A STUDY OVER BIO POLYMERS

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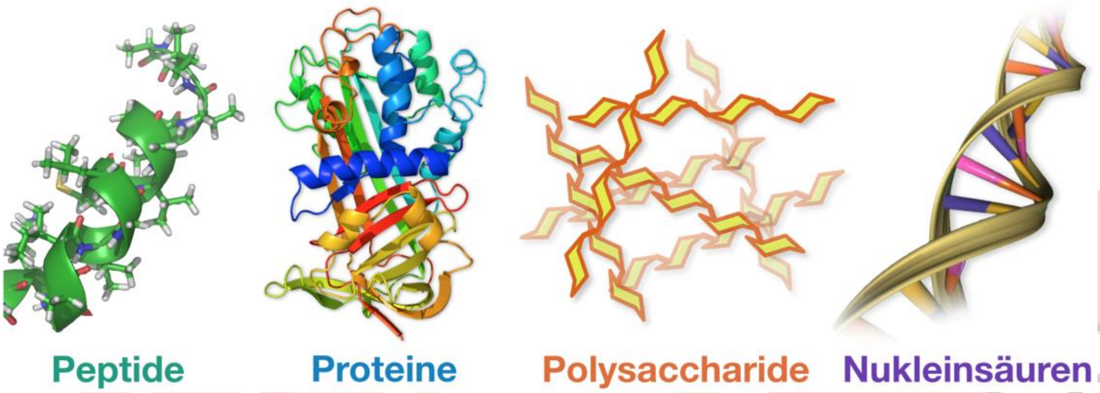
Abstract : The future of fiber technology for medical application depends largely on the future needs of our civilization. The use of new polymers for medical textile application has increased rapidly over the past quarter of century. The polymers are excellent candidates for applications in the medical field because of their versatility, biocompatibility, bio absorbability and absence of cytotoxicity. New polymer encompasses practically every facet of modern civilization. In fact along with other medical hi-technology streams like bio-technology, this technology will also be one of the major propellants for developments. Today emerging polymer includes new capability polymers such as alginate, chitin chitosan, collagen, hydro gels, hydrocolloids, superabsorbent polymers and such others.

***IndexTerms* - fiber,cytotoxicity,chitosan,hydrocolloids,polymer.**

I. Introduction: - Bio polymers are the polymers produced by living organisms. So in other words they are polymeric biomolecules. The biopolymers can be obtained naturally. The word 'bio' means they can be obtained from living organisms. Since they are polymers, they have long chain containing same repeating monomeric units covalently bonded to form larger structures.



II. CHARACTERISTICS: - Bio polymers may have the following characteristics: -

- Bio polymers can control life processes of living organisms and are environmentally friendly.
- Bio polymers are decomposed by the processes named –oxidation (mainly reaction with oxygen), hydrolysis (decomposition by water) or by some enzymes.
- Those are renewable polymers as we get them from plants.
- Some of them are compostable and can show some chemical properties in their surface.
- Bio polymers like polylactic acid, polyglycolate , poly 3-hydroxy butyrate etc. may show plastic properties and instead of plastic those can be used.

III. TYPES: The bio polymers can be classified into three types based on their monomer units from which they are formed. Those are as follows:-
(a) **Sugar based bio polymers**— Those consist of sugar (saccharide as a basic material). As the monomeric unit is saccharide so this is known as polysaccharide. Those are of two types:-
III.1 **Starch based bio polymers**: -- Starch is a kind of natural bio polymer and hence can be obtained from grains like wheat, maize, plant tissues, potato etc. in large quantities. Starch is made of saccharide units (alpha glucose) joined by glycosidic linkage either in linear (amylase) or branched (amylopectin) structure. Starch is modified and developed industrially so that it can be deformed or melted thermoplastically. Thermoplastic starch materials are soluble in water, although those can sustain only a brief contact with water and can act as oxygen barrier.

III.2 Cellulose: Cellulose is the most common organic compound and biopolymer on earth. About 33% of all plant matter is cellulose. Cellulose was discovered by French chemist Anselme Payen. Wood contains almost 45-50% and cotton fibre and cotton fibre contains almost 90% cellulose and from those cellulose is obtained industrially. Rayon, cellophane, paper board are made from cellulose. It is used in paper industry as wet resistance and to increase strength of papers. For packaging of cigarettes and CDS cellulose is used.

