Bioplastic: A Better Alternative to Plastics from Waste Paper

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Abstract— Fossil fuel plastics derived from petroleum are very common in our lives and we cannot think our day without their use. At the same time they are non-biodegradable and produce greenhouse gases, thus causing an environment problem. The solution to this problem is biodegradable bioplastic. Bioplastics are plastics derived from renewable biomass sources, such as vegetable fats and oils, corn starch, pea starch or microbiota. There is a variety of materials that bioplastics can be composed of, including: starches, cellulose, or other biopolymers. In this paper we are dealing with the making of bioplastics from cellulose and for cellulose we will use waste newspapers as our raw material. In this process cellulose is taken out from waste newspapers by decomposing them. Then cellulose is decomposed into starch/glucose by process called Cellulolysis which is done with the help of enzymes. Finally, bioplastic is prepared in lab by starch/glucose.

Key words: Bioplastic, Waste Paper

I. INTRODUCTION

Bioplastic are plastic derived from renewable biomass sources, such as vegetable fats and oils, starch or microbiota. Common plastics, such as fossil-fuel plastics, are derived from petroleum- these plastics rely more on fossil fuels and produce more greenhouse gas. Some, but not all, bioplastics are designed to biodegrade. Biodegradable bioplastics can break down in either anaerobic or aerobic environments, depending on how they are manufactured. There is a variety of materials that bioplastic can be composed of, including: starches, cellulose, or other biopolymers. Some common applications of bioplastics are packaging materials, dining utensils, food packaging, and insulation

Polyactic Acid (PLA), the second most important bioplastic of the world in regard to consumption in volume. PLA is a transparent plastic produced from corn or dextrose. It not only resembles conventional petrochemical-based mass plastics in its characteristics, but it can also be processed on standard equipment that already exists for the production of some conventional plastics. PLA and PLA blends generally come in the form of granulates with various properties, and are used in the plastic processing industry for the production of films, fibers, plastic containers, cups and bottles. PLA, a plastic substitute made from fermented plant starch (usually corn) is quickly becoming a popular alternative to traditional petroleum-based plastics. As more and more countries and states follow the lead of China, Ireland, South Africa, Uganda and San Francisco in banning plastic grocery bags responsible for so much so-called "white pollution" around the world, PLA is poised to play a big role as a viable, biodegradable replacement.

Nowadays, bio-plastics are made by corn starch, potatoes starch or banana starch which is used by humans and animals for their living. So my suggestion is that instead of using starch that are excreted from eatable things we should use waste newspaper which are mainly made up of cellulose and these newspapers are dumped into oceans for disposal

Researchers have conducted many researches for managing plastic waste on earth by finding eco-friendly alternative to plastics. This ecofriendly alternative is bioplastics, which are disposed in environment and can easily degrade through the enzymatic actions of microorganisms. The degradation of biodegradable plastics give rise to carbon dioxide, methane, water, biomass, humic matter and various other natural substances which can be readily eliminated (Azios, 2007).

A. Types of bioplastic

Bioplastics are currently used in disposable items like packaging, containers, straws, bags and bottles, and in non-disposable carpet, plastic piping, phone casings, 3-D printing, car insulation and medical implants. The global bioplastic market is projected to grow from $17 billion this year to almost $44 billion in 2022.

B. There are two main types of bioplastics

1) PLA (polyactic acid) is typically made from the sugars in corn starch, cassava or sugarcane. It is biodegradable, carbon-neutral and edible. To transform corn into plastic, corn kernels are immersed in sulfur dioxide and hot water, where its components break down into starch, protein, and fiber. The kernels are then ground and the corn oil is separated from the starch. The starch is comprised of long chains of carbon molecules, similar to the carbon chains in plastic from fossil fuels. Some citric acids are mixed in to form a long-chain polymer (a large molecule consisting of repeating smaller units) that is the building block for plastic. PLA can look and behave like polyethylene (used in plastic films, packing and bottles), polystyrene (Styrofoam and plastic cutlery) or polypropylene (packaging, auto parts, textiles). Minnesota-based NatureWorks is one of the largest companies producing PLA under the brand name Ingeo.
2) PHA (polyhydroxyalkanoate) is made by microorganisms, sometimes genetically engineered, that produce plastic from organic materials. The microbes are deprived of nutrients like nitrogen, oxygen and phosphorus, but given high levels of carbon. They produce PHA as carbon reserves, which they store in granules until they have more of the other nutrients they need to grow and reproduce. Companies can then harvest the microbe-made PHA, which has a chemical structure similar to that of traditional plastics. Because it is biodegradable and will not harm living tissue, PHA is often used for medical applications such as sutures, slings, bone plates and skin substitutes; it is also used for single-use food packaging.

II. MATERIALS AND METHODS

A. Materials

The raw material used here is newspaper, which is the most common and easily available household asset. Loads of newspapers are dumped into oceans for disposal which come

from 500,000 trees which are cut every week for their production and 88% of that is never recycled. These newspapers can be put to utilization in preparation of bioplastic as raw materials, after undergoing through some simple processing.

Waste newspapers are converted to pulp which can be strongly to each other, cellulolysis is relatively difficult compared to the breakdown of other polysaccharides. However, this process can be significantly intensified in a proper solvent, e.g. in an ionic liquid. The enzymes utilized to cleave the glycosidic linkage in cellulose are glycoside hydrolases including endo- acting celluloses and exo-acting glucosidases. Such enzymes are usually secreted as part of multi enzyme complexes that may include dickering and carbohydrate- binding modules.

