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PHARMACEUTICAL APPLICATIONS OF MARINE-DERIVED POLYSACCHARIDES

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Abstract
Biological macromolecules called natural polysaccharides are made up of one or more monosaccharides joined in a chain. To create linear or branching polysaccharides, the monosaccharides can be joined in a variety of ways. Photosynthesis, a natural process that captures carbon, is followed by biosynthetic changes to produce natural polysaccharides. Both in their natural or chemically altered forms, they are widely used in industrially significant fields such as medicine and food. The food, cosmetics, textile, adhesive, paint, paper, and pharmaceutical industries all appreciate the use of natural or biopolymers as materials. There has been discussion of a wide variety of polysaccharide hydrogels for modified release dosage forms. They are now a crucial component of every drug delivery system, whether it be traditional or innovative. Swellable polymers, often known as responsive polymers or polysaccharides, are unique, highly useful carriers. When water or biological fluids are present, these polymers react by changing their shape, which permits the medicine to be released from the dosage form. Polymers offer a range of characteristics such as diffusivity, permeability and solubility that are important in controlled delivery. Natural polysaccharides have, up to now, caused a lot of interest due to their diverse uses in pharmacy such as binding, thickening, suspending, gelling, stabilizing, emulsifying, disintegrating, film formation, matrix and control release agent.
Keywords: Pharmaceutical Applications of Marine-Derived Polysaccharides

1. INTRODUCTION

Initially, human beings were afraid and awed by various forces of nature that scared him. Once he tamed fire, the process of evolution of human civilizations started. With the advent of fire, they started inventing various weapons which aided their various daily functions. The invention of wheel accelerated this process, and thus the civilizations evolved. The curiosity in human beings was the driving force behind this process and continues to be so even today [1]. When human communities developed from the primitive Stone Age to the new mechanical age through the advancement of science and technology, the life became more and more advanced and modern. However, with this advancement in life and technology, man started degrading and damaging nature for his greed and also created various climatic and other problems, which has become a threat to the new world. Time has made possible for humans to learn new and newer things, to discover new things and new inventions. They made the life more and easy [2]. Among the newer technologies, nanotechnology is on the front-line as the science of the tomorrow. Nanotechnology is leading all the research disciplines like energy, medicine, batteries, optics, magnetism etc. Nanofibres are drug carriers, optical, magnetic and electric particles, tissue engineering scaffolds, dressings for wound, filter membranes etc. Polysaccharides of natural origin have very high numbers of hydroxyl and carboxyl functional groups which provide scope for attachment of different functional groups to modify their chemical nature[10]. In recent advancements, natural polysaccharides have been modified in various ways to obtain tailor-made materials for drug delivery systems and exploring them as a substitute of current synthetic polymers or excipients. Functionalized bio-polymers have effectively ruled the era of synthetic polymers [14]. Polysaccharides can be modified or functionalized to control the interaction between the polymers and between drug and polymer, to enhance drug loading capacity, to engineer the release profile of the drug, to enhance solubility, to modify mucoadhesive or bioadhesive character etc. It is now an important field in pharmaceutical technology and drug delivery. The synthesis of novel molecules with modified physicochemical properties is essential to understanding how chemical alteration affects the structural and functional characteristics of polysaccharides[3]. There have been reports in the literature of polysaccharide oxidation, etherification, quaternization, reduction, ethylation, carboxymethylation, grafting, cross-linking, and acrylation, among other processes. But cross-linking and grafting has been the overall practice to improve the functional characteristics of the biopolymers in order to attain functional three-dimensional polymeric networks with diversified property profile than the native. Among numerous techniques reported some of them are elaborated herewith [12]. Among the several natural polysaccharides psyllium is one among the polysaccharides having such specific properties for it to serve as an efficient carrier in use in the pharmacy. Psyllium husk is also called ispaghula or isabgol husk. Among approximately 200 plants belonging to the genus, only two, i.e., P. ovata and P. psyllium, have been primarily utilized for seed husk production, a white thin membrane on the concave side of the seed[4]. The plantago psyllium is an annual herb that is grown or manufactured in Mediterranean region, South Asia and in India. Biologically, psyllium husk is cleaned, dried seed coat (epidermis) thrashed and winnowed from the seeds of Plantago ovata Forssk., family: Plantaginaceae. The husk is produced by mechanical grinding of the outer seed coat. The name Plantago is Latin, 'sole of the foot', referring to the typical form of the leaf. Isabgol is derived from two Farsi words, 'Isap' and 'ghol,' both meaning 'horse-ear' because it has boat-like seeds.

