Bioplastics from Organic Waste

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***Abstract*— Plastics form an integral part of modern society. They are found in applications as diverse as packaging material, in building and construction, in the electrical industry, automotives, furniture, household goods, clothing and agriculture. Their durability has raised concerns about their end-of-life. Everyone agrees that there can be multiple approaches and technologies to plastics end-of-life. Recycling is clearly an important end-of-life strategy for plastics and continues to grow. Because of their invulnerability to microbial decomposition the precise time needed for biodegradation is unknown, and can produce greenhouse gases on incineration, thus causing environmental problems. The only disposal route is landfill. The nonbiodegradability combined with their relatively low density and high bulk, means that plastics will occupy increasing amounts of landfill space in a world where available suitable landfill sites are shrinking. The extensive use of this plastic has created a problem world over. Plastic waste is increasing every year and Environmental awareness has driven the development of new biodegradable materials. Bio-based plastics mean plastics based on renewable resources. The pattern of production is shifting from the true biodegradable plastics to the bio-based plastics, and that trend is likely to persist in the future. Bioplastics are plastics derived from renewable biomass sources, such as vegetable fats and oils, corn starch, pea starch, or micro biota. Bioplastics are thus made from waste materials and not from products intended for food production. There are a variety of materials that bioplastics can be composed of, including: starch, cellulose or other biopolymers.**

In this paper, one such alternative method to prepare bioplastic from potato peels is presented. Tons of potato chips are being consumed every day in the world. Made under different brands potato chips are being prepared at a very high scale, leaving behind the potato peels 10-30% of the weight of potatoes consumed. These peels can be converted to bioplastic after extracting starch from them thus saving the problem of their disposal after the chips have been prepared and at the same time some useable material is made out of it .Apart from this every individual place from where starch can be recovered can be changed to bioplastic, which to some extent can sort out the problem of conventional plastics. This paper deals with the method of preparation of bioplastic from starchy material extracted from potato peels left after preparing potato chips.

Keywords*— *Bioplastic, organic waste, starch, conventional plastic, renewable biobased resources, biodegradation

I. INTRODUCTION

Plastics are an essential part of modern life. Plastic is a broad name given to different polymers with high molecular weight, the term "plastic" is commonly used to refer to synthetically (synthetic or semi-synthetic) created materials that we constantly use in our daily lives. Plastics continue to play a defining role in finding innovative and forward- looking solutions to the way we live. Plastics are everywhere, in our housing, clothing, automobiles, packaging, electronics, aircraft, signs, decorative items, and medical implants to name but a few of their many applications and often present in the unlikeliest of places: in housing and construction, in wind turbines and solar panels, and even in state-of-the-art sporting apparel.

II. CONVENTIONAL PLASTICS

These conventional plastics are not just polymers which can be molded or extruded into desired shapes but often contain additives that improve their performance. According to the polymer used, the synthetic and semi-synthetic plastics can be designed with a broad variation in properties that can be modified by the addition of such additives. Some additives include the following:

- Antioxidants – added to reduce the effects of oxygen on the plastics during the ageing

process and at elevated temperatures.

- Stabilizers – in many cases used to reduce the rate of degradation of polyvinyl chloride

(PVC).

- Plasticizers or softeners- used to make some polymers more flexible, such as PVC.
- Blowing agents –used to make cellular plastics such as foam.
- Flame retardant –added to reduce the flammability of plastics.
- Pigments –used to add color to plastic materials.

III. DISADVANTAGE OF CONVENTIONAL PLASTICS

Nonbiodegradability of waste plastics make them one of the major components in municipal solid waste. In developed countries, waste plastics are becoming the largest or second largest component in municipal solid waste, while in developing countries it is third largest component, after food and paper. To characterize and quantify waste plastics from municipal waste, it is important to either have information on characterization and quantification of municipal solid waste or to start with the analysis of municipal waste, before moving to analyze waste plastics. Alternative disposal technique is to incinerate them, but it will cause the emission of harmful gases in atmosphere causing atmospheric pollution Increased living standards, growing environmental awareness, and sustainable development thinking are driving the demand for new and innovative material solutions.

