International Journal of Advanced Research and Development
www.multistudiesjournal.com
ISSN: 2455-4030
Received: 05-04-2025, Accepted: 06-05-2025, Published: 21-05-2025
Volume 10, Issue 2, 2025, Page No. 21-23

Bioplastic materials in our daily life - A review

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Abstract
Plastics that have been universally used in our daily lives are now causing serious environmental problems. Petroleum derived plastics dominate the packaging industry even today. It accounts for the largest usage of plastics worldwide and is used in numerous applications. Millions of tons of these non- degradable plastics accumulate in the environment each year. Bioplastics are a suitable alternative to petroleum-based plastics. They are highly complex and sophisticated materials that can help make plastic products more sustainable and eco- friendly. Bio-plastics today are a large family of materials with differing properties and applications. The review is an attempt to investigate the facts about different types of bioplastics, their current status, major advantages and other related issues.

Keywords: Bio-plastics, petro-plastics, sustainability

Introduction
Plastics have become an integral part of our life. However, the incessant consumption of plastics creates a wide spectrum of ecological and public health reverberations among life on earth. It provoked scientists to partially substitute petrochemical-based polymers with biodegradable bioplastics. Various studies around the world revealed that bioplastics are eco-friendly as compared to traditional plastics. They comprise bio-based materials featuring identical properties compared to their fossil-based versions as well as new materials featuring additional properties. These add-on qualities like biodegradabilityand bio-based property can reduce the impact on environment significantly. Moreover, the emission of greenhouse gases during production and degradation of bioplastics is very low when compared to conventional plastics. In short, bioplastics are plastics that are made out of biopolymers. Some, like bio-polyethylene, are identical to their oil derived forms, while others are unique and have no petro polymer equivalent. Bioplastics can be made using plant, animal or bacterial sources. Some bioplastics are biodegradable while others are not which is advantageous, as many products need to be resilient and not degradable (Phillips, 2008) [1]. However, the field of bioplastics is still in its infancy but is explicating quickly.
The keen interest in bioplastics started way back in early 20th century when Henry Ford used corn and soybean oils to manufacture his automotive parts (Stevens E.S.,2003) [2]. Bioplastics are one of the driving tools in the advancement of plastics. Currently, the bioplastic industry promises good opportunities as there is a high demand for plastic in global markets. Macromolecules from natural polymers and smaller molecules such as sugar, disaccharides and fatty acids are becoming the major raw materials in the production of bioplastics.

Bioplastics
Bioplasticsare novel materials of 21st century and would be of great importance to the material world (Mohanty *et al*.,2002) [3]. A bioplastic is a substance made from organic biomass, unlike conventional plastics, which are made from fossil resources (oil and gas). Bioplastics are made from a number of renewable resources such as plant oils, cellulose, starches, sugars, carbohydrates, bacteria and algae. Bioplastics arenot just one single substance-they comprise of a whole family of materials with differing properties and applications.

Classification
The term Bio-plastic refers to several groups of plastics namely bio-based plastics (from renewable resources) and bio-degradable plastics.

Biobased Plastics
Biobasedplastics are those that are derived from plant-based polymers, such as corn starch, sugarcane or cellulose, and are not derived from petroleum resources. They may be referred as ‘biobased’ polymers. Some bioplastics are biodegradable, some are compostable, while others exhibit the properties similar to conventional plasticswhichare not biodegradable. Biodegradability is an addon property of certain types of bioplastics, since they offer an additional recovery option at the end of a product’s life. The biodegradation property depends on its chemical structure. This means that not all bioplastics are biodegradable. The Business-NGO (non-government organization) Working Group for Safer Chemicals and Sustainable Materials defines bio-based bioplastics as “plastics in which 100% of the carbon is derived from renewable agricultural and forestry resources such as corn starch, soybean protein and cellulose” (Alvarez *et al*., 2011) [4]

Photodegradable Bioplastics
Photodegradable bioplastics have light sensitive group incorporated directly into the backbone of the polymer as additives. Extensive ultraviolet radiation (several weeks to months) can disintegrate their polymeric structure rendering

them open to further bacterial degradation (Kalia *et al*., 2000, Kadi,2010) [5].

