BIOPLASTICS

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INTRODUCTION

Plastics are synthetic polymeric molecules that show desirable characteristics such as softness, ability to heat seal, strong strength to weight ratio, and transparency. Plastic, a petrochemical derivative, is a cost-effective, resistant and important product in everyday life. Plastics are used in almost every area, such as packaging material in routine households, in bottles, mobile phones, printers, etc. Global demand for plastic, generated by the growing use of plastic-based materials, has increased and added stress to the existing system for waste management. There is a major interest in reducing the dependency on plastic goods dependent on petroleum, which causes global environmental emissions. Every year, more than eight million tonnes of plastic waste spills into the oceans, which can be mitigated by creative packaging material redesigns. Biodegradable and environmentally friendly alternatives to synthetic plastics have also been produced for the advancement of new technologies. Bioplastics have recently been among the most advanced materials that are biobased and biodegradable, processed from waste, biomass and renewable sources such as jackfruit, waste banana peels, organic waste, agriculture waste, newspaper waste, oil palm empty fruit bunch, sugarcane, corn starch, potato starch, rice straw, rapeseed oil, vegetables oil, cellulose from plants, starch, cotton, bacteria and sometimes from several nanosized particles like carbohydrate chains (polysaccharides). A bioplastic is a plastic that is made partly or entirely of biological polymers, such as sugarcane, potato starch or the cellulose from trees, straw and cotton. It is either biobased, biodegradable or features both properties. Therefore, by using plant, animal, or bacterial sources, bioplastics can be made.

TYPES OF BIOPLASTICS

Starch-based:

Starch-based bioplastics are complex mixtures of starch and compostable plastic compounds, including polylactic acid (PLA), polybutylene succinate, polybutylene adipate terephthalate, polycaprolactone (PCL) and polyhydroxyalkanoate (PHAs). These blends contribute to the water-resistance, thermal and mechanical properties of bioplastics derived from starch.

Cellulose-based:

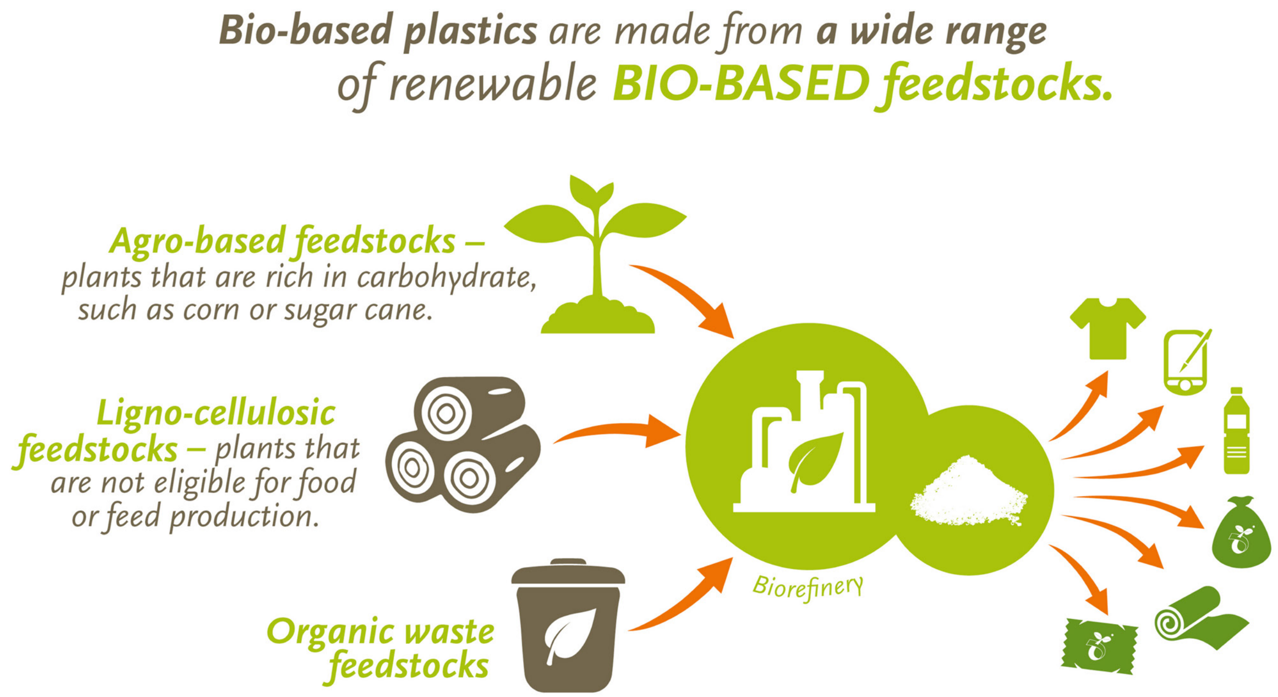
Bioplastics based on cellulose are obtained from esters, including cellulose acetate, cellulose nitrates, and cellulose butyrate and cellulose propionate. These bioplastics produce mechanically robust, gas-permeable, and water-resistant bioplastics when blended with starches. They can be thermoplastically modified and used for packing.

