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Preeti Goel
Department of Chemistry, DPG Degree College, Gurgaon, Haryana, India

Divya Agarwal
Department of Biotechnology, Agra College, Agra, Uttar Pradesh, India

Corresponding Author:
Preeti Goel
Department of Chemistry, DPG Degree College, Gurgaon, Haryana, India

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Role of plant-based biopolymers in bioremediation of environmental pollutants

Preeti Goel and Divya Agarwal

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Abstract
Plastic accumulation in environment create many problems for wildlife, their habitat and as well as for human population. Plastic pollution became a highly evident problem in whole world. It is one of the top polluters of our environment. Plastic is essential for packaging of food, medicines etc, medical devices, daily products and infrastructure.
There is a need of an alternate of traditional plastic because it degrade in thousands of years and emits carbon in environment.
Use of natural polymers obtained from plants like starch, cellulose, chitosan, gelatin, alginates can be alternative to non-biodegradable petroleum based plastics. These plant based biopolymers or bioplastics used as traditional plastic, so it can be a good alternative of traditional plastic.
Human currently produces more than 350 million metric tons of plastic waste per year. It is estimated that global plastic waste generation is projected to triple by 2060 i.e. one billion metric tons. In India, per Capita plastic consumption of traditional plastic. Bioplastic tend to release less carbon emission and degrade sooner as compare to traditional plastic.
Biopolymer plastic can be made from natural resources such as coffee grounds starch, coconut shell and regular PP/PE. It is derived from non-renewable fossil fuels Biopolymer plastic is considered to be more sustainable and environmentally friendly.

Keywords: Packaging of food**,** infrastructure, starch, cellulose, chitosan, gelatin, alginates

1. Introductions
Plastic waste takes hundreds to thousands years to decompose and at the end it harms marine life. It is important for us to reduce our plastic consumption and also it's properly disposal is also today's need, Recycling, Reusing and choosing eco-friendly alternatives can solve the above problem.
Plastic has a wide range of uses and application in our daily lives such as in packaging, in construction, in transportation, electronics, medical & healthcare and many household items. To see the excessive use of plastic there is an urgent need to find sustainable alternatives of it and reduce our reliance on single use products.
Biodegradable packaging, compostable packaging, paper based packaging, reusable plastic and use of cloth bags in place of plastic bags can make a big difference in reducing plastic waste.
Use of stainless steel straws instead of using plastic straws, Beeswax maps in place of plastic wrap, silence food, storage bags, bamboo toothbrushes, reusable coffee cups of steel glass etc., can reduce plastic consumption significantly.
Plant based biopolymers which are biodegradable materials like cornstarch or bamboo can be good alternatives for plastic and can be used in bioremediation of Environmental Pollutants.
In the early 2000s, exploring the idea of using cornstarch to create biodegradable plastic. They discovered by modifying the cornstarch they could create a material which had similar properties to traditional plastics and much more environmental friendly, since then cornstarch based plastic have gained popularity as a sustainable alternative.
Sugarcane, algal products, paper, glass containers, metals and bamboo are other reliable sources which can be used as alternative of plastic [1, 2].

1.1 Difference types of plant-based polymers are shown in table 1

1.1.1 Types of Plant Based Biopolymers

Table 1: Types of Plant Based Biopolymers [3].

Plant-based polymer (Group)	Type of polymer	Structure/production method
Starch polymer	Polysaccharides	Modified natural polymer
Polylactic acid (PLA)	Polyester	Bio-based monomer (lactic acid) by Fermentation, followed by polymerization
Polyhdroxyalkonates	Polyester	Direct production of polymer by fermentation or in a crops
Polyurethanes (PURs)	Polurethanes	Bio-based polyol by fermentation or chemical
Nylon a) Nylon 6 b) Nylon 66	Polyamide	Purification plus petrochemical isocynate Bio-based caprolactum by fermentation Bio-based adipic acid by fermentation Bio-based monomer obtained from a Conventional chemical transformation from Oleic acid via azelaic acid
Cellulose polymer	Polysaccharides	Modifier natural polymer

