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Assessing the Environmental Impact of Compostable Bioplastic Bags

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Abstract— *Plastics made from fossil fuels contribute to pollution and disrupt ecosystems. While bioplastics and compostable bags that are made from renewable materials offer promising alternatives, they can also have severe effects such as eutrophication. Bioplastics can increase the soil nutrients like nitrogen (under certain conditions). A huge impact has been made by bioplastic additives on soil's physical, chemical, and biological properties, land, human health, flora and fauna, and the environment in general.*

Keywords— ***Bioplastics, Biomass, Compostable bags, Plastic pollution, Soil health.***

I. INTRODUCTION

Alternative to traditional plastic bags are compostable bags. Compostable bags are made from renewable resources and degrade more easily, making them better for our planet. Compostable bags are an eco-friendly alternative to conventional plastic bags. They are made from natural materials. These bags play a crucial role in reducing waste in landfills and mitigating climate change. When composted, they turn into three main components: biomass, water, and carbon dioxide. Bioplastics are made from plant-based products making them way better than traditional plastics. However, despite their sustainability, they also have some drawbacks. Feeding a large population is a challenge, and now growing plants for bioplastics will compete with food production and compromise the demands of our population. Also, the fertilizers and pesticides used for biomass production can flow down water bodies and lead to eutrophication. Bioplastics have lower human and terrestrial environmental toxicity and carcinogenic potential than traditional plastics, but they are more harmful to aquatic ecosystems.

Plastic trash bags are the most common method of waste disposal in households. Landfill sites are overflowing with non-biodegradable plastic bags, posing a severe threat to our planet. On the other hand, this research has consistently highlighted the detrimental impact of bioplastic bags on land, human health, and ecosystems. Compostable bags offer a potential solution to this pressing environmental issue.

II. OBJECTIVES

- To compare the environmental impacts of bioplastics and traditional plastic bags, considering factors such as greenhouse gas emissions, and resource consumption.
- To assess the effects of compostable bioplastic bags on soil ecosystems, including their biodegradability, impact on soil fertility, and microbial activity.

- To evaluate the economic and social practicality of transitioning from traditional plastic bags to compostable bioplastic bags, considering their potential impacts on food security and resource competition.

III. RATIONALE OF THE STUDY

The purpose of the study was to find out how bioplastics affect the soil health and the surroundings present in compostable bags. Compostable bags are often seen as a better choice than regular plastic bags, but we need to know more about how they impact the soil. The study is an attempt to investigate how effective are these bioplastics present in compostable bags. This research will bring forth the resultant soil quality when compostable bags are disposed of in the ground and the quality of compost created.

By examining how biodegradable bags break down and influence soil nutrients and organisms, we can determine their overall impact on the environment. This information is crucial for making informed decisions about using compostable bags and promoting sustainable waste management practices.

IV. METHODOLOGY

This research aims to assess the impact of bioplastics on soil health, with a particular focus on compostable bags. Due to the nature of the inquiry, a secondary research approach will be employed. This section details the methodology used to analyse existing research on the subject. A comprehensive search for relevant scientific papers, articles, and reports was conducted using online databases such as Google Scholar, ScienceDirect, and Web of Science. This paper includes details on the type of bioplastic material used, the composition of the compostable bags, soil properties evaluated, and the observed impacts on soil health parameters like nutrient levels or microbial activity.

By following these outlined steps, this research has analysed the data from existing studies to assess the current understanding of how bioplastics, particularly compostable bags, impact soil health.

V. RESULTS AND DISCUSSIONS

5.1 Chemical Composition of Compostable Bags

Bio-compostable bags are made from bioplastics, like PHA (polyhydroxyalkanoate), PBAT (Polybutylene Adipate Terephthalate), and PLA (Polylactic acid), which is generally made from the sugars in corn starch, cassava, or sugarcane. PLA is usually made from cornstarch, cassava, or sugarcane. These bioplastics break down in three to six months, much faster than regular plastics that take hundreds of years to decompose. When they break down, they turn into carbon dioxide, water, biomass, and/or mineral salts when they are exposed to air.

5.2 Degradation of Bioplastics

Some of the plastic can degrade. Amongst them, some take a long time to degrade others do not. Bioplastics are made from plant products, so they can degrade easily. But when bioplastics degrade, they can release methane due to the lack of oxygen. Methane is a greenhouse gas which contributes to climate change.

5.3 Effects of Bioplastics in Soil

Plastic degradation in soil has known adverse effects on soil nutrition and plant growth. However, the breakdown of bioplastics in soil has a different impact. As bioplastics are derived from starch and vegetable oils, their decomposition increases soil nutrient levels by releasing these components into the soil. Moreover, the degradation of bioplastics releases carbon compounds, promoting microbial growth. This process also contributes to the organic matter in the soil, improving its water-holding capacity.

