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# Key Role of Biopolymers in Sustainable Development

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**Abstract :**

Rapid population growth and urbanization often causes adverse effects on the surrounding. Uncontrolled uses of synthetic polymers have raised the serious environmental problems. This contribution of polymer in environmental pollution should be prevented through production of environmental friendly and sustainable products which will play vital role to preserve the environment for the future. Biopolymers are considered to be environmental friendly and sustainable as they are obtained from living origin. In the present investigation we have focused on few biopolymers with their source, applications and challenges ahead of them.

**Key words**: sustainability, synthetic polymers, biopolymers.

**Introduction:**

Polymeric materials are valuable due to their elasticity, reusability and hardiness nature[1].Synthetic polymers are made up of one or more covalently bonded monomers. They appear to suggest a diverse group of chemicals, with differences owing primarily to the type and number of monomer units[2]. The majority of synthetic polymers are made from petrochemicals, which are non-biodegradable in nature, and these polymers will remain in the ecosystem for centuries at the end of their lives, causing pollution and going to rely on nonrenewable feedstock[3].This excessive production of petroleum-based plastics demands sustainable alternatives from renewable resources.

According to UN world commission on Environment & Development, sustainability is defined as "meeting the needs of the present without compromising the ability of future generations to meet their own needs"[4]. Understanding the utilization of renewable biomass can help to reduce the carbon footprint of textiles[5]. The use of fossil fuels and deforestation have caused a disruption in the carbon cycle, resulting in the

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release of massive amounts of $CO_2$ into the atmosphere that cannot be fully reimbursed for by photosynthesis or dissolution in the oceans[6].

Sustainable polymers are materials derived from renewable, recycled, or other lower-carbon feedstock that are managed in environmentally responsible ways at the end of their lives through recycling and biodegradation[7,8]. Renewable bio-based materials are thought to be safer than synthetic fossil fuel-derived materials. Several proteins are being studied for the development of naturally derived biomaterials, including collagen, gelatin, albumin, fibroin, and keratin[9]. These biopolymers can be combined with a variety of natural and synthetic materials to create polymeric composites. These composite materials have properties similar to oilbased polymers. Biopolymers play an important role in long-term development. The current study reveals a few biopolymers, as well as their sources and applications in various fields.

**Classification of biopolymers**

Biodegradable polymers are classified according to several properties. On the basis of origin from which the biopolymers are extracted, they are classified into two classes: a) Extracted from biomass; b) modified with organisms. It is as shown in the following figure.

