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The Embodiment of Characteristic Teaching of Marine Pharmacology-Marine Seaweed Polysaccharides

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***Abstract*—Marine pharmacology is a new branch in pharmacy based on modern medicine theory, studying marine natural compounds and turning into them drugs for disease. It is a characteristic course with the contents of marine natural compounds and their pharmacological effect as well as pharmaceutical preparations. The knowledge on the polysaccharides from the brown algae are representative in the teaching of marine pharmacology. The design and description of brown algae polysaccharides related content can not only enable students to master the main content of marine drugs, but also integrate the knowledge of pharmacy.**

Keywords—Marine pharmacology; marine polysaccharide; alginate; fucoidan; introduction

I. BACKGROUND OF MARINE PHARMACY

The temporal and spatial differences of the marine environment endow marine life with extremely rich biological diversities. The marine biology produces a wide variety of natural products with novel structures and unique functions, providing abundant medical resources for human beings. Due to the long-term sustainable development and utilization of terrestrial biological resources, marine biological resources have become the last resources for human research and drug development. For thousands of years, people's understanding of the medicinal value of marine organisms, especially the research on modern marine drugs, has laid a solid foundation for the long-term development of marine drugs.

In the background of international marine drug research, China also witnessed a boom in the research and development of marine drugs in the late 1970s. With the efforts of several generations, the research on marine drugs has made gratifying achievements and gradually occupies a certain position in the world. Under this impetus, marine pharmacology, as a new discipline direction, develops and matures gradually in the pharmacy discipline. Many institutions of higher learning and research institutions in China have successively set up marine medicine related majors, researches or courses in order to cultivate high-level professionals for marine medicine research and development. Marine pharmacy has become a new branch of pharmacy. As a new cross-application subject, marine pharmacology involves the cross, infiltration and integration of multiple disciplines, and requires the comprehensive understanding and application of multiple knowledge[1].

II. INTRODUCTION OF POLYSACCHARIDES IN MARINE BROWN ALGAE

Marine drugs refer to drugs derived from the sea, that is, drugs developed on the basis of active ingredients in marine organisms. Among them, the traditional marine medicine of China is produced by the marine biology and minerals directly. Modern marine medicine is based on the active natural marine biological products, which are extracted, separated and synthesized. Marine natural products are characterized by novel structure and unique activeness, which are significantly different from terrestrial natural products[2]. Among the marine nature products, the marine polysaccharide research is an important direction of marine drug research and also an important part of marine pharmacology study. Brown seaweed polysaccharides were the connection point between Chinese traditional marine medicine and modern marine medicine[3]. The brown seaweed polysaccharides are made from kelp which is an important source of traditional Chinese medicine. Chinese seaweed herbs that refer to the alga bodies of *Sargasso sargassum* and *Sargassum pallidum*, could strengthen body resistance ability, soften hard lumps, and dispel nodes. Polysaccharide is an important active substance of alga. The structure of marine alga polysaccharide fully reflects the novel structure of marine natural products. There are three kinds of polysaccharides in brown alga: alginate (Fig 1), fucoidan (Fig 2) and brown alga starch (Fig 3). Alginate is a linear acidic polysaccharide containing blocks of (1,4)-linked β-D-mannonate (M) and α-L-guluronate (G) residues. The blocks are composed of consecutive G residues (GGGGGG), consecutive M residues (MMMMMM), and alternating M and G residues (GMGMGM). Guluronic acid is very rare in nature. Fucoidan refers to a type of polysaccharide which contains substantial percentages of L-fucose and sulfate ester groups with multi-branch structure. Sulfated polysaccharides, which only exist in marine plants in the plant kingdom, are important representatives of marine polysaccharides. Brown algal starch is a neutral beta glucan. The structure of the polysaccharides in the brown algae are different from each other. Alginate is a polysaccharide with uronic acid, while fucoidan is a sulfated polysaccharide, and

brown algae starch is glucan. Alginate is linear polysaccharide, while fucoidan and brown algae starch are branched polysaccharides. Thus, polysaccharides from brown algae are characteristic and different. It fully reflects the novel structure of marine natural products.