III.3 Amino acid based biopolymers:-Amino acids are joined together by peptide linkage to form proteins. Proteins are polypeptides which are formed by peptide linkage between the adjacent carboxyl and amino acid. Those bio molecules are applied in protein purification, controlled drug delivery, tissue engineering etc.

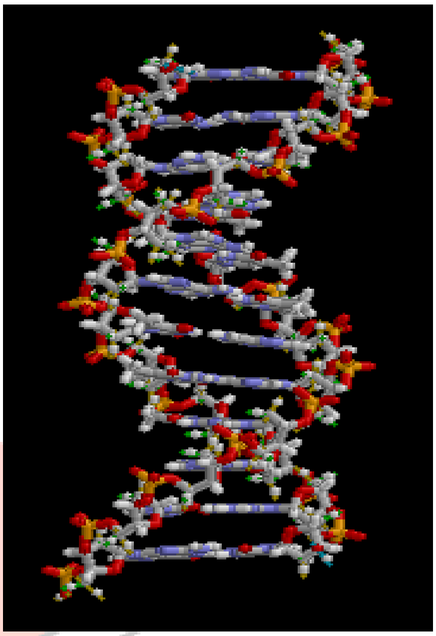
III.4 Nucleic acids:-Nucleic acid was discovered by Friedrich Miescher in 1869.In living organisms they do the functions of encoding, transmitting and expressing genetic information-the information is conveyed through the nucleic acid sequence. The building material of nucleic acid is nucleotides. Polynucleotides are derived from phosphoric acid and sugars. Those are of two types:-

Deoxyribonucleic acid (DNA):-DNA has double stranded helical structure. This consists of two long polymers of nucleotides which is made up of sugars and phosphate group joined together by ester linkage.

IV. Features of the 5'- Structure

- Alternating backbone of deoxyribose and phosphodiester groups
- Chain has a direction (known as polarity), 5'- to 3'- from top to bottom
- Oxygens (red atoms) of phosphates are polar and negatively charged
- A, G, C, and T bases can extend away from chain, and stack atop each other
- Bases are hydrophobic

V. Use s of DNA:-



1)Forensic scientists can use DNA in blood, semen, skin, saliva or hair found at a crime scene to identify a matching DNA of an individual, such as a perpetrator.
2) Bioinformatics involves the manipulation, searching, and data mining of biological data, and this includes DNA sequence data.

VI. RNA:- Ribonucleic acid (**RNA**) is a polymeric molecule implicated in various biological roles in coding, decoding, regulation, and expression of genes. RNA and DNA are nucleic acids, and, along with proteins and carbohydrates, constitute the three major macromolecules essential for all known forms of life. Like DNA, RNA is assembled as a chain of nucleotides, but unlike DNA it is more often found in nature as a single-strand folded unto itself, rather than a paired double-strand. Cellular organisms use messenger RNA (mRNA) to convey genetic information (using the letters G, U, A, and C to denote the nitrogenous bases guanine, adenine, uracil and cytosine) that directs synthesis of specific proteins. Many viruses encode their genetic information using an RNA genome.

VI.1 Functions of RNA:-

1) RNA acts as a messenger between DNA and the protein synthesis complexes known as ribosomes, forms vital portions of ribosomes, and acts as an essential carrier molecule for amino acids to be used in protein synthesis.
2) RNA serves as the template for translation of genes into proteins, transferring amino acids to the ribosome to form proteorins, and also translating the transcript into proteins.

VII. Difference between Polymer and Biopolymer

Biopolymers and bioplastics are often confused for one another. However, these are different materials. Biopolymers are polymers that can be found in manufactured by, living organisms. These also involve polymers that are obtained from renewable resources that can be used to manufacture bioplastics by polymerization.

Bioplastics are the plastics those are created by using biodegradable polymers. A bioplastic car was created by the automobile manufacturer Henry Ford in the 20th century using sections from soybeans back. The bioplastic car production was stopped in the beginning of Second World War. Recently, due to improve of biotechnology, the bioplastic cars have made a good comeback.