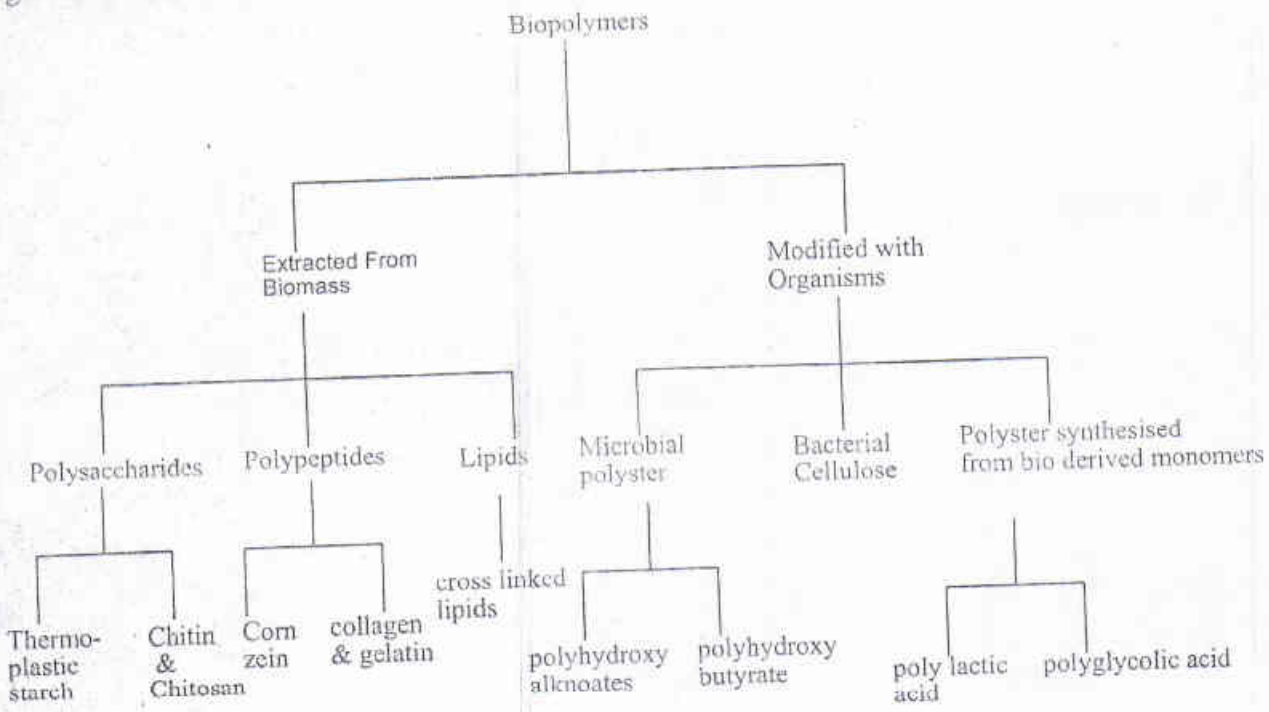


Figure 1 : Classification of biopolymers on the basis of their origin

**A) biopolymers obtained from Biomass**

*a) polysaccharides*

It is a low cost polysaccharide, abundantly available and one of the cheapest biodegradable polymers.T principal crops used for its production include potatoes, corn and rice.

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*i) Thermoplastic starch*

Thermoplastic starch is plasticized starch that has been processed (typically using heat and pressure) to completely destroy the crystalline structure of starch to form an amorphous thermoplastic starch. Thermoplastic starch processing typically involves an irreversible orderdisorder transition termed gelatinization. Starch gelatinization is the disruption of molecular organization within the starch granules and this process is affected by starch-water interactions.Depending on the starch source and processing conditions, a thermoplastic material may be obtained with different properties suitable for various applications. Starch has been widely used as a raw material in film production because of increasing prices and decreasing availability of conventional film-forming resins[10].

*ii) Chitin and Chitosan*

Chitin is long-chain polymers of N-acetylglucosamine, presence of which has been experimentally confirmed in unicellular (diatoms, protists, fungi) as well as in multicellular (sponges, corals, mollusks, worms and arthropods) organisms.These units are randomly or block distributed throughout the biopolymer chain depending on the processing method used to obtain the biopolymer. Chitin is usually found in the shells of crabs, shrimp, crawfish and insects. It could be considered as amino cellulose. Recent advances in fermentation technology suggest that the cultivation of fungi can provide an alternative source of chitin[11].

Chitosan is derived from chitin by deacetylation. Chitosan is generally applied as biomaterials, especially for drug delivery system and use in combination with other substances for improving their therapeutic effects[12].

*b) polypeptides*

*Collagen and gelatin*

Collagen is a protein found largely in mammals (25% of our total protein in mass) and is the major strength provider to tissue. A regular collagen molecule consists of three entangled protein chains that form a helical structure. Collagen is non-toxic, produces only a minimal immune response and is excellent for attachment and biological interaction with cells.

Gelatin is one of the most common biopolymers. It is obtained either by partial acid hydrolysis or by partial alkaline hydrolysis of animal collagen, it's a denaturized fibrous protein[13].

***B) Modified with organism***

*a) Bacterial cellulose*

Bacterial cellulose (BC) or microbial cellulose is an exopolysaccharide produced by bacteria such as Komagataeibacter (previous Gluconacetobacter) in a carbon and nitrogen-enriched media. The species of Achromobacter, Alcaligenes, Aerobacter, Agrobacterium, Azotobacter, Gluconacetobacter, Pseudomonas, Rhizobium, Sarcina, Dickeya, and Rhodobacter have been reported a significant source of bacterial cellulose. Komagataeibacter is used as a model organism for research and food applications, because of its higher Bacterial cellulose yield. They have also attracted significant interest as a source of bio-fuel production[14].

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chitosan with aldehyde produces harder material, biodegradable, insoluble in water with high resistance to fat and oils which make them applicable in packaging of fats[22]. The starch-based polymers are the prominent polymers in the agricultural field, in horticulture threads, clips, staples, bags of fertilizers as wel as trays with seeds are the application of biopolymers[23]. Packaging is another important area where biodegradable polymers are used they are used in curves bottles, paper-based packaging, films etc. They are most demanding in automotive electronic and construction field also[24].

**Challenges**

Biopolymers synthesis is costly as compare to the oil-based polymers. Unlike the synthesis of traditional polymers from carbon footprint sources, the synthesis of biopolymer faces the challenges of monomer diversity and low conversion rate. During synthesis of bio polymers requires additional steps in purification,commonly using organic solvents resulting in extra cost and introduction of new problems associated with solvent residues and recovery. Polymerization method has experienced problems such as time and energy consumption product diversity and use of non-selective catalyst resulting into quality influenced outcome.

**Conclusion**

This study summarizes the brief information on the different types of biopolymers with their properties and applications as well as the different challenges ahead of them for better role in sustainable development. The utilization of biopolymers clearly decreases the requirement of manufacturing of oil-based polymer; this perspective will lead us towards the sustainable development. The research approach on designing of biopolymer and their use on commercial basis should be promoted for betterment of environment and sustainable development. New pathways and strategies should be developed and applied to permit significant breakthrough in sustainable polymer production on an industrial scale.

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