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ORIGINAL ARTICLE

Improvement of lipid profile and antioxidant of hypercholesterolemic albino rats by polysaccharides extracted from the green alga *Ulva lactuca* Linnaeus

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Abstract Sulfated polysaccharides from *Ulva lactuca* were extracted in hot water and precipitated by ethanol then orally gavaged to rats fed on a hypercholesterolemic diet for 21 days to evaluate the antihypercholesterolemic and antioxidant actions. Atorvastatine Ca (Lipitor) was used as a reference drug. The intragastric administration of *U. lactuca* extract to hypercholesterolemic rats caused significant decrease of serum total lipids, triglycerides, total cholesterol, LDL-cholesterol and vLDL-cholesterol levels. Whereas, HDL-cholesterol concentration was markedly increased by 180%. Aqueous extract showed a significant ameliorative action on elevated atherogenic index, creatine kinase and lactate dehydrogenase activities of hypercholesterolemic group. Furthermore, serum activities of transaminases and alkaline phosphatase were also improved. High fat diet intake caused a highly significantly elevated serum urea, creatinine concentration. These effects were reversed by oral administration of *U. lactuca* extract. Sulfates polysaccharides extract of *U. lactuca* ameliorate hepatic enzymatic (catalase, glutathione peroxidase and superoxide dismutase), non-enzymatic (reduced glutathione & total thiol) antioxidant defenses and thiobarbituric acid reactive

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substances. In conclusion, the tested *U. lactuca* polysaccharides extract has potent hypocholesterolemic and antioxidant effects in experimentally-induced hypercholesterolemic animal model.

1. Introduction

In recent years, many marine resources have attracted attention in the search for bioactive compounds to develop new drugs and health foods (Huimin et al., 2005). In addition, marine algae are now considered a rich source of antioxidants (Nagai and Yukimoto, 2003). It is known that seaweeds contain numerous bioactive substances that have been shown to lower cholesterol, reduce blood pressure, promote healthy digestion; and antioxidant activity (Raghavendran et al., 2005). Algal polysaccharides have been demonstrated to play an important role as free-radical scavengers *in vitro* and antioxidants for the prevention of oxidative damage in living organisms (Zhang et al., 2004). Polysaccharide extracted from *Ulva pertusa* is a group of heteropolysaccharide, mainly composed of rhamnose, xylose, glucose, glucuronic acid, iduronic acid, and sulfate, with smaller amounts of mannoses, arabinose, and galactose (Huimin et al., 2005).

Cholesterol-enriched diet has been reported to adversely affect the health of humans and animal species. The prevalence of dyslipidemia resulting from excess energy intake and physical inactivity is increasing in Egypt. High level of blood cholesterol is a contributory factor of atherosclerosis and many lipid associated ailments like obesity, heart attacks and stroke and kidney failure (Sathivel et al., 2008). It has been reported that high levels of fat increase fat-mediated oxidative stress and decrease antioxidative enzyme activity (Slim et al., 1996). In contrast, there are various reports indicating the beneficial effects of antioxidant supplementation in preventing dyslipidemia and cardiovascular disease (Minhajuddin et al., 2005; Gorinstein et al., 2006). Thus, oxidative damage and its consequences may result in many chronic health problems that are attributed to high fat diet.

Many therapeutic agents are available for the management of hypercholesterolemic patients and are employed to promote successful treatment. A number of studies have demonstrated that the use of lipid-lowering drugs can reduce the number of cardiovascular events and mortality from coronary disease (Aronow, 2008). Moreover, a diet restricted in foods high in cholesterol and regular physical exercise should be proposed in the treatment of these patients, contributing significantly to primary health care (De Lorgeril et al., 1999). However, due to certain resistances to dietary restriction and financial limitations to use lipid-lowering drugs, many individuals have turned to alternative treatments to control cholesterol levels. Many of these alternative treatments have been used empirically, lacking scientific studies that would allow for more reliable conclusions (Dickel et al., 2007).

Thus, it is essential to develop and utilise effective and natural antioxidants so that they can protect the human body from free radicals and retard the progress of many chronic diseases. Published data indicates that plant polysaccharides in general have antioxidant activities and explored as novel potential antioxidants (Ng et al., 2004; Jiang et al., 2005; Wang and Luo, 2007). The structure and mechanisms of the pharmaceutical effects of bioactive polysaccharides on diseases have been extensively studied, and more natural polysaccharides with different curative effects have been tested and even applied in therapies. Thus, the present study was designed to evaluate the possible beneficial effect of the extracted sulfated polysaccharide from *Ulva lactuca* on serum lipid parameters and hepatic oxidative stress parameters in albino rats fed with cholesterol-rich diet.

2. Materials and methods

2.1. Algal collection

U. lactuca Linnaeus was collected from Al-Quser province, Red Sea coast, Egypt (at 26° 07′ N and 34° 13′ E) in December 2007. The algal material were washed with tap water many times and further washed two times with distilled water to remove epiphytes, salts and sands. They were air dried in shade and ground by a blender to give small size pieces (2 mm) then stored in plastic bags at room temperature in a dry dark place before use.

2.2. Polysaccharides extraction

Dry algal material (100 g) was autoclaved in 3 L of water at 100 °C for 2 h, and the slurry separated and filtered. The filtrate was dialyzed against tab water for 48 h, and then concentrated to about 800 ml under reduced pressure and 95% ethanol (3 L) was added. The mixture was allowed to stand for overnight at room temperature, and the precipitate was collected and washed twice with absolute ethanol (Pengzhan et al., 2003).

2.3. Infra red measurements

Fourier-transformed infrared spectra were recorded from the polysaccharide powder extract (about 1 mg) in KBr (300 mg) pellets on Shimadzu FT-IR 8201 PC spectrophotometer (El-Sayed et al., 2005).

2.4. Polysaccharides hydrolysis and composition analysis

The isolated crude polysaccharides (5 mg) hydrolyzed with 0.5 M H_2SO_4 at 105 °C for 20 h then neutralized by using $BaCO_3$ and finally centrifuged. The supernatant was concentrated and examined by paper chromatography (PC, descending) using B/A/W (4:1:5 v/v, upper layer) as solvent system. The hydrolysate were also examined by thin layer chromatography (TLC) using the system $CHCl_3$/MeOH/H_2O (15:6:2 v/v) (Chen et al., 1997). The spots were visualized by spraying with aniline phthalate reagent. The hydrolysates (20 μl) were also analysed by HPLC HP1050 model equipped with UV detector (set at 192 nm), Hewlett Packard (HPLC laboratory, Agriculture Research center, Cairo) using the following conditions: Column: APS Hypersil column (4.6 × 200mm i.d.), mobile phase: acetonitrile/water (75:25) v/v., flow rate: 2 ml/min.