There is a patented method to convert cellulose into dextrose done using pulp mills. Pulp can be manufactured by mechanical, semi chemical or fully chemical methods. This treatment can also be done using water which gets rejected in other processes (like household rejected water) to minimize water consumption and wastage. The waste newspapers are now segmented into small pieces in the mill and water is added to them to obtain a lingo Cellulosic fibrous pulpy material which is then grinded finally obtain what is known as paper sludge. The process removes lignin from paper and leaves cellulose fibers intact which facilitates in the process of extraction of cellulose.

B. Preparation of Bio-Plastic

1) Extraction of Cellulose from Pulp:

Cellulose is extracted from paper sludge after treating it with 1- butyl-3-methylimidazolium chloride which is a good solvent of cellulose. This co solvent addition is kept at appropriate stirring conditions (60^0C).This allows the fractionation of a paper-grade Kraft pulp into a separated cellulose and a regenerated hemicellulose fraction. Both of these exhibited high levels of purity, without any yield losses or de polymerization. Thus, this process represents an ecologically and economically efficient alternative in producing dissolving pulp of highest purity.

2) Conversion of Cellulose into dextrose:

The process of breaking down of cellulose is called Cellulolysis. Cellulolysis is the process of breaking down cellulose into smaller polysaccharides called cellodextrins or completely into glucose units; this is a hydrolysis reaction. Because cellulose molecules bind conversion rates considerably less than those obtained in our process.

C. Prepration of PLA Bio-Plastic

To produce PLA, starch is extruded from waste newspaper, which results in a simple starch called dextrose. Dextrose is a type of glucose, which is a simple sugar that plants produce during photosynthesis. Now dextrose is put through a fermentation process similar to the one used to make beer. Instead of alcohol, however, the dextrose is converted into lactic acid -- the same stuff that makes your muscles cramp when you exercise without proper hydration. Heat is applied to the lactic acid polymers, causing them to link together and form a long chain that ultimately becomes the material used to make many bio- plastic products.

D. Side Effects of Bioplastic Production

While bioplastics are generally considered to be more eco-friendly than traditional plastics, a 2010 study from the University of Pittsburgh found that wasn't necessarily true when the materials' life cycles were taken into consideration. The study compared seven traditional plastics, four bioplastics and one made from both fossil fuel and renewable sources. The researchers determined that bioplastics production resulted in greater amounts of pollutants, due to the fertilizers and pesticides used in growing the crops and the chemical processing needed to turn organic material into plastic. The bioplastics also contributed more to ozone depletion than the traditional plastics, and required extensive land use. B-PET, the hybrid plastic, was found to have the highest potential for toxic effects on ecosystems and the most carcinogens, and scored the worst in the life cycle analysis because it combined the negative impacts of both agriculture and chemical processing.

Bioplastics do produce significantly fewer greenhouse gas emissions than traditional plastics over their lifetime. There is no net increase in carbon dioxide when they break down because the plants that bioplastics are made from absorbed that same amount of carbon dioxide as they grew. A 2017 study determined that switching from traditional plastic to corn-based PLA would cut U.S. greenhouse gas emissions by 25 percent. The study also concluded that if traditional plastics were produced using renewable energy sources, greenhouse gas emissions could be reduced 50 to 75 percent; however, bioplastics that might in the future be produced with renewable energy showed the most promise for substantially reducing greenhouse gas emissions.

III. RESULT

What sets bio-plastic apart from petroleum-based plastic is that the process used to make it can also be reversed when the plastic finds its way into a compost heap. Fungi and bacteria found in soil get to work breaking down PLA into its basic parts. Under the proper aerobic (oxygen-rich) conditions, with heat and moisture, PLA will compost like any other organic material. The microorganisms found in compost consume the bio- plastic and break it down into humus, a nutrient-packed, soil-like substance that acts as natural plant food. The waste products are carbon dioxide and water.

PLA Helps to Reduce Greenhouse Gas Emissions Proponents also tout the use of PLA—which is technically "carbon neutral" in that it comes from renewable, carbon-absorbing plants—as yet another way to reduce our emissions of greenhouse gases in a quickly warming world. PLA also will not emit toxic fumes when incinerated.

IV. CONCLUSION

Bioplastics are growing rapidly because of the clear advantages they have in many applications. As oil supply tightens, these advantages will grow. Their carbon footprint can be much lower than oil-based equivalents. Bioplastics can provide excellent biodegradability,helping the world deal with the increasing problems of litter,particularly in the world's rivers and seas. Durable plant-based bioplastics can also be recycled as well as their conventional equivalents, assisting the growth of a more sustainable world economy

- Bioplastics are renewable and sustainable alternatives to oil-based plastics.
- Currently,the main opportunities for bioplastics are in packaging materials， but in future bioplastics may be used more in higher value application （electronics and vehicle parts）.
- Bioplastics have a 0.1% share of the current global plastics market.
- Land usage for the production of bioplastics is currently small（e.g. 0.1% of US maize area for PLA production).
- The world bioplastics market has potential to grow six-fold by 2011.
- Implementation of the correct disposal methods and corresponding infrastructure are vital if the bioplastics industry is to flourish and deliver environmental benefits.

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We have tried hard and soul to gather all relevant documents regarding this subject. We don't know how far we will be able to do that. Furthermore I don't claim all the information in this paper is included perfectly. There may be shortcoming, factual error, mistaken opinion which are all mine and we all are responsible for those but we will try to give a better volume in future

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