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Synthesis of Bioplastics from Banana Peel

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Abstract
The term plastic is derived from Greek word Plastikos which means 'to mould'. Plastics can be pressed, mouldedand bent into various shapes such as containers, pipes, tubes, etc. Plastics have a wide range of synthetic and semi-synthetic materials which has huge application for commercial purposes. The plastics are made from fossil fuels such as coal, natural gas, and crude oil. Because of its low density, transparency, toughness, low cost, and impermeable to water, plastics are used all over the world for various purposes. It has become an integral part of our daily lives. It is non-degradable; it sticks in the environment for ages and produces toxins that result in the emission of greenhouse gases like CO_2 etc., which is the major cause of global warming. Manufacturing Bioplastics is a better alternative and eco-friendly way to overcome all these problems. The objective of this study is to synthesize Bioplastics from banana peel which serves as an alternative to petroleum-based plastics. The Biodegradability of the bioplastics was also studied. The solubility test and swelling's test were carried out to check whether the bioplastics retain their original properties, persistence, and tolerance to various solvents. Hence the bioplastic produced can be used for various commercial purposes.

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INTRODUCTION

Plastic was discovered by German chemist Christian Schonbein in 1846. Fossil fuels (coal, natural gas, and crude oil) have compounds containing hydrogen and carbon (hydrocarbon) which act as building blocks for long polymer molecules, they link together to form long carbon chains called polymers. Polymers are repeating units of monomers. The property of plastics is determined by molecular structure, molecular weight, and the physical and chemical nature of polymers. These properties made plastics withstand and tolerate any degree of temperature, solvents, heat, etc., and made them convenient for packaging. Due to its easy availability, it is being used all over the world, resulting in a certain volume of waste per year and its non-degradability is a serious environmental problem.

These plastics are non-biodegradable and also produce toxins during degradation. It remains in the environment for a long time and adversely affects biodiversity. The population growth has led to the high accumulation of plastics in the world all over the years. It has become a major problem in the environment. Plastics sticks in the environment for ages, it threatens wildlife and spread toxins that contribute to global warming and non-biodegradable pollution. There is a better alternative and eco-friendly way to overcome all these problems is by manufacturing Bioplastics.

Bioplastics can be defined as biodegradable plastics which are made from vegetable and fruit waste such as banana peel, potato peel, etc. It serves as an alternative to petroleum-based plastics. They are environmentally friendly, biodegradable, plant-based, and less toxic. The use of Bioplastics saves non-renewable sources of energy, reduces carbon emission, reduces global warming and it also provides an eco-friendly solution. Bioplastics can be used as a substitute for conventional plastics. Bioplastics also possess many properties such as tensile strength, elongation, tear strength etc. Bioplastics can be used for making shopping bags, bottles, containers, mulch films, and toys and also can be used for food packaging. Common food waste is banana peel which is a good source of starch and easily available and environment friendly. Therefore, banana peels may be steered an appropriate supplies for the production of Bioplastics.

Banana peels are a great source of starch. The banana peel is the major waste of banana processing industries. Starch is the major carbohydrate found in plants and it is made up of two types of polymer chains, they are amylopectin and amylose. Starch is brittle. To enhance its flexibility we can use plasticizers such as sorbitol, and glycerol which convert starch into thermoplastic starch. Amylose is responsible for film formation in bioplastics. The amylose found in starch is capable to make the films flexible, heat tolerant, water soluble, etc. As banana peels, starch content will be high and it can be used as a suitable material for the production of bioplastics. People consume the pulp of bananas and dump the peel as waste. Production of bioplastics from the banana peel is an effective solution, as it promotes the reduced usage of non-renewable raw materials. The main component of peel is starch. This starch acts like a thermoplastic in the presence of a plasticizer. For the production of bioplastics, food waste seems to be an effective choice.

MATERIALS AND METHODS

Materials Required:
Banana peel, Glycerol, $Na_2S_2O_5$ (Sodiummetabisulphite), NaOH (Sodium hydroxide), HCl (Hydrochloric acid), and distilled water.