Biodegradable Bioplastics

Biodegradable bioplastics are fully degraded by microorganism without leaving visible toxic remainders. The term "biodegradable" refers to materials that can disintegrate naturally into biogas and biomass (mostly carbon dioxide and water) as a result of being exposed to a microbial environment and humidity (Alvarez *et al*.,2011) [4]

Compostable Bioplastics

Compostable bioplastics are biologically decomposed during a composting process at a similar rate to other compostable materials and without leaving visible toxic remainders. In order to designate a plastic as bio-compostable, its total biodegradability, its disintegration degree, and the possible eco-toxicity of the degraded material must be determined by means of standard tests (Sarasa *et al*.,2008) [7]

Currently, different types of compostable plastics are available in the market. The most commonly used raw material for making compostable plastics is corn starch, which is converted into a polymer with similar properties to traditional polyethylene plastic products. Other compostable plastics available are made from potato starch, soya bean protein, cellulose as well as from petroleum and its bye products. This means that compostable plastics may be derived from both plant-based and petroleum-derived polymers.

Bioplastics: An alternative to Traditional Plastics

Bioplastics are eco-friendly alternative to traditional plastics and are extracted from renewable resources like corn, sugarcane, cellulose, potato or starch. These are 100% degradable, equally resistant and versatile, already used in agriculture, textile industry, medicine and forpackaging. Modern bioplastics are now suitable for an impressive range of applications without the need for new equipment or infrastructure. These biopolymers are suitable for both short-life and disposal, as well as long-life applications.

Advantages of Bioplastics

In general, Bioplastics have the potential to be more sustainable than those plastics derived from petroleum.

- **Greenhouse Gas Emissions:** One metric ton of bioplastics generates between 0.8 and 3.2 fewer metric tons of carbon dioxide than one metric ton of petroleum-based plastics. According to Columbia University, a 2017 study found that switching from traditional plastic to corn based PLA would cut US greenhouse gas emissions by 25%. The study also concluded that if traditional plastics were produced using renewable energy sources, greenhouse gas emissions could be reduced to 50 to 75% (Megan karriker,2018) [8]
- **Waste:** Bioplastics reduce the amount of toxic run off generated by the oil-based alternatives.
- **Less Costly:** Bioplastics are cheaper than normal plastics with the soaring oil prices
- **Consumes Less Energy:** The manufacturing process of biodegradable plastics requires less amount of energy and does not need fossil fuels to be recycled.
- **End-of-Life Points:** Valuable raw material can be reclaimed and recycled in to other products.
- **Independence:** Bioplastic is made from renewable resources: corn, sugarcane, soy and other plant sources as opposed to common plastics, which are made from petroleum (Yu J, 2008) [9]
- **Energy Efficiency:** Production uses less energy than conventional plastics. On the other hand, plastics are made from about 4% of the oil that the world uses every year. With oil scarcity, the manufacture of plastics becomes increasingly exposed to fluctuating prices (Chen,2014)
- **Eco-Safety:** Bioplastic also generates fewer greenhouse gasses and contains no toxins.
- **Non-Toxic:** Bioplastics are non-toxic and won't leach chemicals into food.
- **Adverse Change:** bioplastic is very hygienic and can be used for food packaging or for drinks
- **Bisphenol A:** Bioplastics are gaining popularity because they do not contain Bisphenol A (BPA)

Disadvantages of Bioplastics

The bioplastics currently on the market are mainly made from flour or starch from corn, wheat or other grains and only a few bioplastics are derived from agricultural residues or food. Large-scale production of bioplastics could have a negative impact on food availability and cause price increases in food.

