Red Macroalgae

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Red Seaweed “Rhodophyta” are an important group of macroalgae that include approximately 7000 species. They are a rich source of structurally diverse bioactive constituents, including protein, sulfated polysaccharides, pigments, polyunsaturated fatty acids, vitamins, minerals, and phenolic compounds with nutritional, medical, and industrial importance. Polysaccharides are the main components in the cell wall of red algae and represent about 40–50% of the dry weight, which are extensively utilized in industry and pharmaceutical compounds, due to their thickening and gelling properties. The hydrocolloids galactans carrageenans and agars are the main red seaweed cell wall polysaccharides, which had broad-spectrum therapeutic characters. Generally, the chemical contents of seaweed are different according to the algal species, growth stage, environment, and external conditions, e.g., the temperature of the water, light intensity, nutrient concentrations in the ecosystem. Economically, they can be recommended as a substitute source for natural ingredients that contribute to a broad range of bioactivities like cancer therapy, anti-inflammatory agents, and acetylcholinesterase inhibitory. This entry touches on the main
points of the pharmaceutical applications of red seaweed, as well as the exploitation of their specific compounds and secondary metabolites with vital roles.

Keywords: bioactive compounds ; drugs ; seaweed ; Rhodophyta

1. Introduction

Macroalgae are macroscopic benthic marine algae (seaweed) living in the intertidal zone. They are characterized by autotrophic nutrition and fast-growth; they do not need land for cultivation and their growth rate is faster than terrestrial plants [1].

Red seaweed are the critical source of numerous bioactive compounds, in contrast with the other two groups of green and brown seaweed like polysaccharides “floridean starch and sulfated galactans, such as carrageenans or agars”, minerals, unsaturated fatty acids, amino acids, vitamins, phycobiliproteins, other pigments, phycolectins and mycosporine-like amino acids, which have many biological and industrial applications [2][3].

The protein content in red seaweed varied between 10–50% of the dry weight and being higher than macroalgal groups and some foods [4]. In addition, they contain the essential amino acid, about 25–50% of the total amino acids, is like other protein sources like leguminous plants [4].

Red and green seaweed contain the largest amount of phenolic compounds like flavonoids, phenolics acids, and bromophenols, which had different medical applications, due to the reaction of these components with proteins, e.g., enzymes or cellular receptors. While, phlorotannins, are the major polyphenolic secondary compounds synthesized only in marine brown seaweed [5].

For decades and at present, seaweed is used in food in many countries, as well as in traditional drugs and cosmetics, due to their richness in natural metabolites. The therapeutic trend has begun searching forward for new medications from natural products like algae. Since ancient times, macroalgae are used for treating different diseases. The approximate numbers of biochemicals are more than up 700 from red species. The majority of these contents have shown promising biological abilities, including antimicrobial, antiviral, antitumor, antioxidant, anticoagulant, anti-inflammatory, antidiabetic, antiallergic, and analgesics efficiencies [5][6].

2. Anti-Obesity Activity

Obesity is excessive fat accumulation, and is known to increase the risk of many dangerous diseases like type II diabetes, hypertension, hyperlipidemia, and cardiovascular diseases. Obesity is gaining increased attention because of the high expense and dangerous symptoms of anti-obesity drugs. Rhodophyta species were shown to have anti-obesity properties [7].

The ethanolic extract of *Grateloupia elliptica* (60%) reduced the accumulation of the lipid in 3T3-L1 cells and inhibited the adipogenic proteins expression. In addition to a significant decreasing in body weight of C57 BL/6J male mice, as well as reducing white adipose tissue (WAT) weight, e.g., fatty liver, leptin, total cholesterol, and serum triglycerides contents in vivo without cytotoxic effect [8]. Forty % of *Plocamium telfairiae* ethanolic extract showed anti-obesity ability via reducing the fat accumulation and suppressed the expression of major adipogenesis factors, like peroxisome proliferator-activated receptor-γ (PPAR-γ),CCAAT/enhancer-binding protein (C/EBP)-α, sterol regulatory element-binding protein 1 (SREBP-1), and phosphorylated ACC (pACC) in 3T3-L1 cells [9]. Seo et al. [10] demonstrated the antidiabetic activity of extract from *Gelidium amansii* via reduction the accumulation of lipid in 3T3-L1 adipocyte cell line.

Generally, marine algal polysaccharides are considered to be dietary fibers so they are not digested by humans [11]; hence SPs can hinder adipogenesis through the mitogen activated protein kinase (MAPK) in 3T3-L1 pre-adipocytes [12].

3. Antihypertensive Activity

Seaweed exhibits significant anti-hypertensive activities [13]. Macroalgae consumption led to decreased blood pressure, which might be linked to the hypotensive effects of the dietary fiber and their rich nitrate content [14]. The antihypertensive effects of macroalgal peptides maintained a healthy heart by stimulating circulation in the blood vessels, and avoiding deadly conditions, such as heart breakdown, atherosclerosis, and peripheral vascular disease [15].