Preparation of Banana Peel:
The banana peels (plate: 1-a) were peeled off from 6-7 bananas. It was washed and then cut into pieces with a knife. The pieces of banana peels were immersed (plate: 1-b) in a 0.2 N solution of Sodium metabisulphite for about 45 minutes. The water was decanted from the beaker. The banana peels were boiled (plate: 1-c)in water for about 30 minutes and the peels were taken out from the beaker and they were left to dry for about 30 minutes on filter paper(plate: 1-d). After drying the peels were made into uniform paste using mortar and pestle. Now the paste is ready for biofilm production, (Prof. Manasi Ghamande *et al.,* 2018).

Preparation of Biofilm from banana paste:
The banana paste of 25 gram is taken in a beaker. 0.5 N of 3 ml HCl is added to the beaker and it is stirred using glass rod. 0.5 N of NaOH is added and again stirred. The mixture was poured in a glass petriplate and it is spread throughout it for a uniform thickness. The petriplate was heated in an oven at 130□ C for about 30 minutes. After it was taken out from the oven and then it was allowed to cooled and scraped off from the pertiplate as the bioplastics film.(Prof. Manasi Ghamande *et al.*, 2018)

Mechanism
The Sodium metabisulphite is used as antioxidant and preservative which inhibits the growth of microorganisms. The HCl is used for the hydrolysis of amylopectin ,since it restricts the biofilm formation. The Sodium hydroxide is

used for the neutralization of pH. The Glycerol is used as a plasticizer.

Characterization of synthesized bioplastic:

Swelling's Test:

This test is conducted to check whether the biofilm retains its original condition and properties. A particular amount of pre-weighed sample was immersed in various solvents such as chloroform, ethanol, distilled water, and methanol containing in different test tubes. The results were recorded, (Rizwana Beevi. K *et al.*, 2020).

Solubility Test:

The solubility test was carried out to check the tolerance and persistence capacity of the biofilm produced. The biofilm was made into small pieces and then it was immersed in various solvents like sulphuric acid, ammonia, acetone, ethanol, acetic acid for their solubility and persistence, (Rizwana Beevi. K *et al.*, 2020).

Biodegradation Test (Soil Burial Test):

The produced biofilm and the petroleum based conventional plastics were buried in different pots contains soil for several days. The results were recorded based on their biodegradability. (SupriyaNandlal *et al.*, 2019).

RESULTS AND DISCUSSION

Banana peels for biofilm production

Banana Peels immersed in Sodium

The Peels are boiled in distilled water

The boiled peels are kept for drying

Plate 1: Showing the preparation mechanism of Banana Peel

Preparation of banana paste from banana peels:

The result of preparation of banana peels was presented in plate-2, and the result of the study showed that the banana paste obtained from banana peel were brown in colour.

Plate 2: showing results of biofilm production

Solubility test of biofilm prepared from banana peel:

The biofilm was made into small pieces and then it was immersed in various solvents like sulphuric acid, ammonia, acetone, ethanol, acetic acid for their solubility and persistence. The result of solubility test of bioflim was shown in Plate – 3and table -1.The results of the solubility test revealed that the material was insoluble in Acetic acid, Methyl alcohol, Acetone, and partially soluble in Ammonia, and completely soluble in Sulphuric acid. Solubility plays a major role in selecting a sustainable biomaterial for bioplastic preparation. Bioplastics are not only efficient to produce at low cost but also (eco-friendly) biodegradable .

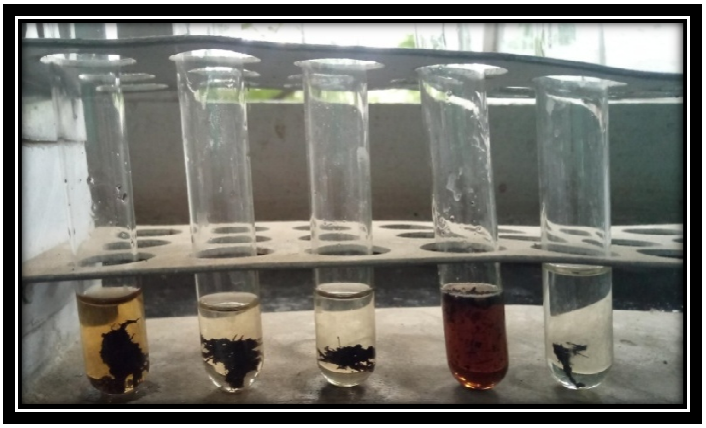

Plate 3: showing results of Solubility Test.

