Research Article

Nutritional and Human Healthcare Aspects of *Ulva Lactuca*

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Abstract

Ulva lactuca also called as sea lettuce is having its wide application in the various field of food, pharmaceutical and nutraceuticals. Current article is discussing about the nutritional profiling of *U. lactuca*, along with the employment of the present seaweed in medical and health aspects. The compounds extracted from this seaweed have exhibited its role as antioxidant, antitumor, anti microbial, antiviral, anti hyperlipidemic etc. It was also reported to play a major role in the area of bioremediation and bioaccumulation of pesticides and heavy metals. Researches are still being carrying out globally to study the application of seaweeds in various field of science and technology.

Keywords: Ulva lactuca, seaweed, nutrition, health care

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Introduction

According to the report of FAO, 2017, global aquaculture production of seaweeds is around 28.5 million metric tons, valuing in US$4.46 billion. Generally seaweeds are used primarily as a source of thickening and gelling agents in food, pharmaceutical and biomedical industrial applications. However, these marine organisms possess and exhibit a lot of original and interesting diversified biochemical properties essentially required in human nutrition point of view. It is noteworthy to understand that seaweeds and seaweed products have been used not only as a staple food supplement, but also as source of ingredients of traditional medicine, in Japan, Korea and China since prehistoric times. Interestingly, in India, it has been a regular practice for the coastal livelihood to use marine seaweeds as medicine for treatment various health ailments such as ulcer, hepatitis, cardiovascular diseases, neurological disorders, etc. Nowadays seaweeds have become a nutrient rich vegetarian diet (fresh or dried) and an important source of ingredients in various food formulations and supplements (1). Recently, scientific research is exerting more attention on applications of seaweeds in the field of health food, medicines, pharmaceuticals, textiles, fertilizers, animal feed etc. due to their potentiality as valuable source of nutrients and bioactive molecules of human healthcare importance. The major nutritive value of seaweeds is due to their high mineral (iodine, calcium) and soluble dietary fiber contents, the occurrence of vitamin B12, n-3 PUFA, functional amino acids and specific components such as astaxanthin, fucoxanthin, βcarotene, fucosterol, phlorotannin, etc (2). Though the human healthcare applications are promising, yet there has been little exploitation and exploration of seaweeds in human nutrition, despite potential industrial and agricultural applications (3). Recently, the aquaculture production of *Ulva lactuca*, an edible green macro alga is gaining importance all along the southern coastline of India owing to its higher commercial value and industrial applications.

Ulva is a genus of marine and brackish water green macro algae, which are abundantly present on the coastal line of Indian waters, especially the southern region of India. Globally Ulva Spp. are generally used as source of phycocolloids in fodder and fertilizer industries. It is also having potential applications as ingredients of thickening and gelling agents in food and feed industries (1). The edible seaweed, *U. lactuca*, is commonly called as "Sea Lettuce". Interestingly, *U. lactuca* is one of the main seaweeds authorized for human consumption. This seaweed grows up to 30 cm across with a wide, crinkly, tough, translucent and membranous frond. Though it is commonly attached to stones and rocks, it is capable of easily getting detached in very sheltered conditions to form extensive floating communities. The formation of these free floating dense malts in sea is often termed as "green tides. In comparison to other algal species, *U. lactuca* is capable of growing relatively at a high rate (up to 35%) in wild as well as in farming conditions (4). Interestingly, this seaweed is capable of tolerating brackish conditions and widely appearing on suitable substrata in estuaries (5). Currently, the research interest on this species has increased due to their rapid cultivable vegetative growth and the presence of high value nutrients and bioactive compounds (6) of industrial applications including human and animal nutrition (7 & 8).

The proximate composition of dried *U. lactuca* is given in the **Table 1**. The carbohydrate content present was high which constituted around 58%.

