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Antimicrobial Bio-Components from Red Algae Species: a Review of Application and Health Benefits

Sivak Elena[1]*, Bugaev Sergey[2], Sokolov Mikhail[3], Glinushkin Alexey[4]

[1]Associate Professor, Doctor of Agricultural Sciences, Department of Standardization and Equipment of Processing Industries, Kursk State Agricultural Academy named after I.I. Ivanov, Kursk, Russia
[2]Associate Professor, Candidate of Agricultural Sciences, Department of general zootechnics, Kursk State Agricultural Academy named after I.I. Ivanov, Kursk, Russia
[3]Academician of the Russian Academy of Sciences, Professor, Department of Herbology, All Russian Research Institute of Phytopathology, Moscow Region, Russia
[4]Professor of the Russian Academy of Sciences, Doctor of Agricultural Sciences, Department of resistance studies, All Russian Research Institute of Phytopathology, Moscow Region, Russia

ABSTRACT

Primarily, Seaweeds contain beneficial metabolites for human body. Algae, a group of seaweeds, have potential of being used to produce food products, pharmaceutical products, biodiesel, etc. There are several groups of Algae throughout the world like, red, green algae etc. Some natural metabolites of red algae are steroid, terpenoid, acetogenin. Regarding growing awareness of consumers on application of natural antimicrobial products, it could be noted that Marine seaweed and algae could be considered as proper sources. The aim of this review is to present a brief description of antimicrobial properties of red algae.

Keywords: Red algae, antimicrobial compounds, seaweeds

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Corresponding author: Sivak Elena
E-mail ✉ kursknich @ gmail.com
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INTRODUCTION

To date, some bioactive compounds have been identified with potentials of treating toward HIV, Ebola, Hepatitis C, and H5N1 virus. Moreover, sulfated polysaccharide found in red algae might attenuate retroviral replications. In general, seaweeds are considered as one of the superb components of marine organisms and currently are used as vegetables in diets (Nisizawa). People from coastal beach area consume both fresh and dry forms of seaweeds [1]. Algae are in a wide range of utilizations such as food, medicine, etc. Seaweeds have 13000 years' history of using in different applications [2, 3]. Phytochemical Substances derived from red algae are frequently used in industries like food, pharmacy, textile, etc. Seaweeds are rich in enzymes, antioxidants, functional components. They also have medicinal applications like antibiotics Swaminathan and anticoagulant [4].

Recently, seaweeds (macro-algae) are being used for many applications such as food [5]. With respect to parameters like pigment and morphological characteristics, seaweeds are classified into three groups: red algae, brown algae and green algae, scientifically known as Rhodophyceae, Phaeophyceae and Chlorophyceae, respectively [6]. Several technological applications for seaweeds could be defined like using as thickening or gelling agent, and as vegetables. Additionally, seaweeds contain some groups of gum including carrageenan, agar, and alginate [7].

Incorporating seaweeds into pasta makes it possess biologically active compounds such as fucoxanthin and fucosterol [8]. Furthermore, seaweeds biochemical profile contains different sources of protein, fat, carbohydrate, etc., and nutritionally would be considered as functional ingredients [9]. Tables 1 and 2 exhibit some bioactive components of red algae as well as some of its biological properties.

Figure 1 . Red algae [10]

Table 1 . Bioactive compounds of several species of red algae

Bioactive molecules	Red algae	Virus targets (within the replication cycle)	Reference
Bromophenols	Polysiphonia morrowii	Fish pathogenic viruses, infectious hematopoietic necrosis virus and infectious pancreatic necrosis virus	[11]
carrageenan	Gigartina	Herpes simplex virus types 1 (HSV-1) and 2 (HSV-2)	[11]
Griffithsin	Griffithsia sp	GRFT Cellular intrusion of the HIV-1, Ebola, SARS, hepatitis C and H5N1 virus	[10, 12]
Sulphated galactans Galactose, xylose	Grateloupia filicina, Grateloupia longifolia	HIV-1 inhibitory activity	[13]
Sulfated glucuronogalactan Galactose	Schizymenia dubyi	HIV-1 inhibitory activity	[14]

Table 2 . Some of the biological activities of red algae

Biological properties	Reference
Antiulcer products and suspending agents in radiological preparation	[15]
terpenoids, phlorotannins, and steroids	[16, 17]
polysaccharides, vitamins, minerals, and fibers	[18, 19]
antibacterial	[20]
antiviral	[21]
antifungal	[22]
anticoagulant	[23]
antitumor	[24]
anti-inflammatory activities	[25]

The presence of antioxidants could be a possible reason for prevention of oxidative damage while the seaweeds are exposed to sunlight [26]. If we consider seaweeds as antioxidant sources, and simultaneously, protecting the human body from disrupting reactions, therefore, the hypothesis of potential defense against oxidation would be possible [9].