2. REVIEW OF LITERATURE

Polysaccharides are a group of macromolecules and exist in several forms naturally, including in plants, animals, and bacteria. Some of the most prevalent polysaccharides are cellulose, starch, glycogen, and chitin. Cellulose is the main structural molecule of plant cell walls, while starch and glycogen are energy storage molecules in plants and animals, respectively [5]. Chitin is found in arthropod exoskeletons and also in certain medical applications, e.g., wound dressings. Polysaccharides play a variety of roles in biological systems, including energy storage, structural support, and cell signalling. Some polysaccharides, such as dietary fibre, are essential to human health[6]. They can assist in digestion, lower cholesterol levels, and guard against some diseases such as diabetes and heart disease. Polysaccharides like fibres coir, jute, cotton, sisal, banana fibres are used to create composite systems with synthetic polymers to enhance their thermo-physical properties [15]. Polysaccharides may be chemically transformed to form novel materials possessing unusual properties. Thus, for example, the chemistry of the biodegradable plastics and other biocompatible materials is an active area of interest in the realm of polysaccharide science. They are also used generally to prepare hydrogels and nanofibres for a variety of biomedical applications [13].

3. MATERIALS AND METHODS

Chemical composition of seaweed is variable with species, environment, maturity, salinity, temperature, intensity of light, tidal fluctuation and other external conditions. Global use of macroalgae by cultivation of edible species or by the manufacture of agar, carrageenan and alginate is a multibillion-dollar industry. Chemically, brominated phenols, oxygen heterocyclics, nitrogen heterocyclics, sulfur nitrogen heterocyclics, sterols, terpenoids, polysaccharides, peptides, and proteins are among the bioactive metabolites of marine algae. Animals, algae, microorganisms (fungi and bacteria), and plants all contain large amounts of polysaccharides[7]. They are vital biomacromolecules in life processes, along with proteins and polynucleotides, and are crucial for immune system molecular recognition, cell adhesion, and cell-to-cell communication[8]. The structurally varied class of macromolecules known as polysaccharides is found in nature in rather large quantities. They are composed of repeating structural elements, which are polymers of monosaccharide residues joined by glycosidic bonds, in contrast to proteins and nucleic acids[9]. Since polysaccharides can have the largest structural variation among the various macromolecules, they have the most ability to transmit biological information. There are also claims that while the monosaccharide residues of oligosaccharides and polysaccharides can join at different locations to generate a wide variety of branched or linear structures, the nucleotides of nucleic acids and amino acids of proteins can only link in one way. [11].