IV. WHAT ARE BIOPLASTICS?

Bio-plastics from renewable origin are a new generation of plastics which are able to significantly reduce the environmental impact in terms of energy consumption and green house effect in specific applications. Bioplastics comprise a range of materials with differing properties. Bioplastics encompasses a family of materials which differ from conventional plastics insofar as that they are biobased, biodegradable, or both. Initially, bioplastics were mostly made of carbon hydrogen rich plants, such as corn or sugar cane, so called food crops or 1st generation feedstock. Consistently, 1st generation feedstock were the most efficient feedstock for the production of bioplastic as it required the least amount of land to grow and produces the highest yields .[1] But due some justified reasons, the bioplastics industry is of course also researching the use of non-food crops (2nd and 3rd generation feedstock), such as cellulose, and some waste material sugarcane bagasse or banana peels or potato peels, with a view to its further use. Today bio-plastics and starch based plastics are used in special industrial applications where bio degradability is required. Bio-plastics are 100% biodegradable, compostable or recyclable free from hazardous chemical and toxic substances. Biodegradable plastic materials take less energy to recycle; it reduces the dependency on limited fossil resources mainly imported from other countries and reduces greenhouse gas emissions. Bioplastics has the potential to reduce the petroleum consumption for plastic by 15 to 20 percent by 2025. [9]

V. MATERIALS AND METHODOLOGY

This study aims to synthesize bioplastic from waste renewable source and investigate the biodegradability of the same. Bioplastic was made from potato peel, a viable and more eco-friendly alternative feedstock for the making of bioplastic.

A. Extraction of Starch from potato peels

Potato peels are ground with distilled water in approximately same ratio in a grinder. Then the resultant solution is filtered using simple filter paper. The filtrate is decanted to get the starch settled at the bottom. The addition of distilled water is done 2-3 times repeatedly in the crushed pulp to extract starch completely. Further powdered starch collected from the bottom of the container is dried completely in an oven.[2]

B. Preparation of bioplastic

The dried starch is mixed with ten times its weight of distilled water. Subsequently hydrochloric acid, distilled water and 50% glycerol solution is mixed separately and then added to above starch solution. Then this mixture is heated to approximately 200-210^{o}C with continuous stirring till we get transparent and highly viscous mass, which ultimately turns into watery liquid.[3] The heat supply is then stopped followed by making the resultant solution neutral by addition of NaOH and checking with the help of universal indicator paper. Finally this mass is spread evenly on aluminum foil to make bioplastic.[8]4

Potato starch is made from two carbohydrate polymers, amylopectin and amylose. The amylopectin needs to be broken down to make bio plastic. This way the starch can be plasticized. The amylopectin present in starch is broken by addition of hydrochloric acid , forming a more satisfactory film. Glycerol acts as a plasticizer, which gives the bioplastic its flexibility.[5]

C. Degradation Test

Paper (cellulose base) sample and potato peel bioplastic is taken of same dimension, weighed separately and their weights were noted separately.[6] Both the samples were then buried under the soil at the same depth having same conditions of pH, temperature, humidity, organic matter, etc.[8]

TABLE I
DEGRADATION TEST

Number of days	Observation for degradation		
	Wt. of Potato peel bioplastic(PPB)	Wt. Of Paper	Observation
Day 1	8 gms.	8 gms.	No degradation
Day 3	6.2 gms.	5.2gms.	Degradation starts
Day 5	5.8 gms.	3.2gms.	Paper degraded, PPB slowly degrading
Day7	4.9gms.	2.0gms.	Rate of degradation slows down
Day 9	3.5 gms.	-	Degradation continues
Under same conditions of soil, temperature and humidity			

These samples were weighed every alternate day for their degradation. Results are given in table 1.

VI. RESULT AND DISCUSSION

Results shows that plastic prepared from potato peel can degrade at a comparable rate with paper. Biodegradable substances means substances which in short span of time breaks down into carbon dioxide, water and biomass. And a compostable substance which breakdown to return the nutrients back in the nature. It can be concluded that degradable plastic can be prepared from waste potato peels generally obtained from potato chips making industries.

VII. CONCLUSION

Potato peel bioplastic is a biodegradable and an environment friendly alternative compared to conventional plastics. Research into bioplastics development should continue so that bioplastics with more diverse applications can be created from organic waste materials. Such bioplastics would reduce the dependency on petroleum based plastics.

VIII. ASPECTS FOR FUTURE RESEARCH

The physical properties are to be worked upon, for example mechanical strength, transparency, etc. Other properties of plastic such as water resistance, acid resistance and transparency will also be investigated and compared with bioplastics obtained from different sources.

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