A REVIEW ON BIO-PLASTICS AS ALTERNATIVES TO PETRO-PLASTICS

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ABSTRACT:
Past few decades have seen an ever escalating emphasis on reduce and reuse of synthetic plastic waste as much as possible. The Earth is highly polluted by synthetic plastics that have shown their deleterious impact on life forms in all strata of the biosphere and especially a decrease in the quantity of underground water due to a decrease in infiltration process. Humans off late have been obsessed with using plastics in daily life for many applications but care less regarding its appropriate disposal. The present scenario insists the need of an effective alternative like bio-plastic to the conventional petro-plastics to reduce its catastrophic effects. These bio-plastics play a significant role in industries, food packaging and agriculture. Bio-plastics are made from agricultural waste, starch and cellulose making it a cost effective alternative to petro-plastics that are derived from fossil fuels. This review aims to create awareness about Bio-plastics, their uses, types and advantages over the non-biodegradable synthetic ones.

KEYWORDS: Bio-plastics, petro-plastics, agricultural waste, cellulose.

INTRODUCTION:

Plastics had proved to be a boon during the early years of industrial revolution but eventually revealed to possess adverse effects on human survival and also on the natural environment [1]. The traditionally used plastics are synthetic or semi-synthetic polymers with high molecular mass. These are derived from petro chemicals and other fossil fuels. These petro-plastics have a wide range of applications in everyday life because of their availability at low cost and beneficial properties like rigidity and ability to be moulded into different shapes [2].The major disadvantage of these petro-plastics is their inability to be decomposed by natural micro flora. According to a study conducted by Sourbh Thakur et al in 2018 [3] 93% of the petro plastics are dumped into the oceans and landfills. On burning 1Kg of plastic, 2.8 kg of CO_2 is released into atmosphere along with toxic gases which are hazardous to health. As an alternative, Bio-plastics which are derived from renewable sources like cellulose, starch, sugar etc are an inevitable solution to the plastic menace in the current situation. In last few years, bio-plastics especially Poly Lactic Acid [PLA] and Poly hydroxybutyrate [PHB] have shown their tremendous potential in food packaging [4]. Petro-plastics on the other hand are proven carcinogens that can contaminate food stuff on long time storage. Bio-plastic are the organic plastics synthesized from biological sources like corn, potato etc and are the polymers of carbon based compounds [5]. Bio-plastics are capable of subsequent decomposition into CO_2, H_2O and other inorganic compounds by the enzymatic action of microorganisms.

TYPES OF BIO-PLASTICS:

Bio-plastics are classified into three types namely Natural polymers, Synthetic polymers and Microbial polymers [6]. The Poly hydroxybutyrate (PHB), Poly hydroxyvalerate (PHV) and Poly hydroxyhexanoate (PHH) are the examples of commonly used bio-plastics [7].

Poly hydroxyalkanoates [PHA]

The Poly hydroxyalkanoates (PHAs) are the polymers containing polyesters of hydroxyl alkanoate and they are produced by various species of bacillus [8].They are bacterial carbon storage polymers. They are mainly produecd by bacterial fermentation or by genetic engineering. They are used for single use food packaging [11]. Structure of PHA is as shown in **FIG 1**.

PHAs are found to be better alternatives to petro-plastics since they have a tendency to be degraded on exposure to soil in both aerobic and anaerobic conditions. PHAs can be degraded in seven weeks over wide range of temperature with moisture level at 55% [9]. Structure of PHA is as shown below.

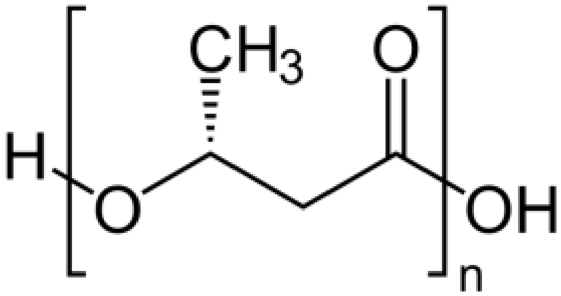

FIG 1: Structure of Poly hydroxyalkanoates [PHA]

Poly Lactic Acid [PLA]

PLAs are mainly made from corn starch or sugarcane and are similar to polyethylene, polystyrene and polypropylene. They are the bio-plastic manufactured by the polymerization of lactic acid monomers [10]. Structure of PLA is as shown in **FIG 2**.

