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Bioplastics from banana peels and biodegradation by micro organisms.

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ABSTRACT

Recently, Bioplastics are one of the most innovative materials that are biobased and biodegradable which is made from waste, biomass and renewable sources such as jackfruit waste, banana peels, organic waste, agriculture waste, newspaper waste, oil palm empty fruit bunch, sugarcane, corn starch, potato starch, rice straw, rapeseed oil, vegetable oil, cellulose from plants, starch, cotton, bacteria, algae and sometimes from several nanosized particles like carbohydrate chains (polysaccharides). Bioplastic can be degraded by the natural micro organisms such as bacteria, algae and fungi. The present research work with emphasis on synthesis of bioplastic material by using fruit waste mainly banana peel. The polymer produced using the banana peel blended with glycerol could help in the formation of plastic having the characteristic features of liability, user friendliness and strength. The degradation studies (soil burial test) conducted is helpful in preparation of environmental friendly product and as they derived from natural polymers. This versatility of bioplastic plays key role in green applications.

Keywords: ***Banana peel, bioplastic, biodegradation***

1.1 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 the synthetically or semi-synthetically 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, aircrafts, cars, autos, decorative items and medical implants to name but a few of their many applications like in housing and construction, in wind turbines and solar panels etc.

1.2 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.

1.3 APPLICATIONS OF BIOPLASTICS

Bioplastics are receiving more attention in various applications in industries [2]. This is because develop bioplastics materials is good alternative in order to decrease the capacity of inert materials disposed in landfills and create sustaining the pollution free environment which is too importance to both consumers and also industries. Natural polymers and polysaccharides when fabricated into hydrophilic matrices is well popular in biomaterials for controlled-release dosage forms by creating a prolongation of release dosage form as reported by Kalia *et al.*, (2011). Once bioplastics is blended with other pharmaceutical excipients, the material becomes extremely good compaction properties whereby the drug-loaded tablets form dense matrices suitable for the oral administration of drugs. Crystalline nanocellulose is advanced pelleting systems which is the rate of tablet disintegration and drug release can be controlled by tablet coating or micro particle inclusion [3]. Moreover, in biomedical industry based bioplastics has been named as the eyes of biomaterial because it is highly applicable in skins replacements for burnings and wounds, scaffolds for tissue engineering, bone reconstruction, nerves and gum reconstruction, drugs releasing system, blood vessel growth and stent covering [4]**.** Besides, in dental industry bioplastics based nanocellulose has been used in dental tissue regeneration in humans which is produced from microbial cellulose by the Glucanacetobacter xylinus strain [6]. Bioplastics have been the great of interesting exploration such as in construction and building industry. However not only builder but home owners are also attracted to use bioplastics for different products such as in fencing, decking and so on [7].

Furthermore, in companies that manufacturing the electroacoustic devices, bioplastics is purpose as a membrane for high quality sound [8]. The advantage of these kind materials is providing the same sound velocity as an aluminium or titanium diaphragm and along with the delicate sound. Besides, it also produces the trebles sparkling clear sound and bass notes are remarkably deep. On the other hand, bioplastics also is applied in membrane for reinforcement for high quality electronic paper (e-paper), combustible cells (hydrogen) and as an ultra filtration membrane for water treatment [9].

1.4 Experimental

1.4.1 Preparation of Banana Peels

Banana peels were boiled in water for about 30 minutes. Water was decanted from the beaker and the peels were left to dry on filter paper for about 30 minutes .After the incubation peels were completely dried and were placed in the mortar and using a hand blender the peels were squashed until a uniform paste obtained.

1.4.2. Production of Bio-Plastic

25 gm of banana paste was placed in beaker and 3 ml of (0.5N) HCl was added to this mixture and stirred using glass rod ,followed by 2 ml of glycerol was added and stirred (0.5N) NaOH was added in order to neutralize the Ph up to 7. The mixture was poured on a glass petric plate and the petri plate was placed under the oven at 130^{o}C and was baked till dry. Water stage petri plate was allowed to cool and the plastic film was scraped off from the surface.

Fig 1. Banana peels are chopped into pieces

Fig 2. Soaked in Sodium metabisulphate

Fig 3. Peels are boiled and allowed to dry

Fig 4. Banana peels are bended to fine paste

Fig 5. Completely dried under direct sun light

Fig 6. Final product – Biopolymer

1.4.3. Application Studies:

1.5. Biodegradability:

Two 200 ml beakers and 1:1 grams of a pre weigh piece of bioplastic were taken in the beaker containing soil at depth of 5 cm from the surface.Some amount of water was sprinkled on the soil, so that bacterial enzymatic activities could be enriched. These sample were kept in the beaker for about 15 days and each 7 days of interval we observed the decrease in the weight of the bio-plastic material and results were recorded accordingly each experiment was done in triplicate in order to ensure results.The weight loss of the bioplastic was calculated using equation

$$\text{Degradation \%} = \frac{\text{Final weight-Initial weight X100}}{\text{Initial weight}}$$

Initially the weight of the sample bio-plastics is 1.03 gms .After a week of decomposition the weight has been reduced by 0.4 gms .It weighed 0.9 gms Here by using the above mentioned Formulae ,the percentage of soil degradation for bio-plastics is observed as 38.83%.In the degrading process a bio-degradable plastic can be converted to carbon dioxide (CO2) and water and composting.