2. Application of plant based polymer

Biopolymers are polymers made by living things that consist of monomeric units joined together by covalent bonds to form more complex structures. Biopolymers are a broad and surprisingly adaptable class of materials that are synthesized from biological source materials or created by biological systems. Biopolymers are used in the food, beverage, pharmaceutical, and packaging industries. Due to their unique set of qualities, polymers can be used to extend product shelf life, shield products from moisture, and facilitate product dispensing. A biopolymer such as starch can be used as a matrix to create nanoparticles. It is projected that the capacity for producing polymers worldwide will increase to 1.5 million MT by 2011 and 766,000 MT by 2009.

Both the food and pharmaceutical industries use biopolymers. The food, pharmaceutical, medical, paper, and textile industries are the key industries that use starches. Carrageenan are utilized in controlled-release tablets as well as gelling and thickening agents. Gums are utilized in a variety of applications as a disintegrant, binder, and sustained release excipient.

2.1 Role of Biopolymers in green nanotechnology

Biopolymers can contribute in a variety of ways to the development of green nanotechnology. The synthesis of nanoscale derivatives of polysaccharides, such as cellulose and starch, in large quantities can be utilized to create bionanocomposites. Naturally occurring polymers with conditioning advantages for skin and hair care - The polysaccharide polymer has a molecular weight of more than 2 million Daltons and is made up of galactose and mannose units. The polymer's ability to flocculate upon dilution in a shampoo or body wash formulation allows it to deliver actives to the hair and skin while also providing a special blend of conditioning and protecting properties for the skin.

2.2 Biopolymers use in office products

Biopolymers are used in office supplies such wall charts, pens, highlighters, and calendars. In the food service industry, biopolymers are used to make straws, silverware, bibs, aprons, plates, and cups. It is used in packaging, which includes boxes, trays, bags, sweet and savory nibbles, candy, bread, and bottles for fresh liquids. It is also used in agriculture and horticulture for things like mulch film, plant trays and pots, netting, and plant holders.

2.3. Industrial

The rise in inquiries from corporate clients looking for assistance in making their packaging or goods more sustainable. The products are tailored for use in films, fibers, coatings, and molded parts; larger rotomolded items are now under development.

3. Methodology

There are two commonly utilized methods: one is quantitative analysis, which determines the composition of the plant, and the other is qualitative analysis, which extracts the fuel's natural ingredients. Different gravimetric techniques were used to determine the lignocellulosic components in accordance with published or normalized methodologies. The experimental process carried out on each fuel is depicted in Figure 1.

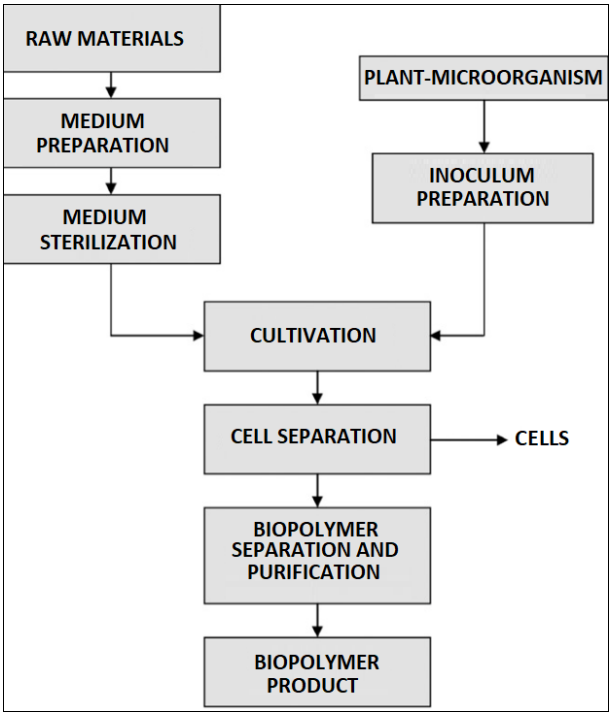

Fig 1: Experimental Process Flowchart for Biopolymer Production from Plant-Microorganism Sources

