Research Papers

BIOPOLYMERS: THE SUSTAINABLE AND RENEWABLE TOOL

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ABSTRACT :
Biopolymers are sustainable, carbon neutral and are renewable since they are obtained from the plant materials which grow indefinitely. 'Advance medical biopolymers' belong to the class of such polymers which finds several applications in the field of medicine. Since these biopolymers can be degraded by natural processes, micro-organisms and enzymes to the end products which can be resorbed in the environment, they provide an environmental friendly and sustainable source. Biopolymers are being widely used to develop biopolymer-based biomaterials in fields such as orthopaedics, cardiology, and general surgery. However, the use of biopolymers in the medical field is relatively new and is an emerging area of research. This short review provides a brief outline of the work in the area of biopolymers, application of these materials, and scope of work in future.

KEYWORDS: *biopolymer, alginate, chitosan, collagen, hydrocolloid, wound dressing, wound healing*

1. INTRODUCTION

Since last several years, fossil fuels such as oil have been the primary source in industries for development and manufacturing of polymers/ plastics. Fossil fuels are non renewable source of energy and an ever increasing demand and dependency on such sourcesare a cause of concern today. Moreover, the use of fossil fuels for energy and industrial productions raises environmental concerns. The employment of biopolymers which are obtained from sustainable source will not only help in addressing the issue of environment degradation but will also decrease the dependency on petrochemicals which are obtained from fossil fuels. In recent years research and development of biopolymers have gained attention and are being used as an alternative to traditional plastics in several applications [1,2].

Biopolymers often have a well defined structure and are made of repetitive units called monomers. The exact chemical composition and the sequence in which these units are arranged are called the primary structure, as in the case of proteins. Biopolymers are Non-toxic, Non-carcinogenic, Non-immunogenic, Non-thrombogenic and carbon neutral in nature. All these properties of biopolymer make them suitable for medical applications. Besides, the renewable and sustainable nature of them has attracted the world and tremendous efforts have been put towards the development and applications of biopolymers against the synthetic polymers [3-6]. The various applications of biopolymers ranging from our day to day activities to specialised fields such as that of medicine are being in use today.

2. BIO-POLYMERS FOR MEDICAL APPLICATIONS

Biopolymers have wide spread applications in the field of medicine[7-9]. These applications can be broadlyclassified into three categories:-

- Application in drug delivery systems
- Application for wound closure
- Applications as healing products, and surgical implant devices

In this paper, we have presented a short review of key biopolymers which are widely used for medical applications:

2.1 Chitosan

Chitosan is a β-1,4-linked polymer of glucosamine (2-amino-2-deoxy-β-D-glucose) and*N*-acetylglucosamine. It is a derivative of chitin (poly-*N*-acetylglucosamine), which is the second most abundant biopolymer after cellulose[7] .Chitin is the structural element in the exoskeleton of crustaceans such as crabs and shrimp and cell walls of fungi. Structurally, Chitosan is identical to celluloseexcept at C-2 positions where it has acetamide groups (-$NHCOCH_3$).Chitosan is the principle derivative of chitin. It is a linear polymer of α (1→4)-linked 2-amino-2-deoxy-β-D-glucopyranose and is easily obtained by N-deacetylation [10-12].

Chitosin is a natural biopolymer, which is very useful for wound management because of its hemostatic properties. When applied on wound, it accelerates bone formation and regenarate connective gum tissues.

Chitosin is biodegradable and biocompatible in nature that makes it suitable for its application in formulation of a particular drug delivery systems. Besides, the non-toxic and anti bacterial characterstics of chitosin help in its use as a drug carrier in various possible routes of administration.Chitosan has also been used for specific drug delevery systems.The inter- and intra-molecular hydrogen bonding and the cationic charge in acidic medium in Chitosan supplements its use in conventional and novel pharmaceutical product. Another important application of Chitosan is its use for controlled-release matrix, with desirable properties, such as muco-adhesion and permeation enhancement. These properties improve oral bioavailability of drug.

The use of local drug delivery systems can minimise the effect of systematic toxicity which occurs because of whole body dosing. There gave been many studies which suggest that Chitosan can act as a delivery vehicle for antimicrobial drugs, particularly for the compromised wound sites that can prevent the reach of systemic antibiotics to the infected tissue. Chitosan is a versatile drug delivery vehicle that can enhance antimicrobialand wound-healing effects [13].

Commercially, Chitosan is produced by deacetylation of chitin using excess of sodium hydroxide as reagent in water. The process is very effective as it gives yields upto 98%.. The degree of acetylation in commercial productions is in the range of 60 to 100%.