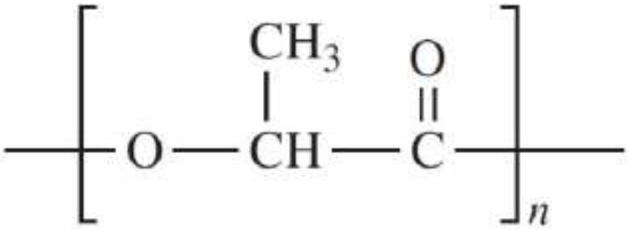

FIG 2: Structure of Poly Lactic acid [PLA]

ALTERNATE CLASSIFICATION OF BIO-PLASTICS:

The bio-plastics are made from vegetable sources like potato peels/starch, banana peels, sugarcane etc. There are different types of bio-plastics based on the source.

1. Starch-based bioplastic
2. Cellulose-based bioplastic
3. Protein-based bioplastic
4. Polyamide 11
5. Bio-derived polyethylene
6. Lipid Derived Polymers

LIFE CYCLE OF BIO-PLASTICS:

The life cycle of Bio-plastic in general can be summarised as shown in **FIG 3.**

FIG 3: Life cycle of bio-plastics

APPLICATIONS OF BIO-PLASTICS:

Currently bio-plastics are used in Agriculture, Industries and mostly in Medical fields such as nanoparticles for drug delivery and bio compatible porous implants [12]. Bio-plastics are used in medical applications for the development of therapeutic devices and also used as a delivery vehicle for controlled drug release [13]. Since the Poly hydroxybutyrate Bio-plastics (PHB's) have properties like tensile strength, elasticity modulus and tensile strain are similar to that of bones, PHB's are used as implant material and also used in Tissue Engineering to replace damaged tissue, blood vessel regeneration, nerve repair, cartilage repair, sutures for muscle and skin regeneration [14]. Moving bed biofilm carriers (MBBC) bio-plastics are used to clean waste water [15].

ADVANTAGES OF BIO-PLASTICS:

1. Mainly Bio-plastics are good alternative for conventional plastics being biodegradable, eco-friendly and compostable [16].
2. Bio-plastics are widely used for food packaging which poses a major disposal threat [17].
3. Bio-plastics have found its application in the biocontrol of *Aspergillus flavus* in corn [18].
4. Bio-plastics show lower carbon footprint compared to petro-plastics and also contribute less emission of greenhouse gases than petro-plastics [19].

DISADVANTAGES OF BIO-PLASTICS:

Bio-plastics are associated with many advantages. However they also possess some disadvantages.

1. Bio-plastics are too expensive than conventional plastics and since bio-plastics are made from biological sources, it may lead to decrease in the raw material reserves [20].
2. Uncontrolled and improper disposal of bio-plastic can also cause problems like soil and water pollution. Inappropriate disposal of bio-plastics into landfills can also contribute for the global warming [21] to an extent.
3. If the ambient conditions like temperature, microorganisms and humidity are not available; biodegradation of bio-plastics is slower and can last for several years [22].
4. Bio-plastic like Poly Lactic Acid (PLA) waste are difficult to convert into useful products [23].
5. The infrastructure requirements for the production of bio-plastic is a major hurdle and parameters like thermal instability, oxygen permeability in food packaging industries pose a question to the use of bio-plastics [4].

CONCLUSION:

With increase in awareness about environmental issues caused by petro-plastics, new age researchers have been trying to find an effective alternative to it while contemplating sustainable use of natural resources. Bio-plastics serve as a good alternative due to their unique properties like quality, flexibility compared to traditional plastics. Bio-plastics have many applications in different fields like industries, food packaging, agriculture attributed to their main advantage of being biodegradable, produced from renewable sources, able to recycle, reused and composted. However the cost of these bio-plastics poses a dominant drawback and therefore requires further investigation. This review signifies the role of several studies to find effective strategies to decrease the production cost and to ease the availability of bio-plastics.

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