

Bioplastics for Sustainable Development: General Scenario in India

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Abstract

Plastic is a major environmental pollutant in the environment. The petroleum derived plastics are mostly non biodegradable and take long time to break down. Thus ecosystem is getting affected by this pollution. So the approach to produce plastic using microbes is a novel approach. Bio-plastics are generally bio-based, they may be or may not be biodegradable but their properties are closed to synthetic polymers. In biodegradation process micro-organisms convert plastics into water, carbon dioxide, and compost. Bioplastics are generally prepared from biomass such as polysaccharides, starch, lipids, proteins, cellulose etc. These biodegradable polymers can be used in various fields like agriculture, automotives, medicine, controlled drug release and packaging etc. That means bio-plastic is eco-friendly. Scientists around the world working for the progressive development searching for substitute of fossil fuel derived plastic for sustainable development of the future environment. They are exploring the possibility of using different waste materials to produce the bio-based polymers. India has a potential in the development of bioplastic market. Environmental awareness programs, easy availability of feedstock and government backing are boosting the bioplastic market. New products are coming in the market with the help of homemade technology.



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Introduction

Plastic materials are used almost everywhere from ordinary polythene bag to biomedical fields. Although plastic is a major environmental pollutant¹ in the environment. Petroleum derived plastics accumulation² is a major cause of pollution for the

environment and its adverse effect destroying the balance in the eco system. So it is a novel approach to produce plastic using microbes and bioplastic³ is the answer of this problem. These biopolymers can break down into biomass, water and carbon dioxide either aerobically⁴ or anaerobically.

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Disposable properties and eco-friendly properties of biopolymers make them so special over conventional plastics. This review paper provides information how bioplastics can be an alternatives to petroleum based plastics for the sustainable development and the undergoing progress that India has made in this field.

What is Bioplastics

Bioplastics are produced from biomass like polysaccharides, lipids, proteins, etc. If a plastic material is either biobase or biodegradable or have both biobase and biodegradable property can be termed as bioplastic. The three different categories of bioplastics are depicted in Figure 1.

Biodegradation

In this process plastic degrade into biomass, water and carbon dioxide; in presence of air, moisture and microbes. The degradation process is thickness and composition⁵ dependent.

Degradation

It is an abiotic degradation process where fragmentation initiated by UV light, oxygen attack,

and biological attack. Polyethylene breaks down in this process.

Bio-Based Plastics

These plastics are recyclable but may or may not be biodegradable. Bio-based plastics are mainly derived from natural resources. Bio- PVC, bio- PE are the example of bio-based plastic. Sugarcane⁶ is the resource of the these polymers.

Compostable Plastics

These plastics cannot fully degrade on their own; compost site needed for the break down process. These plastics are eco friendly than petroleum based plastics as less toxic substance released after the degradation process. Enzymatic degradation process may also takes place. PLA is suitable for both methods to degrading completely.⁵

Conventional Plastics

Plastic derived from non-renewable resources are the conventional plastics.

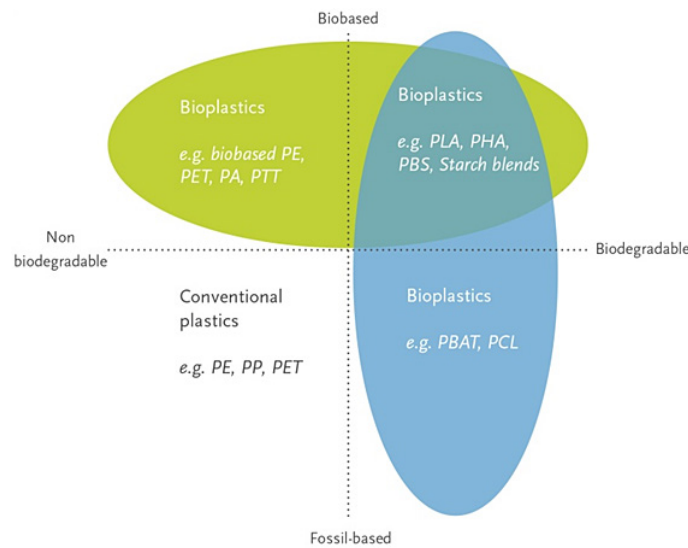


Fig. 1: Different bioplastics.³ (PE: Polyethelene, PP: Polypropylene, PET: Polyethelene terephthalate, PA: Polyamide, PTT: Polytrimethylene terephthalate, PLA: Polylactic acid, PHA: Polyhydroxyalkanoates, PBS: Polybutylene succinate, PBAT: Polybutylene adipate, PCL: Polycaprolactone