Table 1 The proximate composition of dried *Ulva lactuca*

Components	Percentage composition (%)
Protein	13.6
Moisture	16.9
Lipid	0.19
Ash	11.2
Carbohydrate	58.1

Table 2: Fatty acids composition of *Ulva lactuca*

Fatty acids		Percentage
Saturated Fatty acids (SFA)		
C6:0	Caproic acid	0.75
C8:0	Caprylic acid	0.07
C10:0	Capric acid	0.03
C12:0	Lauric acid	0.43
C13:0	Tridecylic acid	0.08
C14:0	Myristic acid	2.72
C15:0	Pentadecyclic acid	1.92
C16:0	Palmitic acid	48.34
C17:0	Margaric acid	1.05
C18:0	Stearic acid	2.16
C20:0	Arachidic acid	0.31
C21:0	Henecosylic acid	0.54
C22:0	Behenic acid	1.41
C23:0	Tricosylic acid	0.00
C24:0	Lignoceric acid	0.67
	Total SFA	60.47
Monosaturated fatty acids (MUFA)		
C14:1	Myristoleic acid	1.42
C15:1	cis-10-Pentadecenoic Acid	0.19
C16:1	Palmitoleic acid	12.39
C17:1	cis-10-Heptadecenoic Acid	0.64
C18:1 n9	Oleic acid	12.09
C20:1	Gadoleic acid	0.16
C22:1 n9	Erucic Acid	0.00
C24:1 n9	Nervonic Acid	0.62
	Total MUFA	27.51
Polysaturated fatty acids (PUFA)		
C18:2	Linoleic acid	0.00
C18:2 n6	Linolelaidic Acid	2.11
C18:3 n3	α-Linolenic acid	2.67
C18:3 n6	λ-Linolenic acid	2.96
C20:2	Eicosadienoic acid	0.12
C20:3 n6	cis-8,11,14-Eicosatrienoic acid	0.76
C20:3 n3	cis-11,14,17-Eicosatrienoic Acid	1.51
C20:4	Arachidonic acid	0.00
C20:5 n3	Eicosapentaenoic acid	1.31
C22:2	cis-13,16-Docosadienoic Acid	0.33
C22:6 n3	Docosahexaenoic acid	0.94
	Total PUFA	12.71

U. lactuca contains a huge amount of carbohydrates as structural, functional and storage polysaccharides. Ulvan, the antioxidant sulfated polysaccharides of *U. lactuca*, are widely used in pharmaceutical and biomedical research with well recognized biological activities and have been expansively investigated for various physiological, biological, textural and functional food applications. It is interesting to note that ulvan is resistant to both human enzymes of gastrointestinal tract and degradation by human colonic bacteria. The different biological functions of

ulvans and ulvan-derived oligosaccharides such as antioxidant activity and hypolipidemic properties are well known to reduce the risk factors associated with cardiovascular diseases and disorders (9).

The fatty acid composition and the chromatogram of the *U. lactuca* has been analysed and is depicted in **Table 2**. From the data it is evident that the *U. lactuca* consisted of almost all the essential fatty acids along with saturated fatty acids and monounsaturated fatty acids. The chromatogram of the fatty acid profile is also given in **Figure 2**. Among the saturated fatty acids, palmitic acid contributed the most.

Figure 1 Green algae (© M.D. Guiry 2000-2020)