VIII. Use of biopolymers in medical field

Introduction:-

The use of natural polymers in medical applications spans to ancient times. These polymers offered a bioactive matrix for design of more biocompatible and intelligent materials. Oligosaccharides and polysaccharides are biopolymers commonly found in living organisms, and are known to reveal the physiological functions by forming a specific conformation. In recent years in identifying the biological functions of polysaccharides as related to potential biomedical applications natural polymers or they might be poly anionic consisting of only one type of monosaccharide types. They can be linear or branched and they might be substituted with different types of organic groups, such as methyl and acetyl groups. Other types of polysaccharides isolated from plants used in the traditional medicine were identified as having their biological active sites in the complementary systems. Virtually new polymers coming but also well known materials with significantly improved properties using advanced technologies and new methods are in the centre of research which is high technical, technological, functional and effective oriented. The key qualities of polymers and dressings as health care products include that they are bacteriostic, ant-viral, fungi static, non-toxic, high absorbent, non-allergic, breathable, haemostatic, and biocompatible and manepulatable to incorporate medications, also provide reasonable mechanical properties. Many advantages over traditional materials have products modified or blend with also based on alginate, chitin/chitosan, collagen, branan ferulate polymers. Wound care also applied to materials like hydro gels, matrix, films, hydrocollids, foams, specialized additives with special functions can be introduced in advanced health care with aim to absorb odors, provide strong antibacterial properties, smooth pain and relive irritation. Because of unique properties as high surface area to volume ratio, film thickness, nano scale fiber diameter, porosity, light weight, nanofibers are used in health care.

Table 2.Biopolymers in medical applications

APPLICATION	POLYMERS
Wound care	polyethylene glycol and agar , Xanthan, methyl cellulose, carboxymethyl cellulose, alginate, hyaluronan and other hydrocolloids
Drug delivery, pharmaceutical	starch, poly(vinylpyrrolidone), poly(acrylic acid) , chitosan, acrylic acid,
Dental Materials	Hydrocolloids
Tissue engineering, implants	Hyaluronan, collagen
Injectable polymeric system	polypeptides, chitosan
Technical products (cosmetic, pharmaceutical)	gum Arabic, xanthan, pectin, carrageenan, gellan, welan, guar gum, locust ,bean gum, alginate, starch, heparin, chitin and chitosan
Skin derivatives	Highly purified bovine collagen Formaline fixed skin
hemostasis	Fibrin sealant and foam, chitosan and poly (Nacetyl glucosamine) gels, Chitosan adhesives,
suture	Collagen, catgut, branan ferulate

IX. Sodium Alginate Biopolymer

Alginate was first produced from seaweed in 1940. It is a product of a neutralizing reaction between Alginic acid and caustic soda. It is non-flammable. When combined with other fibres, it takes on a sheer appearance. The raw material for the production of calcium alginate fibres is Alginic acid, a compound that is obtained from the marine brown algae. The first scientific reports on the extraction of alginates from brown algae were presented towards the close of the nineteenth century by the chemist E.C. Stanford. He observed that alginates posses a variety of properties, including the ability to stabilize viscous suspensions, to form film layers, and to turn into gels. Chemically, alginate is a polymeric acid, composed of two monomer units

(i) L-guluronicacid(G)

(ii) D- mannuronic acid (M)