Bioplastics and Conventional Plastics

Researchers are involved to invent easier methods for bioplastic synthesis. Disposable properties and

eco-friendly properties of biopolymers make them so special over conventional plastics. (Table 1)

Table 1: Comparison of conventional plastics and Bioplastics

Conventional Plastics	Bioplastics
Mainly Chemicals	Generally Microbes
High Green House Gas emission	Low Green House Gas emission
Non bio degradable, harmful	Bio degradable, harmless
Recycling and destroying process is difficult	Recycling and destroying process is less difficult
Low production cost	High production cost

Biodegradation⁷ is the process where polymers break down into biomass, water and carbon dioxide; in presence of air, moisture and microbes. The complete process is called mineralization. Temperature plays a crucial role in this conversion process.

Bioplastic and Social Benefits

Use of petroleum based plastic increasing the pollution level, so we have to find an alternative and ‘Bioplastic’ is the answer. Bioplastics has both advantages and disadvantages. Lower carbon footprint, energy efficiency, and eco-safety are some of the advantages. On the other hand, high cost, recycling, reducing raw material, misuse and lack of legislation should be mentioned as weakness.

It should be mentioned that in order to eliminate these disadvantages and have a more sustainable market and industry, better recycling system, restrict legislation, and standardization and management should be applied.

Bioplastic and Market

Bioplastics is going to dominate the plastics industry in coming days. Bioplastics mainly used in packaging industry although potential application in automotive and electronics sector⁸ is well established. Bioplastics also play an important role in developing bioeconomy.⁹ Developing countries like in India use of bioplastics will create new the job opportunity.



Fig. 2: Plastic spectrum in accordance with the data.¹⁰

PVC: polyvinyl chloride; PU: polyurethane; PS: polystyrene; ABS: acrylonitrile butadiene styrene; PC: polycarbonate; PET: polyethylene terephthalate; PE: polyethylene; PP: polypropylene

Selection of plastics depends on several tools, “plastic spectrum” (Figure 2) helps us to find right one. In this spectrum, bio-based bioplastics are most preferable as they are at the right of the pyramid and are made from renewable resources.

Biodegradable bioplastics have been found to have potential application in different field. One of the pioneer applications has been found in delivering drugs and tissue

engineering scaffolds.¹¹ Integration of these materials into their technologies has been developing worldwide. Bioplastics market is a growing market¹² and it increases about 20%~25% per year globally and by 2020 it will increase to 25%~30% of total plastic market. According to Figure 2, the bioplastics at the right are the most preferable as they are biodegradable and also compostable.¹³

Bioplastics and India¹⁴

Bioplastics market in India is in infant stage. Very few companies are operating in the bioplastic segment in India. Environmental awareness programs, easy availability of feedstock and government backing giving major support to Bioplastics manufacturers in India. More initiative needed for production, raw materials and technology development. Environmental awareness and promoting the long-term benefits of bio-plastics is an initial step that needs to take toward bringing this change. The National Green Tribunal's state-level committee has set August 31, 2019 deadline for the government to enforce the ban on plastic.

Scientists across the India working for the development of bioplastics. Very recent development¹⁵ came from IIT-Gwahati and the new bioplastic is under commercial production. Biogreen India's 1st Biotechnology Company¹⁶ for Biodegradable Products. Truegreen, Plastobags, Ecolife, Envigreen these companies are already producing bioplastics in India. Many technological discoveries have boosted Indian Bioplastics market and significant growth¹⁷ in industry has been observed. It is up to every individual to stop the use of conventional plastics in their daily life as much as possible.

Conclusion

Plastics in different size accumulated in environment and take long time to break down. Microplastics, which comes after breaks down of plastic, is of size less than 5 nm in diameter, are bioavailable to organism through food chain, are dangerous to health. Whereas bioplastic end up with biodegradable or compostable materials which on treatment may give biofuels. Environmental as well as economic issues are addressed by bioplastics. Thus bioplastic is a developing field of research for sustainable development.

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Conflict of Interest

The authors do not have any conflict of interest.

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