2.2 Alignate Fibres

“Alginate" term is usually used for alganic acid, the salts of alginic acid and all the derivatives of alginic acid. Alginate is present in the cell walls of brown algae as the calcium, magnesium and sodium salts of alginic acid. It is then extracted using different processes to obtain dry, powdered, sodium alginate.

The widely used process to obtain sodium alginate involves conversion of insoluble alginate salts into soluble sodium alginate. It is then precipitated either as alginic acid or calcium alginate. The products so obtained are in turn treated to get sodium alginate.

Chemically, alginate is a polymeric acid composed of two monomer units, namely, L-guluronic acid and D- Mannuronic acid.

Alginate is a natural polymer with a unique gel forming characteristics which makes it an important material in wound dressing. The alginate fibres are widely used for manufacturing modern dressing materials, and are suitable for use on- and highly-draining partial and full thickness wounds. Because of their high absorbency, they are the ideal primary dressing for infected wounds. Thet also find applications in dressing of surgical wounds, burns, and ulcers [14].

2.3 Collagen Fibres

Collagen is a natural product.The Collagen, also called as 'tropocollagen' is part of larger aggregates such as fibrils. When used for wound healing, Collagen fibres serve to guide fibroblast which migrates along with connective tissue matrix. Moreover, the large surface area available on fibres attracts fibrogenic cells which help in healing. Collagen can also act as a nucleating agent for the formation of fibrillar structures. The of Collagen make it effective for wound dressing applications [4].

The excellent biocompatibility of Collagen and hemostatic properties makes it a popular component in artificial tissues and wound dressings. Collagen is also used as an absorbable suture material.

Collagenconsists of three polypeptide strandscalled alpha chains, with each of them having a conformationof left-handed helix. These three left-handed helices are twisted together into a right-handed coiled coil, forming a triple helix or"Super helix" which is stabilized by numerous hydrogen bonds. Collagen contains specific amino acids – Glycine, Proline, Hydroxyproline and Arginine. These amino acids have a regular arrangement in each of the three chains of collagen subunits. The sequence often follows the pattern Gly-Pro-X or Gly-X-Hyp, where X may be any of various other amino acid residues. Collagens do not contain chemically reactive side groups.

2.4 Hydrocolloids

Hydrocolloid dressings are made from a layer of gel-formingmaterial supported on a semi-permeable film or foam backing. The combination of absorbent materials such as sodiumcarboxymethylcellulose, pectin and gelatine forms an adhesive matrix in the gel layer.

Hydrocolloid dressings are available in a variety of shapes, sizesand thicknesses. Accordingly, they have different fluid handling properties. Also, they possess other key properties which provide barrier to microorganism, release of pain, and facilitate the autolytic debridement. Many of the more recently available hydrocolloid dressings,including some thicker products, combine tapered edges and asmooth backing surface. Variations in the backing materials may alter the 'slipperiness' ofthe dressing. The 'slipperiness' assist in reducing friction or shear to the underlying skin to protect it againt further damage.

Hydrocolloid dressings can be used on a wide variety of wound types, such as ulcers (stages 1 and 2), surgical wounds, Abrasions, Minor burns etc [15]. The advantages of using hydrocolloid dressings are as follows

1) The dressings create a moist wound environment that is known to be beneficial to wound healing.
2) The dressings are adhesive and waterproof;they can also be used as secondary dressings to preventother dressings from becoming contaminated.
3) The dressings act as viral and bacterialbarrier and are useful in areas such as the sacrum that are regularlysubjected to heavy contamination.
4) Hydrocolloid dressings can cope with different volumes of exudates.

The Hydrocolloids can also be used in granulating wounds and drier wounds. They are found to be extremely useful in all the types of wound dressings.

3. CONCLUSIONS

Biopolymers are eco friendly substitutes for traditional plastics. They are renewable resources and are carbon-neutral. They help in reducing the amount of toxic or allergic products released in the environment. The use of biopolymers helps in reduction of waste generated because of their peculiar properties. The usage of biopolymers will facilitate conservation of depletable petrochemical resources.

The usage of biopolymers in medical and several other fields with advancement and modifications is a viable option in future [16-22]. For example, the Chitosan salts can be mixed with other materials to make them more absorbent or to vary the rate of their solubility and bioabsorbability. Hydrocolloids can be blended with collagen and as used as fat replacers thus reducing fats in body and making the skin younger looking.Natural collagens can be assimilated with other proteins and biomolecules and these combinations can be tuned to treat diseases.Adhesive bandages covered by woven fabric, plastic or latex rubber can be replaced by non-adherent biopolymer made from alginate.

4. REFERENCES

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