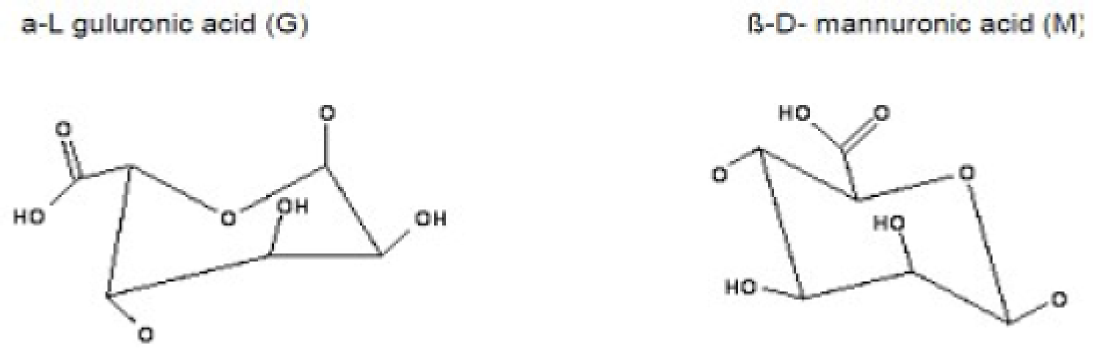


Fig.1. Chemical Structure for Alginic acid

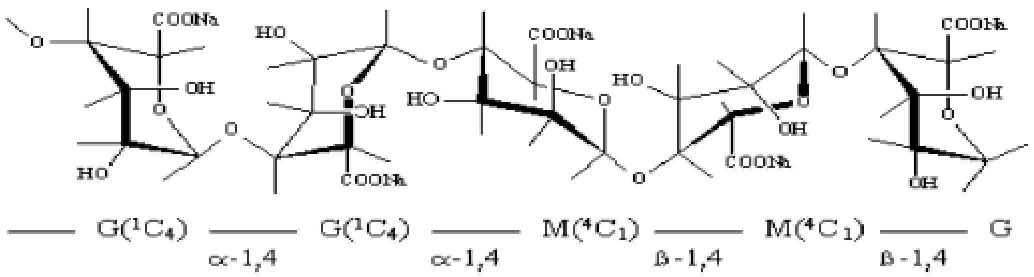


Fig. 2.Chemical structure for sodium salt of alginic acid

X. Properties

- Good surface detail
- Reaction is faster at higher temperatures
- Elastic enough to be drawn over the undercuts, but tears over the deep undercuts
- Not dimensionally stable on storing due to evaporation
- Non toxic and non irritant
- Transport excess exudates away from the wound surface

- Be self adhesive to provide mechanical and microbial protection
- Be anti-microbial (e.g. silver)
- Enable tissue cleansing and scar reduction
- Be fibre free

XI. Applications :-

- Uses of calcium alginate are:
- Used in plant tissue culture to produce insoluble artificial seeds
- Used for immobilizing enzyme by entrapment
- Used to produce an edible substance
- Used incorporated into wound dressings

XII. Biopolymeric Nanomaterials

Biopolymer nanomaterials also have a wide number of applications in the food systems particularly to extend the shelf life of foods. A very common example of biopolymeric compounds is polylactic acid (PLA), which is a synthetic food-grade biopolymer that has the potential to deliver functional ingredients in food systems (Weiss et al., 2006). Some other commonly used synthetic biopolymers include polyethylene glycol and polylactic-co-glycolic acid (PLGA) that also have wide applications in the regulation of proper delivery of added ingredients through biological systems (Gupta and Gupta, 2005). Antimicrobial potential of phenolic compounds is seen to be enhanced with the use of PLGA nanoparticles containing delivery systems in raw and processed chicken. Researchers revealed that phenolics like benzoic and vanillic acids were found to be very effective at lower concentrations to inhibit the growth of pathogenic microorganisms like *Salmonella typhimurium, Escherichia coli* O157:H7, and *Listeria monocytogenes* when embalmed in polylactic glycolic acid nanomaterials (Ravichandran et al., 2011). Contrarily, chitosan has been claimed as a best alternative for synthetic biopolymers for the encapsulation of functional ingredients (Weiss et al., 2006). Accordingly, in a work conducted by Abdou et al. (2012), chitosan nanoparticles having antimicrobial potential were deployed in fish coatings and a significant control in the growth of microorganisms was recorded in comparison with the uncoated fish fingers as well as those coated with commercial edible films, proposing a potential shelf life extension of fish fillets. Investigation of the rheological properties also showed that pseudoplastic coatings were used for all chitosan concentrations (Abdou et al., 2012).
Several protein- and carbohydrate-based biopolymers have also shown their potential to generate nanoparticles (Chang and Chen, 2005; Gupta and Gupta, 2005; Ritzoulis et al., 2005). Utilizing aggregative associations, a single biopolymer can be distributed into various small nanoparticles. Functional components are encapsulated by using nanoparticles and are released under particular environmental triggers.
Polylactic acid is the most common part of biodegradable biopolymeric nanoparticles. It is widely available and used as delivery systems for a number of functional ingredients such as proteins, laminations, vaccines, and pharmaceutics. It is immediately expelled from the circulatory system, staying segregated in the liver and kidneys. Because its function as a nanoparticle is to deliver functional ingredients to the body, polylactic acid needs a cooperative compound, for example, polyethylene glycol to be effective in such cases (Riley et al., 1999)