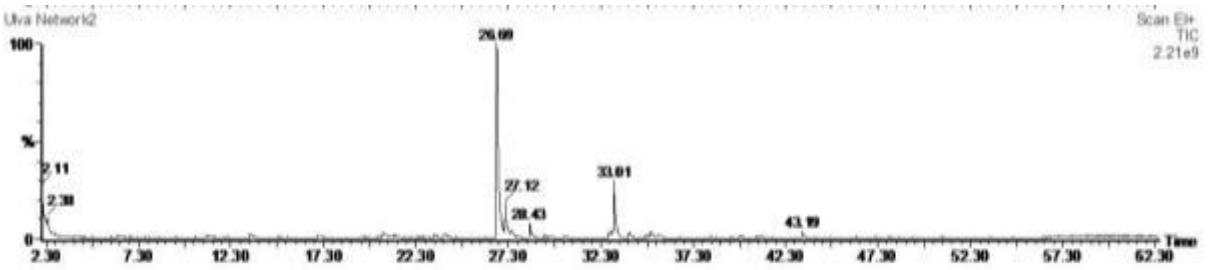

Figure 2 Total ion chromatogram of fatty acids composition of *Ulva lactuca*

The amino acid composition of *U.lactuca* exhibits a high concentration of amino acids (proline, glycine, lysine), which are the basic components of structural proteins, and that it has an ability to stimulate the cells in the connective tissues to synthesize collagen, which plays a major role in modulating the elasticity of skin and promoting oral facial tissue reconstruction (Seaweed Industry Association, 2015). Though it has high concentration of functional carbohydrates and dietary fibre content, but has a very little lipid content with neutral lipids and glycolipids as the major lipid classes. Interestingly, the lipid content of *U. lactuca* comprises substantial amount of ω-3 fatty acids as the major component. The presence of significant concentration of antioxidants, bioactive molecules, β-carotene, n-3 PUFA, bio-minerals and sulphated polysaccharides is designating *U. lactuca* as an attractive source of additive in the food and feed formulations (10;11;12). The availability of vitamins, minerals and trace elements is labelling this green seaweed as a potent nutritive biomass for the healthcare of young children and pregnant women. The experimental and clinical investigations have shown that *U.lactuca* is capable of exerting antioxidant, antimutagenic, anticoagulant, anticancerous and antibacterial properties in addition to its nutraceutical potentials.

U. lactuca is used as a key ingredient in many therapeutic, cosmetic and skin care items such as moisturizers, eye cream, body polish, novelty soaps, body lotions, shaving lotions, face toners, face lift creams, bath soaks, lip cream, anti-aging products, makeup remover, shampoo, and conditioners. It is also utilized as a basic constituent in organic fertilizer and gardening products. As a seasoning by itself and in blends, it is used in preparation of soups and salads. Scientific reports (13) have demonstrated the application of green seaweed in the treatment of anthelmintics, astringents and gout. Recent experimental investigation by (14) has depicted that the sulphated polysaccharides extracted from *U. lactuca* is capable of ameliorating the thiacloprid-induced reprotoxicity and inhibiting oxidative stress damages, DNA breakdown and histological aberrations in rat testis. A previous reported study (15) has indicated that the ethanol extract of *U.lactuca* is capable of attenuating experimentally induced acute myocardial infarction by its antioxidant and antiapoptotic properties. Earlier reports by (16) have shown that the polysaccharides

extracted from *U.lactuca* has exerted the bioactive properties such ashypohypotensive, hypoglycemic, hypolipaemic and antiatherogenic properties, which are well known to ameliorate certain cardiovascular complications linked to a high fat diet. Observations of (17) have indicated that ulvan polysaccharides is capable of exerting chemopreventive effects against breast carcinogenesis at the level of initiation and promotion through improvement of antioxidant defense mechanisms, suppression of free radical mediated-oxidative stress and inflammation, and augmentation of apoptosis. Investigations by (18) have shown that the sulphated polysaccharides of *U.lactuca* acts on bradykinin pathway in its antinociceptive and anti-inflammatory responses. In the experiments carried out by (19), the sulfated polysaccharides from *U.lactuca* have delivered distinctive mechanism of actions of chemoprotection against DENA-induced oxidative stress in experimentally induced hepatocarcinogenesis. The research findings by (20) has shown that dietary supplementation of *U.lactuca* polysaccharides can positively influence the cellular antioxidant defense system against d-galactosamine-induced nuclear damage and hepaticnecrosis in rats. The dietary fibres of *U.lactuca* have been reported to exhibit potent hypocholesterolemic property and antioxidant activity in experimentally-induced hypercholesterolemic animal model (19). Experimental studies by (21) have demonstrated that sulphated polysaccharides present in green algae have been shown to exert anti-inflammatory properties without any undesirable side effects in rats. The antimycobacterial, antiprotozoal and cytotoxic potential of *U.lactuca* was reported by (22). Studies by (23) have indicated that edible green algae, *U. lactuca* can be considered as an excellent dietary fibre source to prevent or treat fibre-deficiency related diseases and disorders.

Though the nutritional properties and healthcare benefits are promising, there is little documentary evidence and awareness on utilization of *U. lactuca*, especially available in Indian Waters, for the industrial scale extraction of novel biomolecules and food formulation ingredients. The nutrients and bioactive molecules present in *U.lactuca* could be developed as nutraceuticals, chemopreventive agents and therapeutic drugs. Hence, it is important to explore the potential for valorization of the *U. lactuca* available in India, especially as a potential natural resource of healthy nutrients essentially required for human nutrition and healthcare.

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