Table 1: Showing results of Solubility test

S. No	Solvents Used	Insoluble	Partially Soluble	Soluble
1	**Ammonia**	-	+	-
2	**Acetic Acid**	+	-	-
3	**Sulphuric Acid**	-	-	+
4	**Methyl Alcohol**	+	-	-
5	**Acetone**	+	-	-

Swelling's test of biofilm prepared from banana peel:

The results of the swelling's test of biofilm were shown in plate-4 and table 2. The study showed that there was no much change in sample when it was soaked in Distilled water, chloroform and methanol, but slight increase in weight was observed. The results also shows that low amount of differences in weight in water, chloroform, methanol are more desirable to be a bioplastic material.
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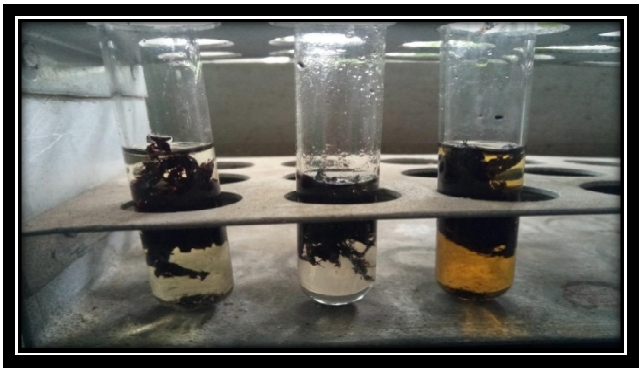

Plate 4: showing results of Swelling's Test

Table 2: showing results of Swelling's test

S. No.	Sample	Solvent medium	Quantity	Initial weight(gm)	Final weight(gm)	Difference in weight(gm)
1.	Synthesized biofilm	Distilled water	5 ml	0.35	0.38	0.03
2.		Methanol	5 ml	0.35	0.39	0.04
3.		Chloroform	5 ml	0.35	0.36	0.01

Biodegradation test of biofilm prepared from banana peel:

The result of the biodegradability test using SBT method was shown in plate-5. It was seen that the degradation of biofilm occurred within 100 days. There was weight loss of bioplastic seen, when the longer burial time.

Starch has acetyl bonds which are very easy to degrade. The magnitude of this mass reduction was due to the bioplastic composition was a natural material, that is easily digested by microbes. The natural polymer containing a hydroxyl group (-OH), which was helps the microbes to degrade. The rate and mechanism

of biodegradation of plastic materials are strongly influenced by temperature, oxygen, humidity and microbial conditions of polymeric materials (Nissa *et. al.,* 2019).

Plate-5: Showing results of Biodegradation Test

CONCLUSION

The present study is carried out to produce bioplastics from banana peel which serves as an alternative to conventional plastics. Plastics are widely used because of their low cost, impermeablility to water, and easy availability. Plastics are made from fossil fuels, which are nonbiodegradable. The population growth resulted in a high accumulation of plastics which is a major problem for the environment and biodiversity. Plastic pollution results in global warming due to the emission of green house gases and toxins. There is an alternative and eco-friendly way to overcome all these problems by producing Bioplastics. Bioplastics are biodegradable plastics that are made of vegetable and fruit waste such as Banana peel, and potato peel. They are biodegradable and reduce CO_2 emissions. Banana peels are a great source of starch which is a good raw material for bioplastic production. The biofilm waste was produced by adding glycerol, NaOH, HCl to the banana peel paste and made as a film the solubility and swelling's test was conducted to check the tensile strength, and a biodegradation test was carried out to check the biodegradability of the film. To conclude that the study was carried out for the synthesis of bioplastics this serves as a substitute for conventional plastics and also reduces global warming by lowering the emission of greenhouse gases and toxins. The bioplastics are biodegradable which is good for the environment.

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