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Biodegradation Studies of Polymeric Surfactants Based on Sugar

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Abstract— ***In developing country environmental pollution by synthetic polymer has assumed dangerous proportions. The mitigation of this problem is possible by increasing use of biodegradable polymer. Sugar based polymer derived from renewable resources offering a promise in alternative to conventional synthetic polymer which are often non biodegradable and contribute to environmental pollution. There is a worldwide research effort to develop biodegradable polymers as a waste management option for Polymers in the environment. This review explores recent advancement in the synthesis, characterization and biodegradation of sugar based polymer. The biodegradation mechanism and environmental impact and future prospects of this novel material are also discussed.***

Keywords— ***Biodegradable, explore, advancement, mitigation.***

I. INTRODUCTION

The ever-growing demands of Biodegradation is a chemical degradation of material proverb by the action of microorganisms such as bacteria, fungi and algae. The most common definition of biodegradable polymer is a degradable polymer wearing the primary degradation mechanism is through the action of metabolism by microorganism. Biodegradable polymers have given a solution to environmental issues post by conventional. Polymers based on Sugar including monosaccharide like glucose and polysaccharide such a starch and cellulose have attracted attention due to their renewable origin and potential for complete biodegradation. The use of sugar base polymer offers and advantage in terms of sustainability as sugars are abundant, easily accessible and biodegradable. This review paper aims to provide an in depth biodegradation studies of sugar based polymer. Focusing on their synthesis, degradation mechanism and environment implication.

Biological system degrades large natural molecules like starch, cellulose protein by hydrolysis followed by oxidation. It is therefore not surprising that by and large most of the non biodegradable polymer contact in hydrological group along the polymer main chain they classified based on their origin and chemical composition.

A. Types of Sugar Based Polymers

The Common types of sugar based polymers include

Cellulose base polymer- cellulose the most abundant natural polymer derived from plant cell wall it has been used in production of cellulose Acetate and other varieties that exhibit biodegradability in various polymers.

- **Starch based polymers-**

Potato, corn and wheat Polymers are widely studied due to their biodegradability and versatility in different application.

- **Polysaccharide base polymer-**

Polysaccharides derived from Natural Sources offer a range of application in biomedicine and packaging their biodegradable nature make them suitable for environmentally friendly application.

Monosaccharide-based Polymers: Glucose based polymers and other monosaccharides are used to synthesize biodegradable polyesters and polyurethanes.

B. Synthesis of Sugar-Based Polymers:

The synthesis of sugar-based polymers involves the use of sugar monomers or derivatives as building blocks. The most common methods for the production of sugar-based polymers include

- **Polymerization of monosaccharides**

Glucose can undergo polymerisation to form polymer like polylatic acid (PLA) and polyhydroxyalkanoates (PHAs), which are biodegradable and derived from renewable resources.

Enzymatic polymerization- Enzymatic polymerization is a greener alternative to Chemical synthesis Enzymes such as glycosyltransferases can be used to create sugar based polymer with specific property

- **Chemical modification of polysaccharides –**

Biodegradability depends not only on the origin of polymer but also on its chemical structure and environmental degradation condition. The nature of chemical structure of polymer determines biodegradability where as physical properties of polymer sample affect the rate of biodegradation. Starch and cellulose can be chemically modified to improve the mechanical properties and thermal stability. Common techniques include etherification, esterification and cross linking.

- **Biodegradation mechanism of sugar based polymer**

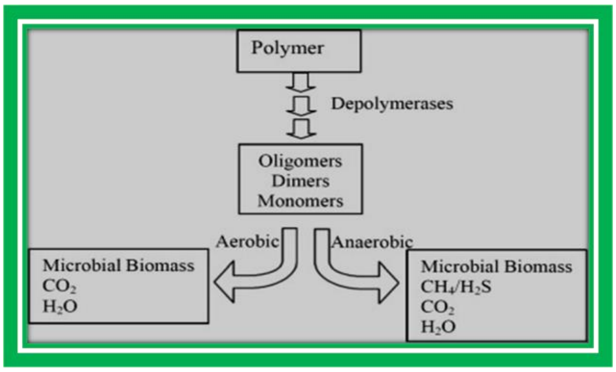
Biodegradation process can be influence by polymers chemical structure, molecular weight and environment condition. The major biodegradation mechanism include

- **Enzymatic degradation**

In enzymatic degradation microorganisms produce enzymes like amylasecellulases, and lipases that can degrade sugar-based polymers. Starch and cellulose-based polymers are particularly susceptible to enzymatic attack.

- **Microbial degradation-**

Bacteria and fungi play a key role in biodegradation of sugar base polymer.



Microbial Biodegradation https://www.google.com/url

C. Environmental IMPACT OF SUGAR BASE POLYMER

Sugar base polymer can be compost with organic waste and return to enrich the soil. Their use will not only reduce injurious to wild animals caused by dumping of conventional plastic but with also lesson the labour cost of the removal of plastic waste in the environment because they are integrated natural their decomposition will help to increase the longitudinity and stability of land field where reducing the volume of garbage activity leads to the conversion of polymers into carbon dioxide, water and Biomass under aerobic condition.

Sugar-based polymers offer several environmental benefits compared to synthetic plastics. Their biodegradability reduces the risk of long-term pollution, particularly in marine environments. However, the environmental impact of these polymers depends on various factors, such as:

- **Degradation Rate:** The rate at which a polymer degrades depends on the environmental conditions, such as temperature, humidity, and microbial activity. Faster degradation rates minimize the polymer's environmental footprint.
- **Ecotoxicity:** Although sugar-based polymers degrade into natural components, the presence of additives or by-products during degradation could pose ecotoxicological risks.
- **Life Cycle Analysis (LCA):** A comprehensive assessment of the environmental impact of sugar-based polymers requires a life cycle analysis. This includes the evaluation of energy use, greenhouse gas emissions, and waste generation during production, use, and disposal.

D. Applications OF SUGAR BASE POLYMER

Sugar base Polymers have wide range of application due to their biodegradability renewable origin and melodious properties.

Agriculture: Sugar-based mulch films and seed coatings help in reducing environmental impact in agriculture, promoting sustainable practices.

Biomedical Applications: Sugar-based polymers like PLA and PHAs are used in drug delivery systems, tissue engineering, and wound dressings due to their biocompatibility and degradability.

Packaging: Starch-based and cellulose-based films are used in biodegradable packaging, reducing plastic waste in landfills and oceans.

E. Future prospects

Sugar based polymer face several challenges that limit their wide spread application.

Cost- The production of sugar a based polymer is often more expensive than conventional plastic hindering their large scale commercialisation.

Degradation control

The rate of biodegradation needs to be control to match their specific application requirement which is challenge for many sugar based material.

Mechanical property- starch exhibit poor mechanical strength and water resistance which limits their use in demanding applications.

Future studies should focus on improving the performance of sugar based polymer and exploring new applications.

II. CONCLUSION

The biodegradability of sugar based polymer their origin and potential applications in various industry make them attractive alternative to synthetic polymers however challenges related to mechanical property production cost and degradation control need to be address for their broader application continue research in this field will be Crucial for developing more sustanainable polymer material reducing environmental pollution.

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