalgae and macro algae are also rich sources of flavonoids 4.

Present oneself indicate that there is an inverse relationship between the dietary intake of antioxidant-rich foods and the incidence of human diseases. As a result, many researchers have focused on natural antioxidants as a lot of crude extracts and pure natural compounds have previously been reported to exhibit the antioxidant properties in the plant kingdom 5. .

Recently, aquatic habitats have increasingly been shown to provide a rich source of natural bioactive compounds with hypo-cholesterolemia, anti-inflammatory, antiviral, antineoplastic, antimicrobial and hypertensive properties. According to their chemical structure, most isolated compounds belong to sulfated polysaccharides, phenolic, terpenoids, lactone, sterol and fatty acids 6-8.

Recently, for their important role in the prevention of human diseases and disorder the macro-algae extracts has received recognition for evaluation of phytochemicals constituents having antioxidant properties. The presence of antioxidant substances such as alkaloids, flavonoids, phenols, tannins, phlorotannin, terpenoids, pigments, glycosides, and steroids in algae was thought to act as a defense mechanism, protecting them against reactive oxygen species (ROS) resulting from severe environmental conditions 9, 10. The presence of antioxidants in macro-algae protected the species structural components from environmental oxidative damage 11.

High amounts of essential proteins, vitamins and minerals are obtained from a number of seaweed. It is reported that seaweeds as a dietary supplement are found to be good for the prophylaxis of coronary atherosclerosis 12, 13. A lot of algal and algae-derived compounds such as carotenoids, phenolic, terpenoids and sulphated polysaccharides exhibit potent antioxidant activities. The antioxidant activities of these compounds are mainly allocated to the scavenging activity against superoxide and hydroxyl radicals, chelating ability, quenching singlet and triplet oxygen and reducing power 14, 15.

One of the key pharmacological activities attributed to green algae is their antioxidant capacity. Antioxidant properties are provided by polyphenols 16. The phenomenon of more than one hydroxyl group bonded to the benzene ring is a usual feature of polyphenols 17. Flavonoids consist of a large group of poly-phenolic compounds containing a benzo- γ -pyrone structure and are everywhere present in plants. Secondary metabolites of phenolic nature including flavonoids are responsible for various ethno pharmacological activities which are proven by multiple reports 18.

Among many of the plant pigments, flavonoids are classed as edible. They are derived from derivatives of 2-phenyl-benzo- γ -pyrone 19. Flavonoids have a common flavone structure that is a 15-carbon phenyl propanoid chain (C6-C3-C6), which is assembled into two aromatic rings and linked with another O2 containing pyrene ring. This basic structure is changed through oxidation and also modified in substituents to the pyrene ring that leads to the formation of other flavonoid classes 20.

Flavonoids are categorized into six different types. Flavanols (catechin, epicatechin and epigallocatechin), Flavanones (naringenin and hesperetin), Flavonols (quercetin, kaempferol or myricetin), Isoflavones (genistein and daidzein), Flavones (apigenin and luteolin) and Anthocyanidins are the groups shown in figure 1 found in plant and algae 19.