XIII. Environmental impacts

Biopolymers can be sustainable, carbon neutral and are always renewable, because they are made from plant materials which can be grown indefinitely. These plant materials come from agricultural non food crops. Therefore, the use of biopolymers would create a sustainable industry. In contrast, the feedstocks for polymers derived from petrochemicals will eventually deplete. In addition, biopolymers have the potential to cut carbon emissions and reduce CO_2 quantities in the atmosphere: this is because the CO_2 released when they degrade can be reabsorbed by crops grown to replace them: this makes them close to carbon neutral.
Biopolymers are biodegradable, and some are also compostable. Some biopolymers are biodegradable: they are broken down into CO_2 and water by microorganisms. Some of these biodegradable biopolymers are compostable: they can be put into an industrial composting process and will break down by 90% within six months. Biopolymers that do this can be marked with a 'compostable' symbol, under European Standard EN 13432 (2000). Packaging marked with this symbol can be put into industrial composting processes and will break down within six months or less. An example of a compostable polymer is PLA film under 20μm thick: films which are thicker than that do not qualify as compostable, even though they are biodegradable. In Europe there is a home composting standard and associated logo that enables consumers to identify and dispose of packaging in their compost heap.

XIV. Biopolymer Environmental Benefits

Some of the environmental benefits of this polymer are:

- These polymers are carbon neutral and can always be renewed. These are sustainable as they are composed of living materials.
- These polymers can reduce carbon dioxide levels in the atmosphere and also decrease carbon emissions. This happens because bio-degradation of these chemical compounds can release carbon dioxide that can be reabsorbed by crops grown as a substitute in their place.
- It is also compostable which means there is less chance of environmental pollution from this compound. This is one of the primary advantages of this chemical compound. However, the materials composed from this compound are not compostable.
- These chemical compounds reduce dependency on non-renewable fossil fuels. These are easily biodegradable and can decrease air pollution. It greatly reduces the harmful effect of plastic use on the environment. Long term use of biopolymer use will limit the use of fossil fuel.

XV. Effect of biopolymers

Biopolymers may affect taste perception in several ways:

•The use of biopolymers may decrease the efficiency of mixing of a liquid or gelled food with saliva, which general decreases the taste perception.

•The thickener may have a taste effect itself.

•Biopolymers may bind taste molecules, which result in decreased perceptions. For example, sodium ions can bind to oppositely charged biopolymers. Rosett *et al.* (1994, 1996) found that saltiness in chicken broths was suppressed by the use of 0.3% (w/w) xanthan gum. This was explained by ^{23}Na nuclear magnetic resonance (NMR) spectroscopy, which showed ionic binding of sodium ions to xanthan. Binding of sapid components to biopolymers might also be used to decrease off-tastes of healthy ingredients; e.g. tea and olive oil phenolics were less bitter in the presence of proteins (Haslam, 1998; Pripp *et al.*, 2004). Katsuragi *et al.* (1995) found that bitter tastes could be masked by lipoproteins. They suggested binding of the hydrophobic region to the receptor membrane, but an alternative mechanism could be complexation of the bitter molecules with the lipoproteins.

XVI. Future trends

Biopolymer films have been regarded as potential replacements for synthetic films in food packaging applications in respond to a strong marketing trend towards more environmentally friendly materials. However, hydrophilicity is a central limitation that needs to be overcome in order to allow such replacement. To date, most methods of increasing the water barrier ability of biopolymer films depend on the addition of waxes, fatty acids, and lipids. Plasma treatments on synthetic film surfaces have achieved a significant improvement of their surface energy, and thus it should be worth trying them on the surface of biopolymerfilms to reduce water permeability.

A greater interest in understanding the surface properties of biopolymer films is expected within the next few years. This may be the key to solve the fundamental issue of excessive hydrophilicity, which would allow full-scale commercial utilization of biodegradable films as food packaging materials.

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