In fact, antioxidants prevent DNA damage or mutation with reduction of reactive oxygen and obstruction of free radicals [27]. Some methods to detect antioxidant activity include beta-carotene bleaching (BCB) assay, ferric reducing antioxidant power (FRAP) assay, DPPH free radical scavenging assay [28-30].

Antimicrobial effects

Antimicrobials refer to any kind of substances with ability of killing or inhibiting the growth of microorganisms like bacteria, yeasts, molds with

the least damage to the host cells. Since seaweeds are living in aquatic environment where microbiota is rich, it could be noted that they have accustomed to have some antimicrobial components [31]. Repeatedly, to avoid increasing resistance of pathogens to the conventional antimicrobials, we can consider them as proper alternatives [32]. A bulk of published documents have been assigned to pronounce the micro- and macro-algae as potential antimicrobial sources against pathogens. To date, many studies have focused on isolated bioactive natural compounds, and for developing and designing new drugs to control pathogens.

Both food industry and consumers achieve to awareness of having more natural antioxidants, and healthier foods [33]. In literature, several studies have revealed efficacy of algae derived bioactive compounds against gram (+) but not gram (-) bacteria. New antimicrobial substances derived from algae are promising to act against pathogens [34].

Table 3. Some antimicrobial components derived from red algae

Anti-HIV compounds	red seaweeds	[34]
polybromocatechol compounds effects on a HeLa cell	Neorhodomela aculeata	[35]
HSV-1 and HSV-2	Sargassum vulgare	[36]
antiviral activity	Stoechospermum marginatum	[37]
anti-HSV-1	Laminaria angustata	[38]

Recently, several studies on seaweeds led to extraction of two new prenylated para-xylenes from Caulerpa racemos, which acts against some pathogens like Candida glabrata, Trichophyton rubrum, and Cryptococcus neoformans [39, 40].

Antibacterial Compounds From Red Algae

Several species of red algae have been reported, and this review deals with some of them such as Laurencia spp., Gracillaria spp., Acanthophora spp and other rare species.

Table 4 . Antimicrobial compounds derived from Laurencia (Rhodomelaceae, Ceramiales)

C15 acetogenin en-ynes	antistaphylococcal	8-256 mg/mL	[41]
halogenated sesquiterpene alcohol	antiherbivore activity		[42]
5-acetoxypalisadin B	Antimicrobial activities		[43]
palisadin A	Antimicrobial activities		[43]
palisadin B	Antimicrobial activities		[43]
pannosanol	Antimicrobial activities	60 µg/disk against Proteus mirabilis and 100 µg/disk against Chromobacterium violaceum and Vibrio cholera	[43]
pannosane	Antimicrobial activities	60 µg/disk against Chromobacterium violaceum	[43]
3(Z) Chlorofucin	Antimicrobial activities	100 µg/disk against Chromobacterium violaceum	[43]
10-acetoxyangasiol	Antimicrobial activities	10-acetoxyangasiol against Vibrio cholerae at 100 µg/mL	[44]
1-methyl-2,3,5-tribromoindole	Antimicrobial activities	Staphylococcus sp. at MIC 300 µg/mL	[44]

Acanthophora spp.

Some of the bioactive compounds have derived from them are β-sitosterol, saringosterol, 5α-cholestane-3,6-dione, and cholest-4-ene-3-one [45, 46]. It has been reported that some of the sterols have cytotoxic and antimicrobial properties.

Gracilaria spp.

This genus contains more than 300 species. The main reason that make this group especial is a commercial product derived from them called agar which is extensively used in food and cosmetic industries [47-50].

Asparagopsis spp.

Detected chemical components of this genus by chromatographic methods are octadec-9-enoic acid 2,3-dihydroxypropyl ester, 9-octadecanoic acid, octadecanoic acid, and chlorobenzene.

Members of this genus have been revealed to be effective against pathogens like Escherichia coli, and Pseudomonas aeruginosa. GC-MS method

have been used to identify the antimicrobial compounds (bromoform, and dibromoacetic acid) of this genus [51].

CONCLUSION

In conclusion, we could mention that red algae are an appropriate source of promising antimicrobial agents, which could even play a role in synthesis of novel substances. Technical and chemical methods could employ some templates for designing new antimicrobial products. Additionally, other science branches like, biology, chemical engineering, along with biomedical techniques are needed to align synthetic products as natural antimicrobial products.

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