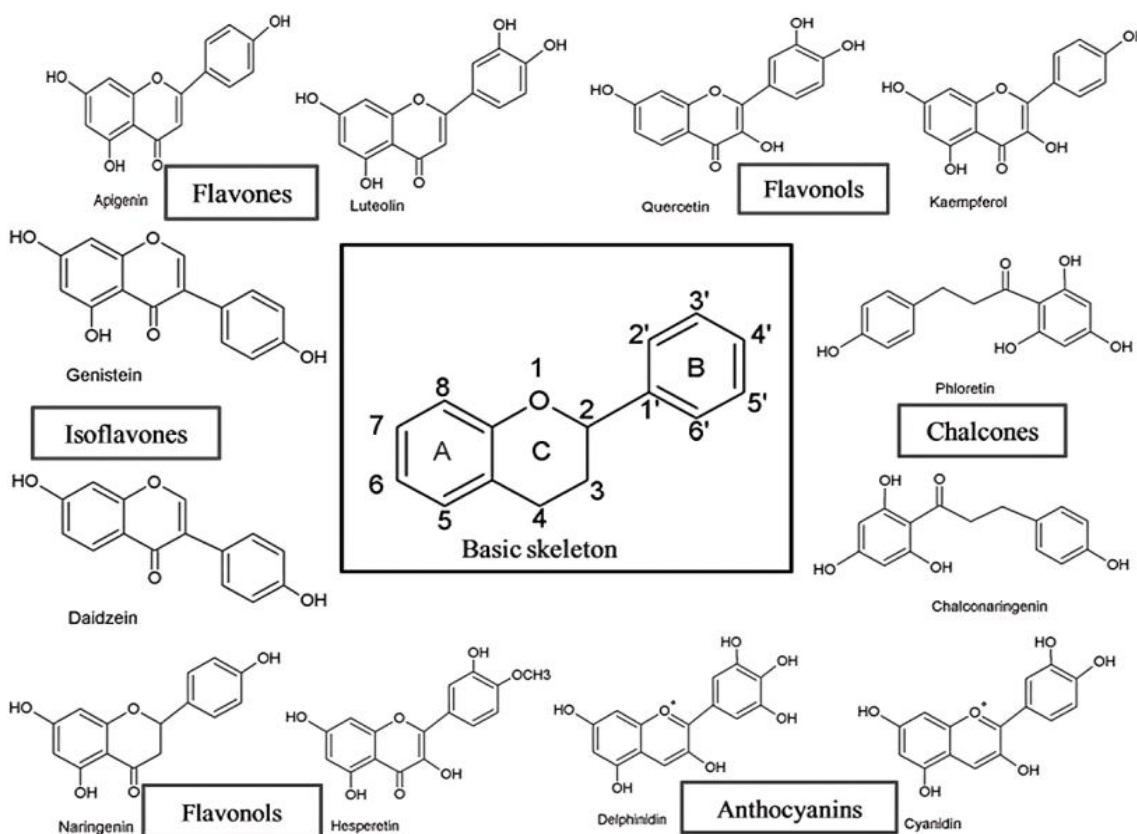


Figure 1: Chemical structure of flavonoids and its different types.

The biological and oxidative properties of flavonoids are responsible for their anti-allergic, cardio protective, anti-diabetic, anti-inflammatory, anti-oxidative activity, and free radical

scavenging capacity 21-22. Anti-cancer activity has also been reported to be exhibit by Flavonoids²³.

Green algae are rich in bioactive compounds such as polyphenols, carotenoids, and vitamins, which have been shown to possess potent antioxidant properties. These compounds scavenge free radicals, neutralizing their harmful effects and reducing oxidative damage to cells, thereby potentially preventing chronic diseases such as cardiovascular disorders, neurodegenerative disease and cancer.

In addition to their antioxidant activity, green algae have also been studied for their anti-diabetic effects. Diabetes is a common endocrine disorder characterized by high blood sugar levels, which can lead to serious complications such as cardiovascular diseases, kidney failure, and blindness. Green algae contain bioactive compounds that have been shown to inhibit key enzymes involved in the breakdown of carbohydrates and fats, thereby reducing blood glucose levels and improving insulin sensitivity. Furthermore, these compounds may also help regulate lipid metabolism, leading to potential benefits in managing diabetes and its associated complications.

Moreover, green algae have demonstrated anticancer activity, making them a promising candidate for cancer treatment and prevention. Cancer is a complex disease characterized by uncontrolled cell growth and proliferation, which can eventually lead to the formation of tumors and metastasis. Green algae produce bioactive compounds such as phycocyanin, chlorophyll, and polysaccharides, which have shown anti-proliferative, pro-apoptotic, and anti-inflammatory effects on cancer cells. These compounds target various signaling pathways involved in cancer development, including cell cycle regulation, apoptosis, angiogenesis, and metastasis, making them potential candidates for the development of novel anti-cancer drugs.

II. CONCLUSION

Phytoconstituents present in Green algae exhibit a wide range of pharmacological activities including antioxidant, anti-diabetic, and anticancer effects. The bioactive compounds present in green algae have shown promising results in preclinical studies, highlighting their potential as natural sources of therapeutic agents for various diseases. Further research is warranted to elucidate the mechanisms of action of these compounds and to evaluate their safety and efficacy in clinical trials. Overall, green algae hold great promise as a valuable resource for the development of novel drugs and therapies for the treatment and prevention of various diseases. Innovative delivery systems and sustainable sourcing of algae can contribute to advancing the development of functional products with multiple benefits.

