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POTENTIAL USE OF BIO POLYMERS

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INTRODUCTION:

Biopolymers are polymers produced by living organisms; in other words, they are polymeric biomolecules. Since they are polymers, biopolymers contain monomeric units that are covalently bonded to form larger structures. There are three main classes of biopolymers, classified according to the monomeric units used and the structure of the biopolymer formed: polynucleotides (RNA and DNA), which are long polymers composed of 13 or more nucleotide monomers; polypeptides, which are short polymers of amino acids; and polysaccharides, which are often linear bonded polymeric carbohydrate structures.

POTENTIAL USE OF BIOPOLYMERS:

Biopolymers, due to its biocompatible and biodegradable nature, can be used to improve the performances of other biologically active molecules in a product. They can also be modified to suite various potential applications which include the following.

BIOMEDICAL APPLICATIONS:

In recent years, biopolymer materials have aroused great interest because of their biomedical applications, such as those in tissue engineering, pharmaceutical carriers, and medical devices. A common biopolymer, gelatin, was widely applied in medicine for dressing wounds, as an adhesive, and so on. Porous gelatin scaffolds and films were produced with the help of solvents or gases as simple porogens, which enable the scaffolds to hold drug or nutrients to be supplied to the wound for healing. Electrospun PLGA-based scaffolds have been applied extensively in biomedical engineering, such as tissue engineering and drug-delivery system. MWCNT-incorporated electrospun nanofibers with high surface area-to-volume ratio and porous characteristics have also shown potential applications in many aspects of tissue engineering.

Biomaterials made from proteins, polysaccharides, and synthetic biopolymers are preferred but lack the mechanical properties and stability in aqueous environments necessary for medical applications. Cross-linking improves the properties of the biomaterials, but most cross-linkers either cause undesirable changes to the functionality of the biopolymers or result in cytotoxicity Glutaraldehyde, the most widely used cross-linking agent, is difficult to handle and contradictory views have been presented on the cytotoxicity of glutaraldehyde-cross-linked materials

Biopolymers are also named natural polymers. Biodegradable polymers are growing in importance, day the day and current research in focused on producing newer biodegradable polymers. living matter is able to synthesize a wide range of different polymers and in most organisms, these biopolymers contribute the major fraction of cellular dry matter. The functions of biopolymers are in most cases, essential for the cells and are as manifold as their structures. These biopolymers fulfill a range of quite different essential functions for the organisms. The environmental impact of persistent plastic wastes is raising general global concern, and disposal methods are limited. The continuously growing public concern in the problem has simulated research interest in biodegradable natural polymers. Biopolymers have various applications in medicine, food and petroleum industries. Microorganisms can produce and excrete good amount of polysaccharides in sample but costly production conditions. A number of polysaccharides produced by microorganisms have been adopted as commercial products have the potential for commercialization. An important group of biopolymer is represented by the homopolymers of β-glucanes because of in its very low-to-negligible toxicity. They have tremendous potential use in a verity of diseases. The advent of modern biotechnology has fundamentally transformed the way scientists view organisms and the materials they produce. The use of biopolymer materials for drug delivery can minimize tissue reaction and allow drugs to be administrated in nonconventional ways. The use of biopolymers in these formulations has thus far been restricted to a narrow set of applications. Drug formulations incorporating polymer drug delivery systems are currently undergoing registration and are likely to make an impact on the market in near future. The major area of application for these novel sustained release systems in the treatment of cancers and diseases of the elderly. In the treatment of hormone disorders biopolymer delivery systems allow drugs to be administrated occasionally. The main draw back limiting the development of these polysaccharides is the lack of efficient process of their extraction and purification. However new applications in agronomy, foods, cosmetic and therapeutic could in a near future accentuate the effort of research for their development.

SYNTHESIS OF NANOMATERIALS:

Nanotechnology is the science of nanomaterials which deals with its synthesis, characterization, and applications. Researchers are currently focusing on developing more eco-friendly processes for the synthesis of nanoparticles. The main focus for the synthesis protocol has shifted from physical and chemical processes towards "green" chemistry and bioprocesses. Metal nanoparticles, due to their quantum size effects, possess various novel properties. However, most of their synthesis protocol imposes a major threat to the environment. In common synthetic methods, the reducing agents used which include organic solvents and toxic-reducing agents like hydrazine, N-dimethylformamide, and sodium borohydride are considered to be highly toxic for the environment. All these chemicals are highly reactive and pose potential environmental and biological risks. With the increasing interest in minimization/elimination of waste and adoption of sustainable processes, the development of green chemistry approaches is desirable. Biopolymers have been extensively used as capping and reducing agent for the synthesis of various nanoparticles. Biopolymers like chitosan, heparin, soluble starch, cellulose, gelatin, PVA, PVP, and so on can be used to replace various toxic regents in synthesizing different nanoparticles.