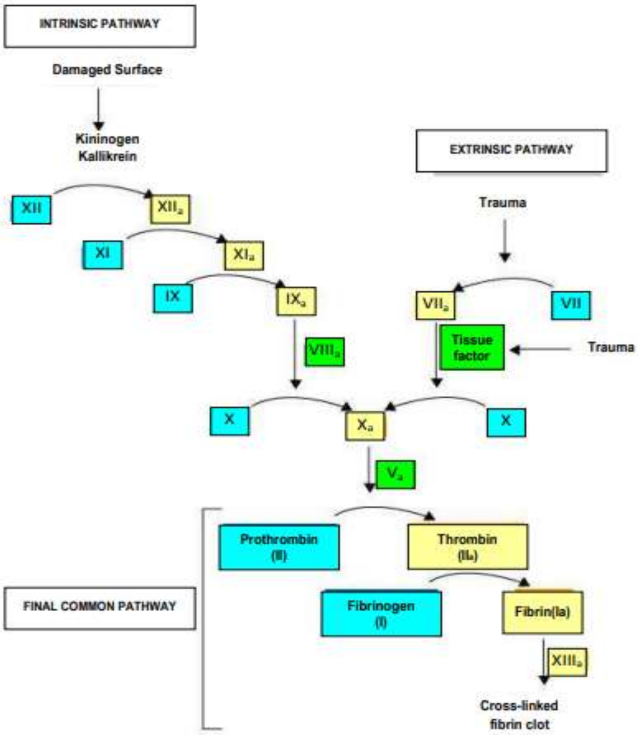

Figure 1: Working principle

Sulphated polysaccharides are heteropolysaccharides that are polydisperse, in which some or all of the hydroxyl groups of the sugar residue are substituted with half ester sulphate groups. Marine algae are the main source of nonanimal SPs, and the chemical structure of the polymers is based on the species of algae. This is odd because sulphated polysaccharides are found in marine algae but lacking in higher plants. Every kind of seaweed contains some kind of sulphated polysaccharide. The main processes of development, cell differentiation, adhesion, signalling, and matrix interactions are all impacted by sulphated polysaccharides, which can bind with proteins at varied levels of specificity. These bioactive compounds have a wide range of potential uses in medicine, pharmacology, and biotechnology, including wound dressings, biomaterials, scaffolds for 3D culture, tissue regeneration, and even medications. A new, contemporary age of study into the phenomenon of carbohydrate-mediated recognition, known as glycobiology, has begun with the identification of the biological significance of mammalian glycoconjugates. In marine eukaryotes or prokaryotes, sulphated polysaccharides display biological activity similar to those of glycosaminoglycans. Important physicochemical characteristics of polysaccharides that are correlated with their biological activity are their molecular weight and structure. Because seaweed polysaccharides differ greatly in their molecular weights, structural characteristics, and physiological attributes, they exhibit a variety of bioactivities, including anticoagulant, antioxidant, anti-inflammatory, and antitumor activity.

4. RESULT AND DISCUSSION

Natural products and their respective synthetic analogues or mimics are used in the cure of about 87% of all categorized human ailments and finding new agents is routinely utilized in unravelling targets and paths in disease procedures. Natural products-derived drugs are harvested from broad sources that move from terrestrial crops to terrestrial microorganisms, through marine floras, to terrestrial vertebrates and invertebrates (Newman et al., 2000).

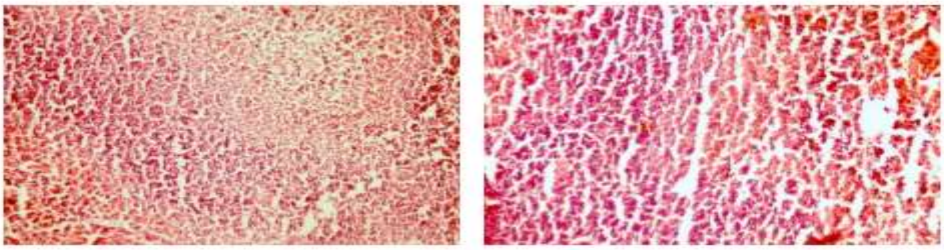

Figure 2: Effect of polysaccharide on liver toxicity

The ocean, which makes up over 71% of the planet's surface, is a large repository of biodiversity, with microflora and microalgae accounting for over 90% of marine biomass (Kathiresan and Duraisamy, 2005). The potential for developing novel medications is enormous given the abundance of oceanic flowers. It's becoming more widely acknowledged that the ocean is home to a vast array of natural products and novel chemical compounds with distinctive biological activities that may be useful in discovering possible medications with higher specificity and efficacy for the treatment of human illnesses (Haefner, 2003). Polyunsaturated fatty acids (PUFA), polysaccharides, vital minerals and vitamins, antioxidants, enzymes, and bioactive peptides are among the functional components found in the marine environment.

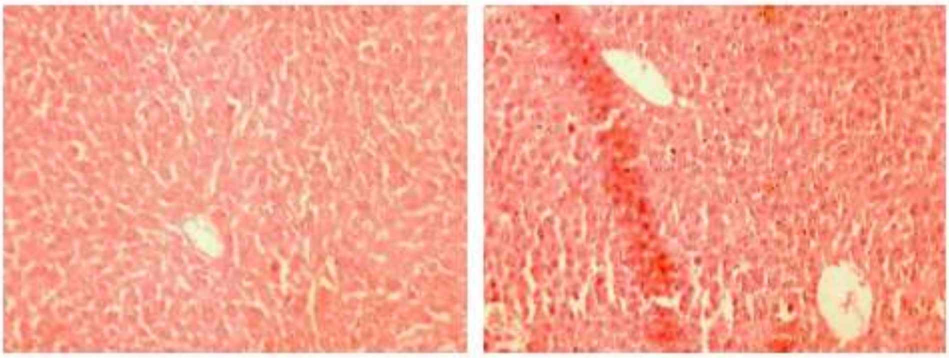

Figure 3: Effect of polysaccharide on spleen toxicity

Marine algae are a storehouse of bioactive substances with a variety of biological activities and complex structures among marine animals. Scientists have discovered that chemicals derived from marine algae exhibit a variety of biological actions, and their significance as a source of novel bioactive molecules has recently increased dramatically.