REFERENCE

- [1] NASELLI FLORES L, Barone R. Green algae. In Encyclopedia of inland waters 2009 (pp. 166-173).
- [2] Vidyasagar A. What Are Algae? Live Science. < <https://www.livescience.com/54979-what-are-algae.html>> Pristupljeno. 2016 Jun; 1.
- [3] Ruiz-Torres V, Encinar JA, Herranz-Lopez M, Perez-Sanchez A, Galiano V, Barrajon-Catalan E, Micol V. An updated review on marine anticancer compounds: The use of virtual screening for the discovery of small-molecule cancer drugs. *Molecules*. 2017 Jun 23; 22(7):1037.
- [4] Goiris K, Muylaert K, Voorspoels S, Noten B, De Paepe D, E Baart GJ, De Cooman L. Detection of

GREEN ALGAE: PHYTOCHEMICAL AND PHARMACOLOGICAL PROPERTIES

- flavonoids in microalgae from different evolutionary lineages. *Journal of phycology*. 2014 Jun; 50(3):483-92.
- [5] Halliwell B. Antioxidants: the basics-what they are and how to evaluate them. *Advances in pharmacology*. 1996 Jan 1; 38:3-20.
- [6] McDermid KJ, Stuercke B. Nutritional composition of edible Hawaiian seaweeds. *Journal of Applied Phycology*. 2003 Nov; 15:513-24.
- [7] Qi H, Zhao T, Zhang Q, Li Z, Zhao Z, Xing R. Antioxidant activity of different molecular weight sulfated polysaccharides from *Ulva pertusa* Kjellm (Chlorophyta). *Journal of applied phycology*. 2005 Dec; 17:527-34.
- [8] Duan XJ, Zhang WW, Li XM, Wang BG. Evaluation of antioxidant property of extract and fractions obtained from a red alga, *Polysiphonia urceolata*. *Food chemistry*. 2006 Mar 1; 95(1):37-43.
- [9] Yuan YV, Walsh NA. Antioxidant and antiproliferative activities of extracts from a variety of edible seaweeds. *Food and chemical toxicology*. 2006 Jul 1; 44(7):1144-50.
- [10] Senguttuvan J, Paulsamy S, Karthika K. Phytochemical analysis and evaluation of leaf and root parts of the medicinal herb, *Hypochoeris radicata* L. for in vitro antioxidant activities. *Asian Pacific journal of tropical biomedicine*. 2014 May 1; 4:S359-67.
- [11] de Alencar DB, de Carvalho FC, Rebouças RH, Dos Santos DR, de Lima RL, Baracho BM, Bezerra RM, Viana FA, Sampaio AH. Bioactive extracts of red seaweeds *Pterocladia capillacea* and *Osmundaria obtusiloba* (Floridophyceae: Rhodophyta) with antioxidant and bacterial agglutination potential. *Asian Pacific journal of tropical medicine*. 2016 Apr 1; 9(4):372-9.
- [12] Norziah MH, Ching CY. Nutritional composition of edible seaweed *Gracilaria changgi*. *Food chemistry*. 2000 Jan 1; 68(1):69-76.
- [13] Velichko MA, Shevchenko VP. Biologically active food additives. *Voenno-Meditsinskii zhurnal*. 1998 Jul 1; 319(7):24-7.
- [14] Ruberto G, Baratta MT, Biondi DM, Amico V. Antioxidant activity of extracts of the marine algal genus *Cystoseira* in a micellar model system. *Journal of Applied Phycology*. 2001 Oct; 13:403-7.
- [15] Athukorala Y, Lee KW, Kim SK, Jeon YJ. Anticoagulant activity of marine green and brown algae collected from Jeju Island in Korea. *Bioresource technology*. 2007 Jul 1; 98(9):1711-6.
- [16] Lima GP, Vianello F, Corrêa CR, Campos RA, Borguini MG. Polyphenols in fruits and vegetables and its effect on human health. *Food and Nutrition sciences*. 2014:1065-82.
- [17] Dai J, Mumper RJ. Plant phenolics: extraction, analysis and their antioxidant and anticancer properties. *Molecules*. 2010 Oct 21; 15(10):7313-52.
- [18] Pandey AK. Anti-staphylococcal activity of a pan-tropical aggressive and obnoxious weed *Parthenium hysterophorus*: an in vitro study. *National Academy Science Letters*. 2007; 30(11/12):383-6.
- [19] Brodowska KM. Natural flavonoids: classification, potential role, and application of flavonoid analogues. *European Journal of Biological Research*. 2017 Jun 30; 7(2):108-23.
- [20] Kopustinskiene DM, Jakstas V, Savickas A, Bernatoniene J. Flavonoids as anticancer agents. *Nutrients*. 2020 Feb 12; 12(2):457.
- [21] Egert S, Rimbach G. Which sources of flavonoids: complex diets or dietary supplements? *Advances in Nutrition*. 2011 Jan 1; 2(1):8-14.
- [22] Tiwari SC, Husain NI. Biological activities and role of flavonoids in human health—A. *Indian J Sci Res*. 2017; 12(2):193-6.
- [23] Kozłowska A, Szostak-Wegierek D. Flavonoids-food sources and health benefits. *Roczniki Państwowego Zakładu Higieny*. 2014; 65(2).