Protein-based:

High protein sources, such as wheat gluten, casein, albumin, whey and soy, are used to obtain protein-based bioplastics. Similar thermal and viscoelastic properties are exhibited by albumin and whey bioplastics, whereas soy bioplastics have modified viscoelastic properties and are water sensitive.

Aliphatic polyesters:

Natural bacterial fermentation of inexpensive carbon sources such as molasses, sucrose, lactose, glycerol, oils and methane mainly produces aliphatic bioplastics. Moreover, they are composed of PHAs, poly (3-hydroxybutyrates (PHBs), PLAs, polyglycolic acid (PGA), PCL and poly (3-hydroxyvalerate). PHAs and PHBs are widely produced among these.



Polyamides:

Bioplastics based on polyamides are derived from diamine and dibasic acid condensation (e.g., ricinoleic acid, sebacic acid, 1,12-dodecanedioic acid, and pentamethylenediamine). Their manufacturing reduces the emissions of greenhouse gases and different natural resource consumption. They show remarkable resistance to heat. Polyamide 6 and polyamide 66 are the most commonly used varieties. They are used for high-performance operations such as automobile fuel lines, catheters, gas pipes, etc.

Polyethylene:

It is similar to conventional polyethylene. Ethylene is the building block of this material and is derived from ethanol produced by fermentation from sources of agricultural feedstock, such as sugarcane or maize. Polyethylene, similar to polyamides, is non-biodegradable but can be recycled.

Lipid polymers:

Biopolymers based on lipids are synthesised from the triglycerides of lipid sources derived from animals and plants. The plant-based triglycerides commonly used are obtained from sunflower, palm, linseed, castor and soybean oils. Lipid bioplastics are used commercially, including polyurethanes, PHAs and epoxy resins.
Properties of bioplastics

Physical properties	
Mold shrinkage	0.0125-0.0155 in/in
Density	1.4g/cm^3
Apparent viscosity (180°C, 100 sec^{-1})	950 Pa-s
Thermal properties	
Melting point	160-165°C
Heat distortion temperature	143°C 78°C
Vicat softening temperature	147°C
Mechanical properties	
Tensile strength	26 MPa(3800psi)
Shrinkage	0.93% caliper
Moisture absorption	0.16% (23°C, 50% RH)
Transparency	High
Oxygen barrier	Medium-high
Other Properties	
Stackability	Fair
Punctur Resistance	Excellent
Crystallinity	60

ADVANTAGES OF BIOPLASTICS

- Potentially a much lower carbon footprint.
- Do not use scarce crude oil.
- Reduction in litter and improved compostability from using biodegradable bioplastics.
- Bioplastics is environmental friendly and energy efficient.
- Less likelihood of imparting a different taste to the product contained in a plastic container.
- A bioplastic may have much greater water vapour permeability than a standard plastic.
- Bioplastics can be made clearer and more transparent.
- Bioplastics is the key for increasing resource efficiency.
- Bioplastics helps in saving fossil resources and for substituting them step by step.

BIO-BASED POLYMERS AND THEIR USES

Types of polymer	Applications
PLA	Tea and coffee cardboard packaging
	Beverage cups and bottles
	Trays for vegetables bakery and salads
	Yoghurt jars
	Chips and Pretzels bags
	Packaging long shelf-life foods such as pasta and chips
	Salad bowls
Starch-based	Corn starch trays for milk chocolates
	Corn base packing for organic tomatoes
Cellulose-based	Cellulose film wrap for fruits. E.g. Kiwi
	Films for chips
	Metalized film for sweets
	Cellulose packaging for pasta

CONCLUSION

Due to the clear benefits they have in many applications, bioplastics are growing quickly. By lowering the carbon footprint and the use of fossil fuels, bioplastics give the earth an advantage. To minimise environmental risks, petroleum-based plastics should be replaced with bio-based polymers due to the biodegradability and renewability of biopolymers. The biological process of recycling has given a fresh direction to waste management. Most bioplastics are mainly used in the food packaging industry, followed by medical, agriculture, automotive and electronics industry. The market for bioplastics is increasing gradually, recognising the maximum potential for applications in various other sectors, such as textiles and construction. Bioplastics, with their excellent characteristics and broad biotechnological applications, have an extremely promising future as substitutes for plastics. Further research is needed, however to reduce production costs, improve biodegradability, avoid negative environmental impacts, and develop novel strategies to involve markets and society in sustainable development.