A multi-step procedure is used in the extraction from cellulose 1. Soxhlet extractions using dichloromethane for six hours are used to determine the extractives. The sample is then dried in an oven after being cleaned with distilled

water. The lignin, holocelluloses 1, 2, and cellulose 2 are extracted from the extraction residue. After a sulfuric acid attack, the lignin "Klason" content is determined by gravimetric analysis. Following the so-called delignification process, which involves reacting the extraction residue with sodium chlorite in acetate buffer, the content of holocellulose (i.e., cellulose + hemicellulose) is also measured by gravimetric measurement. Cellulose 2 was made possible by the action of hydroxyl sodium on holocelluose 2. Following a reaction with nitric acid, a gravimetric analysis is used to assess the cellulose 1 content of the powders directly in accordance with the Kürschner method.

Different biopolymers are made by different methods such as cornstarch based plastic film is made by following process.

The creation process for a biodegradable plastic film made of maize starch is disclosed in the invention. The following steps make up the preparation method: Initially, prepare 90–100 parts by weight of corn starch in a starch water solution, then gelatinize for 30 minutes at 85-90 degrees Celsius; cooling to 50º – 60 °C, adding an initiator, and stirring; adding vinyl acetate and methyl methacrylate in a time frame of two to three hours; performing graft copolymerization to produce a graft copolymer emulsion; performing reduced-pressure suction filtration; and drying to produce graft copolymer starch; combining polycarbonate and a plasticizer in a high-speed mixer; stirring, adding graft copolymer starch, blending, and extruding the uniformly mixed materials using a double-screw extruder; cooling and drying to produce degradable corn-starch-based plastic particles; utilizing a single-screw extrusion and film blowing machine to perform hot melting and extrusion-blown molding on the biodegradable corn-starch-based plastic particles at a machining temperature of 175º – 190 °C in order to create a plastic film, followed by cutting, coiling, and packaging. The biodegradable plastic film made of maize starch is both water resistant and biodegradable.

4. Conclusion

Overall, research on biopolymers as sustainable alternatives to plastics is promising, and the development of new biopolymers and manufacturing processes can help reduce the environmental impact of plastic waste. Biopolymers are natural polymers that are derived from living organisms. They have gained significant attention in recent years due to their potential applications in various industries, including medicine, agriculture, packaging, and textiles. Biopolymers offer several advantages over conventional petroleum-based polymers, making them a sustainable alternative.

One of the main advantages of biopolymers is their biodegradability. Unlike conventional polymers, biopolymers can be broken down by microorganisms, resulting in the release of carbon dioxide and water. This makes biopolymers an eco-friendly alternative to conventional plastics that can persist in the environment for hundreds of years. Another advantage of biopolymers is their renewability. Conventional polymers are made from non-renewable fossil fuels, whereas biopolymers are derived from renewable resources such as plants, animals, and bacteria. This makes biopolymers a more sustainable alternative to conventional plastics [6-10].

Biopolymers are also non-toxic, making them suitable for use in applications such as medical devices and implants. Conventional polymers can contain harmful chemicals such as biphenyl A (BPA), which has been linked to health problems such as cancer and reproductive disorders. Biopolymers offer excellent mechanical and barrier properties, making them suitable for use in various applications such as packaging and textiles. For example, polylactic acid (PLA), a biopolymer made from corn starch, has similar mechanical properties to conventional plastics and can be used in applications such as food packaging and disposable cutlery. Finally, biopolymers offer a reduced carbon footprint compared to conventional plastics. The production of conventional polymers is energy-intensive and results in the release of greenhouse gases. Biopolymers, on the other hand, have a lower carbon footprint due to their renewable nature and biodegradability.

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