- Bioplastics could have a damaging effect on soil, water usage and quality
- Bioplastics are designed to be composted, not recycled. The plant-based material will actually contaminate the recycling process if not separated from conventional plastics such as soda bottles and milk jugs.
- Many people believe that bioplastics are biodegradable. This is only partially true, as some bioplastics are biodegradable while some are not (Grabianowski,2018) [11]. Surprisingly, many bioplastics won't degrade at all if placed in landfill with other garbage.
- Plants grown for bioplastics have negative impacts of their own. Bioplastics are often produced from genetically modified food crops such as corn, potatoes, and soybeans, a practice that carries a high risk of contaminating our food supply. Also, corn and soybean producers typically apply large amounts of chemical pesticides and fertilizers that pollute our air and water.
- Waste collection and resource management needs to be standardized along with the packaging industry to create some synchronized systems for waste to resource management.
- Most bioplastics require high temperatures to degrade, and most cities lack the infrastructure for proper bioplastic composting. As a result, many bioplastics

end up in the trash, are deprived of oxygen, and release harmful methane into the environment (Cho., 2017) [12].

Innovations in The Field of Bioplastics Continues

- Researchers around the world continue to develop greener varieties of Bioplastics that can be more effectively reduce plastic pollution and our carbon footprint.
- More durable bioplastics are being designed for automotive, electronics and consumer goods such as Electrolux's new refrigerator made from corn and sugarcane bioplastic material.
- Newer bioplastics are being made in laboratories from straw, wood chips and food waste. Genetically modified bacteria eat the wood and produce useful chemicals to create the plastic.
- Researchers at the Univ., of Otago have managed to develop food packaging made from corn and shellfish industry by products. Surprisingly, these wrappers are also edible.
- Two Dutch designers have developed a form of bioplastic made from algae which could completely replace synthetic plastics for the manufacture of 3D printers. Researchers are making efforts to develop bioplastics from banana peels, shrimp shells and sea weed. These options are much more sustainable than using food crops like corn or sugarcane.
- Genetic Engineering: Bioplastics can be genetically engineered from Pseudomonas by the mutation of some of the genes involved in the β-oxidation pathway.

Conclusion

Even though the production of bioplastics is costly, their applicationsare of interest owing to the drawbacks of conventional plastics. Industrial progress in packaging technology in future appears to be moving towards newer breed of bio-materials. The trend is to maximize the production of bioplastics by enhancing the properties of bioplastics producing microorganisms, plants, and algae. Itisclear that bioplastics can reduce many of the environmental problems posed by the conventional plastics.

References

1. Phillips AL, Bioplastics boom. Am. Scientist,2008:96(2):109.
2. Stevens ES. What makes green plastics green? BioCycle,2003:44(3):24:4.
3. Mohanty AK, Misra M, Drzal LT "Sustainable Bio-composites from Renewable Resources: Opportunities and Challenges in the Green Materials World." Journal of Polymers and the Environment, 2002, 10(1-2).
4. Alvarez-Chavez CR, Edwards S, Moure-Eraso RL, Geiser K. "Sustainability of Bio-based Plastics: General Comparative Analysis and Recommendations for Improvement." Journal of Cleaner Production, 2011:23(1):46-7.
5. Kalia VC, Neena Raizada Sonakya.V j.sci.ind. research,2000:59:433-445.
6. El Kadi, S. Bioplastic Production Form Inexpensive Sources Bacterial Biosynthesis, Cultivation System, Production and Biodegrability. USA: VDM (Verlag Dr. Müller) Publishing House, 2010
7. Sarasa J, Gracia JM, Javierre C Study of the bio-disintegration of a bioplastic material waste. Bioresource Technology,2008:100:3764-3768
8. Megan Carriker Blog-Reducing Plastic, 2018. https://plaineproducts.com/ accessed on 02.05.2025
9. Yu J Chen LXL. "The Greenhouse Gas Emissions and Fossil Energy Requirement of Bioplastics from Cradle to Gate of a Biomass Refinery." Environmental Sci Tech,2008:42:6961-6.
10. Ying Jian Chen Bioplastics and their role in achieving global sustainability, J. Chem. Pharm. Res,2014:6(1):226-231
11. Grabianowski Ed. "What Is the Future of Bioplastics?" How Stuff Works Science, How Stuff Works, 2018. https://www.howstuffworks.com/ accessed on 02.05.2025
12. Cho Renee. "The Truth About Bioplastics." State of the Planet, 2017. https://news.climate.columbia.edu/2017/12/13/the-truth-about-bioplastics/ accessed on 02.05.2025