While this is beneficial, it's important to note that microorganisms like bacteria and fungi involved in bioplastic decomposition utilize essential nutrients, like nitrogen and phosphorus to metabolize bioplastics, potentially leading to a shortage of these nutrients in the soil. While bioplastics can release nutrients, the net effect on nutrient availability for plants is complex and depends on factors like microbial activity and the specific type of bioplastic. There will be a shortage of nutrients in soil after bioplastic degradation unless there are prior nutrients present in the soil as microorganisms require nutrients for metabolizing bioplastics.

5.4 Advantages of Bioplastic Degradation

•Increased Soil Fertility

- Organic Matter Contribution: Some types of bioplastics, especially those produced from organic ingredients such as cellulose or starch can decompose into soil-enriching organic matter thus improving fertility and structure.
- Nutrient Release: Bioplastics can disintegrate and release into soil carbon, nitrogen, and other vital elements necessary for the growth of plants and microbial activities.

•Reduction in conventional Plastic Pollution

- Biodegradability: Bioplastics designed to decompose naturally can lessen the build-up of traditional plastic materials in soils that usually last centuries causing environmental degradation.
- Less Microplastic Formation: The risk of microplastic contamination in soil is lower when properly formulated bioplastics are used because they degrade more thoroughly than conventional plastics thereby reducing the possibility of ecological disturbance within soils' ecosystems through entry into food chains.

Decreased Ecotoxicity

- Reduced Chemical Additives: Unlike common types of plastics, a lot of bioplastics have reduced toxic additives which implies that the danger of poisonous substances leaching to the ground is minimized hence promoting beneficial organisms living in it and maintaining soil health.
- Safer Decomposition: At times, breakdown products originating from decomposition processes involving bioplastic may be less toxic to soil organisms; therefore encouraging healthier and more balanced.

5.5 Disadvantages of Bioplastic Degradation

•Misleading biodegradation information: Not all bioplastics degrade completely in the natural environment. Some require composting technologies with specific conditions (high temperature, humidity) that are not always handled in natural soil. As a result, these bioplastics can persist in the environment, causing pollution like conventional plastics.

•Microplastic formation: As bioplastics degrade, they may break down into microplastics instead of disappearing altogether. These microplastics can accumulate in the soil, causing long-term pollution.

•Physical degradation: Bioplastics can interfere with soil structure by altering soil porosity and water-holding capacity, and can affect plant root systems and microbial communities

•Effects on soil organisms: Bioplastics in soil can adversely affect soil organisms such as earthworms and microorganisms that play an important role in maintaining soil health and fertility

•Residual toxins: Some bioplastics contain chemical additives (such as plasticizers, stabilizers, and colorants) that can leach into the soil during decomposition These chemicals can be toxic to soil bacteria, plants, and groundwater, and it has destroyed the ecosystem.

•Accumulation of heavy metals: Some bioplastics, especially those produced from agricultural residues or industrial by-products, may produce small amounts of heavy metals and as these bioplastics degrade, the metals can accumulate in the soil, which can cause toxicity issues.

•Agricultural Applications: The production of bioplastics is heavily dependent on crops such as maize, sugarcane, and potatoes, which need large amounts of water and fertilizers.

VI. CONCLUSION

Bioplastics are derived from renewable resources, such as cornstarch, sugarcane, or potato starch. These materials offer environmental benefits by **reducing reliance on fossil fuels and decreasing the carbon footprint**.

Bioplastics also break down more rapidly than conventional plastics, especially in composting conditions. Bioplastics have the potential to provide a sustainable and eco-friendly alternative to traditional plastics by reducing non-renewable energy consumption and greenhouse gas emissions.

However, they also have a negative impact on soil health and surroundings. All bioplastics do not fully degrade naturally. Some require industrial composting facilities with specific conditions (high temperature, humidity) that are not always met in natural soils. Additionally, when bioplastics degrade, they may break down into microplastics rather than completely disappearing. These harmful microplastics can accumulate in the soil, leading to long-term contamination.

Microplastics resulting from bioplastic degradation can accumulate in soils and negatively affect agricultural productivity. Proper plastic waste management is crucial to mitigate these harmful effects. However, their environmental impacts, particularly with regard to eutrophication, acidification, and ozone depletion, must be considered. Bioplastics have a high degradation rate due to their material composition; their high degradation rate solves a major problem which is soil contamination. Bioplastics have the potential to transform our world into a cleaner and better place.

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