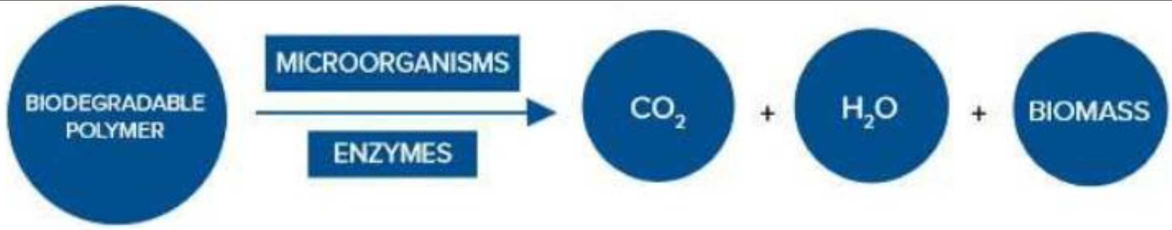

Fig.1.5.1 The process of Biological degradation of biodegradable polymers

1.6.Test with Microorganisms

1.7.Introduction :

Bacteria are some of the smallest and most abundant microbes in the soil, there can be billions of bacteria. There are estimated 60,000 different bacteria species; most live in the top 10 cm of soil where organic matter is present. In general soil micro organisms are decomposing organic materials in the environment, such as fruit waste, vegetable waster and tree trunks decay by the action of decomposing microbes. The idea of this research is to find a cost effective way to produce biopolymers from the biomass. Biodegradation of the bioplastics with the help of microorganisms like bacteria into the natural environment that includes changes in chemical structure physical appearance.

1.8 Microbial Assays:

The process of biological degradation of bioplastic by using micro-organisms such as Azotobacter, Azospirillus, Agro bacterium etc. The Procedure of microbial assays can be done by three processes are:

1. Serial dilution method

2. Streak plate method

3. Gram staining technique

1.8.1. Serial dilution method

The synthesized bioplastics are buried under soil for a week. After 7 days that soil sample is collected weighed for 1 gram and then performed serial dilution method. In this serial dilution method is to estimate the concentration of bacteria, colonies and biodegradable bioplastic sample by the enumeration of the number colonies cultured from serial dilutions of the sample.

1.8.2. Streak plate method

The streak plate method is a rapid qualitative isolation of soil micro-organism from 10^{-4} dilution through serial dilution sample. The techniques commonly used to isolation of discrete colonies initially require that the number of organisms in the inoculums be reduced. It is essentially a dilution technique that involves spreading a loopful of culture over the surface of an agar plate. The resulting diminution of the population size ensures that following inoculation, individual cells will be sufficiently far apart on the surface of the agar medium to effect a separation of the different species of microorganisms present.

1.8.3. Gram staining technique:

The gram staining is one of the most crucial staining technique. The first step in gram staining is the use of crystal violet dye was added over the fixed culture. After 10 to 60 seconds the stain is poured off and the excess stain is rinsed with water the goal is to was the stain without losing the fixed culture. And then Iodine solution is poured off and the slide is rinsed with running water. A few drops of decolourizer is added to the slide. Thus the decolourizers are often the mixed solvent of 95% of ethanol and acetone. Then add safranin for about 1 minute and wash with water. Air dry blot dry and observe under microscope.

Examine the slide under the light microscope. It appears pink coloured since the violet dye washed through the thin cell walls, then the pink counter stain entered them. If the decolourizer ran too long, you may see false negative results. Stain a new sample if all bacteria types are gram-negative to double check your results.

Fig a. Streak plate method.

Fig b. Growth of culture is observed.

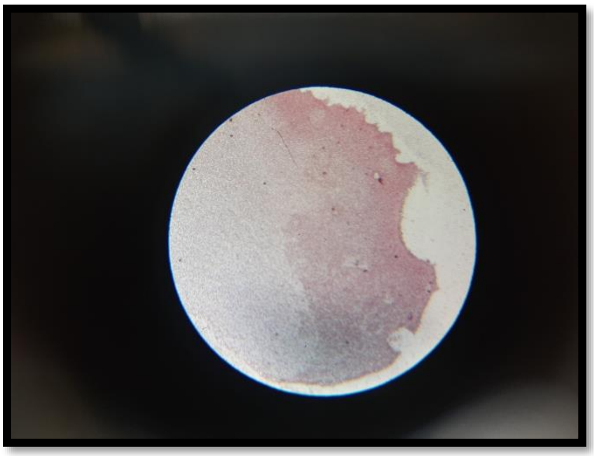

Fig c. Pink stained bacterial species are observed.

1.8.4 Conclusion:

The bioplastic produced through this method could be substantial and the biodegradable too and one of the main challanges in developing bio-plastic material.The new developments of bioplastics in future can cause the efficiency of production will be increase ,built up the new applications and new opportunities of bio-plastics.Furthermore,the future market for bio-plastics will be increasing owing to its sustainability. Besides the biotechnology of microorganism gives an opportunity to bioplastic manufacture because it could significantly apply and commercialize for various industries such as agriculture, medicine, pharmaceutical,veterinary etc,.

Banana peel bioplastic is a biodegradable and an environment friendly alternative to conventional plastics. The main advantage of bioplastics over conventional plastic is that they degrade in environment without creating any pollution. These type of bioplastics would reduce the dependency on petroleum based plastics this versatility of bioplastic plays key role in green applications.

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