WATER PURIFICATION:

Safe drinking water is a significant, but simple indicator of development. Nanotechnology has shown promising developments in providing safe drinking water through effective purifying mechanisms. Several nanomaterials have already proved to have antibacterial and antifungal properties. Developing affordable materials which can constantly release these antibacterial materials like silver nanoparticles to water is an effective way of providing microbially safe drinking water for all. Developing various nanocomposites with functional materials which can scavenge various toxic metals like arsenic, lead, etc., from water together with the antibacterial agents can result in affordable water purifiers that can function without electricity. The main challenge in this technology is developing stable materials which can release nanoparticles continuously overcoming the scaling on nanomaterials caused by various complex species present inside water.

A relatively new biopolymer, chitosan, shows superior performance where many conventional polymers fail. It is a versatile polymer with applications in water treatment, biomedical and dietary supplement industries. Chitosan is used as a flocculent in water treatment processes and will biodegrade in the environment over periods of weeks or months rather than years. Compared to chitosan, many aggressive and cheap synthetic flocculants are available but they leave a residual impact on the environment. Chitosan removes metals from water by forming chelates.

Chelation is a process by which multiple binding sites along the polymer chain bind with the metal to form a metal cage like structure, to remove it from a solution. This property of chitosan together with its biodegradability make it an eminent candidate for treating difficult industrial storm water and waste water, where conventional methods failed to reduce the contaminant levels. Porous GO-biopolymer gels can efficiently remove cationic dyes and heavy metal ions from wastewater. Nanocrystalline metal oxyhydroxide-chitosan granular composite materials prepared at near room temperature through an aqueous route was also efficient in water purification. Nanofiber membranes can improve the water-filtration process without adversely affecting environment. Combining various nanomaterials together with biopolymers can effectively restrict the formation of biofilms on the polymer surface.

IMPORTANCE OF BIO POLYMERS TO FOSSIL FUELS:

The main property that distinguishes biopolymers from fossil-fuel-derived polymers is their sustainability, especially when combined with biodegradability. Biodegradable biopolymers from renewable resources have been synthesized to provide alternatives to fossil-fuel-based polymers. They are often synthesized from starch, sugar, natural fibers, or other organic biodegradable components in varying compositions. The biopolymers are degraded by exposure to bacteria in soil, compost, or marine sediment. Furthermore, subjecting biodegradable biopolymers to waste disposal by utilizing their characteristic of being degradable by the bacteria in the ground significantly reduces emission of CO_2 compared with conventional incineration. Therefore, attention is drawn to the use of biodegradable biopolymers from the viewpoint of global warming prevention. In recent years, with the critical situation of the global environment worsening due to global warming, the construction of systems with sustainable use of materials has been accelerated from the viewpoint of effectively using limited carbon resources and conserving limited energy resources. Furthermore, the cost of petroleum feedstocks has risen dramatically and there is a rising consumer interest in using "green" (or renewable resources) as the basis for consumer products.

One of the fastest-growing materials sectors in the past several years has been the production of polymers from renewable resources. Their development is fueled by the potential these polymers hold to replace fossil-fuel-based polymers. The main reasons for this drive can be summarized as follows: (1) inadequate fossil-fuel resources; (2) pricing instability of fossil fuel; (3) contribution of fossil fuel as a feedstock to climate change; (4) its occasional role as a political weapon; and (5) its association with the waste disposal problem created by the fossil-fuel-derived polymers.

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 feed stocks 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.[10] In Europe there is a home composting standard and associated logo that enables consumers to identify and dispose of packaging in their compost heap.

CONCLUSIONS:

Increasing awareness towards the sustainable development has caused the researchers to think about natural and biodegradable polymers for replacing synthetic polymers for various applications. Nanotechnology has already emerged as the future technology which can make tremendous changes to the current existing technology. Various biopolymers are produced by the bacteria under limiting conditions to store carbon and energy resources. Incorporation of various nanofillers to these biopolymers will improve its mechanical and barrier properties which will improve its various applications. The biocompatibility together with the biodegradability of these materials encourages the use of these materials in day-to-day applications.

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