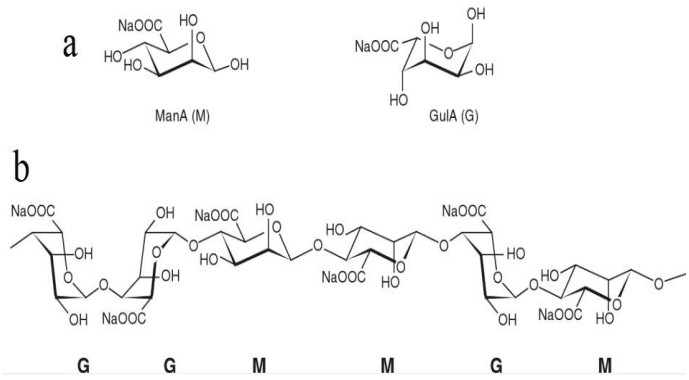

Fig. 1. The structure of alginate from the brown algae

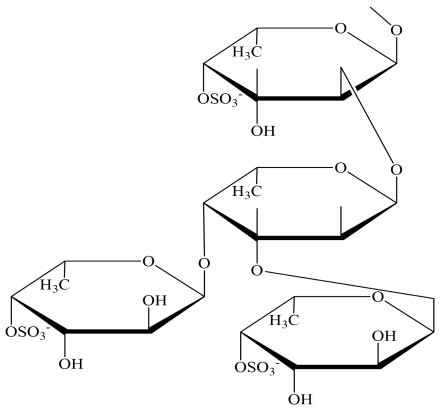

Fig. 2. The structure of fucoidan from the brown algae

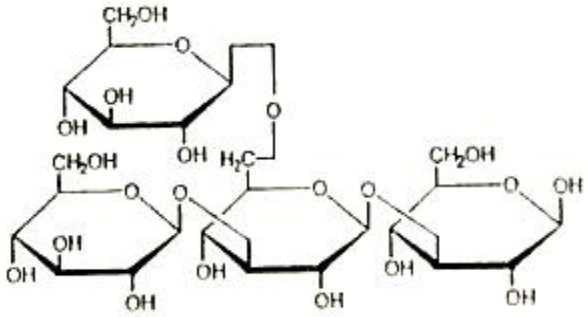

Fig. 3. The structure of starch from the brown algae

The brown seaweed polysaccharides are not only special in structure, but also unique in bioactivity. Thus, the study of brown seaweed polysaccharides involves not only natural pharmaceutical chemistry, but also knowledge of pharmaceutical analysis, pharmaceutical chemistry, pharmacology and pharmacy. Therefore, the study on the brown algae polysaccharides involves and integrates the professional knowledge of pharmacy, which could be a good chance for the students to review and master the professional knowledge[4-5].

III. The Function of Brown Algae Polysaccharides Teaching in Marine Pharmacy

The three polysaccharides of brown algae differ a lot from each other in properties, molecular weight, monosaccharide composition, pH value and ionic strength, so the they can be quickly distinguished and analyzed by infrared spectroscopy, ion chromatography and high-performance liquid chromatography after complete hydrolysis. For example, in the infrared spectroscopy, alginate has the characteristic absorbance of carboxyl groups, while fucoidan has the unique absorbance of sulfation group. The distinguish of the three polysaccharides is related the knowledge of pharmaceutical analysis.