The secondary metabolites of seaweed act as hypoglycemic agents, reduce blood pressure and regulate cholesterol levels, inhibition of hepatic cholesterol biosynthesis, also for hyperplasia prevention, gastrointestinal, regenerative Nori-peptides from *Porphyra yezoensis* have the important antihypertensive ability in hypertensive patients, as well as spontaneously hypertensive rats [16].

4. Acetylcholinesterase Inhibitory ‘’Alzheimer’s Disease”

Alzheimer’s disease (AD) is a progressive and degenerative problem in brain regions, chiefly campus, and neocortex responsible for mental functions that reduced neurotransmitter acetylcholine (ACh). AD can prompt amnesia, abnormalities, and cognitive disturbances [17]. In the cholinergic theory, serious damage of cholinergic neurotransmitter AChE in the central nervous system (CNS) gives AD indications [87]. The principle therapeutic strategy against AD is acetylcholinesterase hindrance.

There is very few research reporting on the AChE inhibitory (AChEI) impact of seaweed. The AChEI ability of plant extracts is classified into potent inhibitors (> 50% inhibition), moderate inhibitors (30–50% inhibition), and weak inhibitors (< 30% inhibition) [18]. As clarified in Figure **1**, *Ochtodes secundiramea* extracts exhibited moderate potency (48.59 ± 0.8%), while the red algae *Hypnea musciformis* (7.21%) and *Pterocladia capillacea* (5.38%) extracts had a weak action. The AChEI abilities of these algae are related to solely compose of halogenated monoterpenes [19].

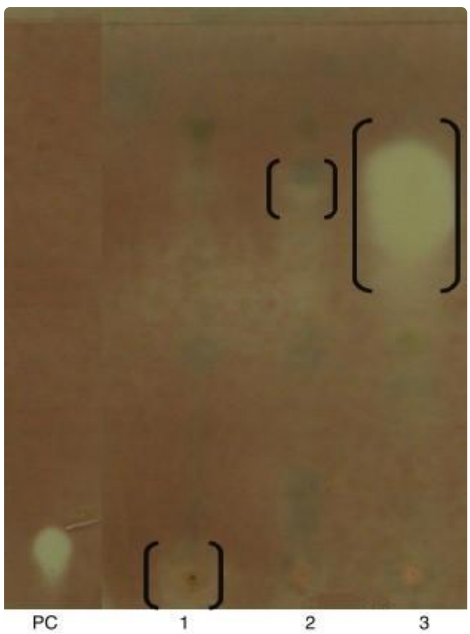

Figure 1. TLC qualitative AChEI assay. PC: +ve control, physostigmine (0.03 µg). DCM/MeOH extracts (100 µg) of (1) *Hypnea musciformis*, (2) *Pterocladia capillacea,* and (3) *Ochtodes secundiramea*. TLC elution system: hexane:ethyl acetate:methanol (2:7:1 *v*/*v*/*v*) [19].

The alcoholic extract of *Gracilaria corticata* (IC50 9.5) and *G.; salicornia* (IC50 8.7 mg/mL) extracts showed moderate AChEI efficiency [20]. The sulfated polysaccharides from *Gelidium pristoides* exhibited inhibitory potency on acetylcholinesterase that related to their antioxidant and neuroprotective potentials [21].

Some red seaweed species synthesize homotaurine, aminosulfonate compounds, which could be a promising medicine for Alzheimer's disease prevention [22].

5. Macroalgae for Skincare

Macroalgae metabolites reduced the appearance of redness and blemishes, the appearance of sun damage, brightening, re-mineralizing, hydrating and firming skin [23]. They have a reaction mechanism toward the hazardous ultraviolet 'UV-A and -B' impacts via delivering phenolic compounds, mycosporine, amino acid, and carotenoids, which act as UV-absorbing [24]. The extracts of red seaweed *Asparagopsis armata*, *Gelidium corneum*, *Corallina officinalis* had skin softness, whitening/lightening, and elasticity restoring anti-aging properties so they can be used as skincare products including creams, oil, soap, mask, or lotion [25]. Agarose from *Gracilaria cornea* and *G.; lemaneiformis* are used for skin whitening, due to its anti-melanogenic activity by inhibiting melanin synthesis [26][27]. Fatty acid-like palmitic acid and its derivated ascorbyl palmitate from seaweed are used in cosmetics as emulsifiers and antioxidant agents for anti-wrinkle and anti-aging characteristics [28]. Amino acid extracted from *Asparagopsis armata* is inserted in some anti-aging lotions [29]. Mycosporine from different Rhodophyta species act as photoprotective substances for skin care products with antioxidant properties [3].

6. Conclusions

There are some species from Rhodophyta whose feasibility medical potential is higher, like *Gracilaria* spp., *Pterocladia* spp. *Jania* spp. and *Corallina* spp. Due to the economic importance of seaweed, more studies should be undertaken, focusing on improving seaweed production on a large scale by adjusting the culture conditions. Cultivation of economic species in seaweed aquaculture may be the future road for the sustainability of seaweed and controlling the production of active compounds. Optimization extraction methods, purification, and fractionation of bioactive compounds led to the production of more active and safe compounds. Therefore, more clinical studies should be carried out on a large scale for economic production.

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