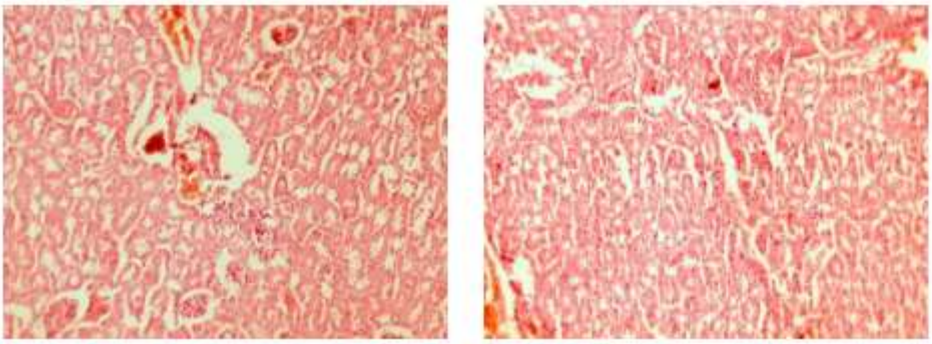

Figure 4: Effect of polysaccharide on kidney toxicity

The antithrombotic activity of polysaccharide in rats was examined by stasis induced venous thrombosis. Stasis was induced by ligation of a 1cm segment of inferior vena cava as shown in Plate V-2. Thrombus was induced and the resulting thrombus was isolated and weighed.

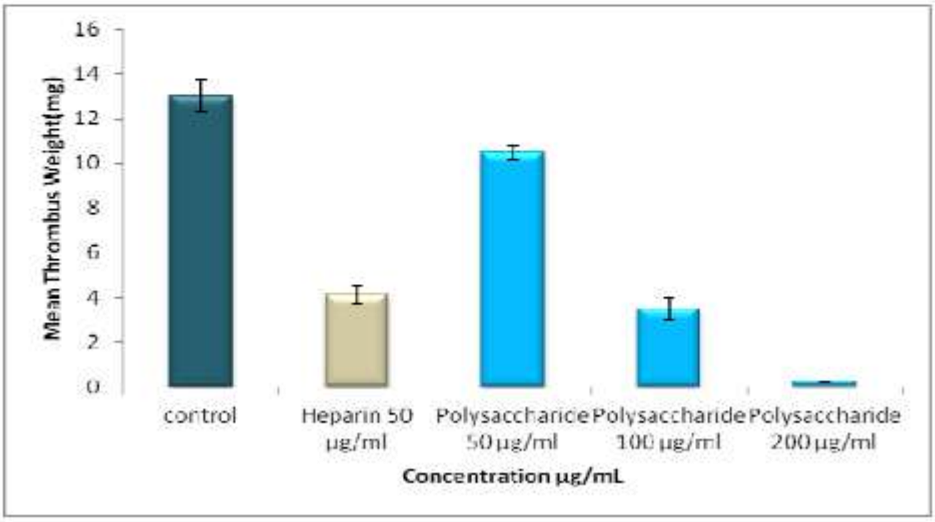

Figure 5: Effect of polysaccharide on mean thrombus weight

In this test to establish the toxic effect of polysaccharides, acute death did not occur in Wistar rats weighing 160 g average. No change in weight when compared with control rats was noticed. Polysaccharide administered as much as 1000 mg/kg body weight was not toxic to animals. The field of haematotoxicology includes the study of the toxicant's harmful effect on mature blood cells but any haematological toxicity was observed in rats after administration of polysaccharide.

5. CONCLUSION

Sulphated polysaccharides have been found to be generally endowed with anticoagulant activity. Seaweed polysaccharides play the coagulation-modulating function at times to serve as heparin substitutes, an anticoagulant drug used as medication. The coagulation cascade was long presumed to possess two distinct sites of initiation known as the extrinsic and intrinsic pathways and the anticoagulants are known to be inhibiting one or both of the pathways. Its anticoagulant activity is brought about by its distinct polyanionic character. Heparin's anticoagulant mechanism and antithrombotic action are both mediated by the action of plasma cofactors of specific nature, namely antithrombin and heparin cofactor. There has to be a distinct pattern of sugar composition and of sulfation so that it triggers a conformational activation of the antithrombin. Heparin has another anticoagulant effect due to bridging the protease and the antithrombin molecules. This action is characterized by the volume and mass of the heparin structure.

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