These three polysaccharides also have rich biological activities. Alginate has the function of regulating blood lipid. Alginate sodium diester, the chemical modification product of alginate, has recently been developed into a drug for treating hyperlipidemia and has been listed in China. It could reduce whole blood relative viscosity at both high and low shear rates, decrease packed-cell volume and increase erythrocyte sedimentation. In addition, it also reduces rat erythrocyte electrophoresis time (EPT) both in vitro and in vivo, shortening platelet EPT in vivo, while prolonging that in vitro. Alginate could improve hemorheological properties, increase surface electric charge of erythrocyte and platelet. Therefore, it could inhibit adhesion and aggregation between cells and expresses its antithrombosis function. Fucoidan isolated from different species has been extensively studied due to their varied biological activities, including anticoagulant and antithrombotic, antivirus, antitumor and immunomodulatory, anti-inflammatory, blood lipids reducing, antioxidant and anticomplementary properties, activity against hepatopathy, uropathy and renalpathy, gastric protective effects and therapeutic potential in surgery. Compared with other sulfated polysaccharides, fucoidans are widely available from various kinds of cheap sources, so more and more fucoidans have been investigated in recent years to develop the drugs or functional foods, for they have anticoagulant, antiviral and other activities, and unique advantages in hypoglycemic and treatment of diabetic nephropathy and other diabetic syndromes. It is also an important raw material of marine health products. Brown algal starch has the function of enhancing immunity and anti-tumor, and it can be used as an anti-tumor drug in a preclinical study. Their different pharmacological effects are closely related to their structural differences, which is related to the knowledge of pharmacology.

Alginate is typically used in the form of a hydrogel in biomedicine, including wound healing, drug delivery and tissue engineering applications. Alginate could make mild gelation by addition of divalent cations such as Ca^{2+}. The divalent cations are believed to bind solely to guluronate blocks of the alginate chains, as the structure of the guluronate blocks allows a high degree of coordination of the divalent ions. The guluronate blocks of one polymer, then forms junctions with the guluronate blocks of adjacent polymer chains in what is termed the egg-box model of cross-linking,

resulting in a gel structure(Fig. 4). The gelation is reversible into the liquid again after removing the calcium ions,

and has good biological compatibility. Alginate is inherently non-degradable in mammals, as they lack the enzyme (i.e., alginase) which can cleave the polymer chains, but ionically cross-linked alginate gels can be dissolved by release of the divalent ions cross-linking the gel into the surrounding media due to exchange reactions with monovalent cations such as sodium ions. It has been developed into a hemostatic gauze (Fig.5) and matrix for cell implants, which has a good application prospect in medical materials. In addition, alginate could also be used as a thickener and Nano capsule-targeted materials in the field of medicament. This part is related to pharmacy and biomedicine.

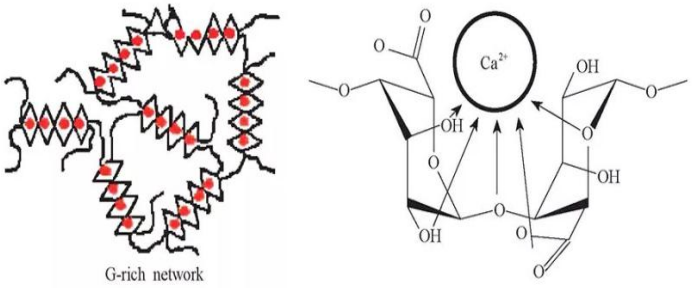

Fig. 4. The egg-box model of cross-linking and gel structure of alginate with $Ca2^{+}$

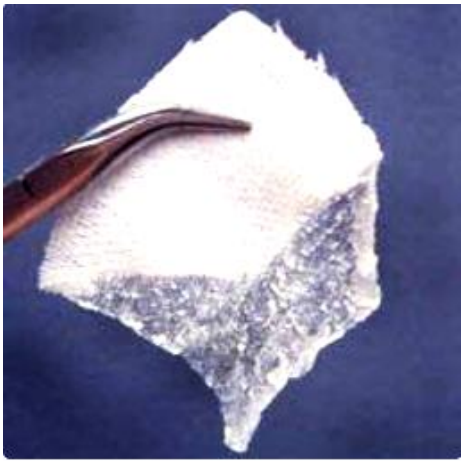

Fig. 5. Soluble hemostatic gauze made from alginate

IV. CONCLUSION

To sum up, the brown seaweed polysaccharide not only reflects the characteristics of marine drug research, but also can integrate the professional knowledge of pharmacy. Therefore, the design and description of brown algae polysaccharides related content can not only enable students to master the main content of marine pharmacology, understand the characteristics of marine drugs, but also integrate the knowledge of pharmacy.

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