PRODUCTION OF BIOPLASTIC FROM BANANA PEELS

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ABSTRACT

Plastic are essentially a by-product of petroleum refining and its industry is considered one of the most essential industries because plastic, today, is practically ubiquitous. Right from sheets, rods, building blocks and domestic products. But extreme use of plastics can lead to damaging effects and degradation of these plastic requires more than 500 years to decompose completely, releasing toxic elements in the environment. It also affects human by destroying thyroid hormone axis or hormone levels.

Thus, the biodegradable plastic becomes the encouraging result to solve all this problem. The objective of this study was to produce biodegradable plastic from banana peels as a substitute for the conventional plastic and to prove that the starch in the banana peel could be used in the production of the biodegradable plastic. Degradation of bioplastic in soil was determined.

The physical parameters of soil were tested by growing moong seeds in the soil containing biodegradable plastic and compared with natural soil. The physical parameters of soil and plant such as heavy metals were also determined. Based on all the testing that was carried out, the biodegradable plastic from banana peels was found to be the best and ecofriendly than synthetic plastic. Hence, it can be used in the industry for various application such as molding and packaging, at the same time rescuing the environment from potential harm by synthetic plastics.

Keywords- Bioplastic, Banana peels, Biodegradation, Plastic

INTRODUCTION

A large part of the plastic that we see around us is made of three- dimensional cross- linked networks, so-called ‘thermoset plastics. The classic example being Bakelite, the phenol formaldehyde-based resin invented in the early 20th century. Most of the plastics today, still use the same basic compounds.

Today’s resins are all based on petrochemical sources, whose production involves highly toxic ingredients such as epichlorohydrin and phosgene. Phosgene is the same gas that was used during the First World War as a means of inducing death by choking. These are non-biodegradable and highly toxic, since their combustion releases several pulmonary irritants.

As of 2018, a staggering 380 million tons of plastic is produced worldwide each year. That’s nearly equivalent to the weight of the entire human population.

In total, half of all plastic produced is designed to be used only once- and then thrown away. Plastic waste is now so ubiquitous in the natural environment that scientists have even suggested it could serve as a geological indictor of the Anthropocene era. If current trends continue, our oceans could contain more plastic than fish by 2050.

Considering the ongoing scenario, it has become essential for us to look for other forms of usable products that can be as flexibly used as plastic is. And this need was correctly acknowledged by several scientists in the past years who have tried to come up with various biodegradable, ecofriendly, and economic options that can replace plastic. Options that can be degraded by microbial actions to produce natural end products in a reasonable amount of time. But most of the options, (example plastic made from PHA) are expensive since the extraction of PHA as a raw material for plastic manufacturing is difficult.

This project aims to present a workable substitute to replace petroleum-based plastic, while providing all the usable attributes of it minus the negative, non-ecofriendly toxic behavior of it. Banana peels contain starch and its ability to conform into a polymer was exploited to manifest a biodegradable form of plastic. The degradation of this plastic was tested to judge its nature-friendliness and it can be safely said that it does not leave traces behind after a reasonable amount of time.

It’s time that we realize that as inhabitants of this planet Earth, if our planet’s resources are available at our disposal, it is our responsibility to shield our sole provider.

Extraction of starch from the banana peels:

Banana peels were collected from the waste disposals of local markets. The peels were the cleaned to remove any possibility of macro contaminants. After slicing them to a thickness of 5 to 10 mm, they were soaked in Sodium metabisulphite to prevent browning. This was followed by boiling the soaked peels in a beaker of distilled water for thirty minutes. The water was decanted, and the peels were left to dry on a filter paper, after which they were grinded to a paste like consistency. (Manimaran *et al*., 2016)

Production of biodegradable plastic from the peels:

A solution of corn starch with water was made and boiled for thirty minutes, and 100 grams of the formed banana peel paste was added to it. Subsequently,16ml of vinegar, 7ml of glycerol, 2ml of formaldehyde and 3ml of triton X-100 were added to the solution. The prepared solution was mixed adequately and kept in the oven for drying for three to four hours. (Manimaran *et al*.,2016)

Biodegradation test of the biodegradable plastic:

The bioplastic is cut into circular shapes of specific diameter and kept in natural soil for a period of 70 days. This specimen was collected at a regular time interval (7days) from the soil and wash gently with distilled water. The specimen was dried at 50℃ until a constant weight was obtained. Loss of weight of the specimen with respect to time was used to determine the rate of biodegradation of the specimen by following equation: (Manimaran *et al*., 2016)

$$\text{Degradation \%} = \frac{\text{initial dry weight} - \text{final dry weight}}{\text{final dry weight}} \text{ x } 100$$

Estimation of protein and carbohydrate content of the prepared bioplastic:

Varying quantities of bioplastic was added to soil in different containers, after which moong seeds were grown on the same soil, with adequate sunlight and water. Along with this, a control plant of moong was grown in the same environment. After adequate growth, their protein and carbohydrate content were estimated by Folin Lowry's method and Anthrone method respectively.

Estimation of minerals in the plants grown and the soil containing bioplastic:

Minerals such as phosphorous and iron were extracted by nitric acid and perchloric acid in the ratio 2:1 and the samples were analysed by ICP-AES. The quantities of moong plants (3.2 gm) and soil (2 gm) were taken.

Trypsinization

Take a chick tissue sample in a petridish containing sterile PBS and then transfer the tissue sample into sterile petridish with 5ml sterile PBS (containing gentamycin 5mg/ml). Wash the tissue sample twice with sterile PBS to clean all the traces of blood (2-3ml). Transfer the tissue sample to the sterile beaker and add 1ml of sterile PBS and 1ml of 0.25% trypsin into it. Chop and mix the tissue for 1 minute exactly and keep at 37℃ for 5 minutes. After 5 minutes of incubation, immediately add 1ml of sterile BME containing serum and then filter with sterile muslin cloth into the beaker. Transfer the filtrate into sterile centrifuge tube and centrifuge it at 1000rpm for 5 minutes. Discard the supernatant and distribute the pellet into two. In one pellet, 2 ml of standard BME was added, while in the other, 2 ml of BME containing 1 gm bioplastic was added. Mix well or trichurate and repeat the process twice. Discard the supernatant, resuspend the pellet in 1% sterile media. Divide the trypsinized sample in to 2 parts for monolayer formation and viability test.

Protocol for viability testing

0.9ml of cell suspension was taken and 0.1ml of 0.4% trypan blue was added. Incubate at 28 for 3-4 minutes. Observe the viable and non-viable cells on glass slide at 45X magnification. Calculate % viability.

$$\text{\% viability} = \frac{\text{viable cells}}{\text{total cells}} \times 100$$

Result and discussion

Production of biodegradable plastic from the peels:

The banana peels were moulded into definite shapes such as bowl and holder and further it can be made into plates or bags.

Fig 1: BOWL

Fig 2: HOLDER

Fig 3: BOWL

Biodegradation test of the biodegradable plastic:

The biodegradability of the bioplastic was determined by allowing it to degrade in soil and it was observed that after a time period of 70 days, the initial weight of the plastic 15.02gms had reduced to 1.02gms by its degradable property.

Table 1: Biodegradation test

Days	Weight of degradation	% degradation
1st day	15.02	-
7th day	14.01	7.65
14th day	12.99	7.85
21st day	11.80	10.08
28th day	10.20	15.68
35th day	8.56	19.15
42nd day	6.02	21.76
49th day	4.58	31.44
56th day	3.25	40.92
63rd day	2.22	46.39
70th day	1.23	80.48

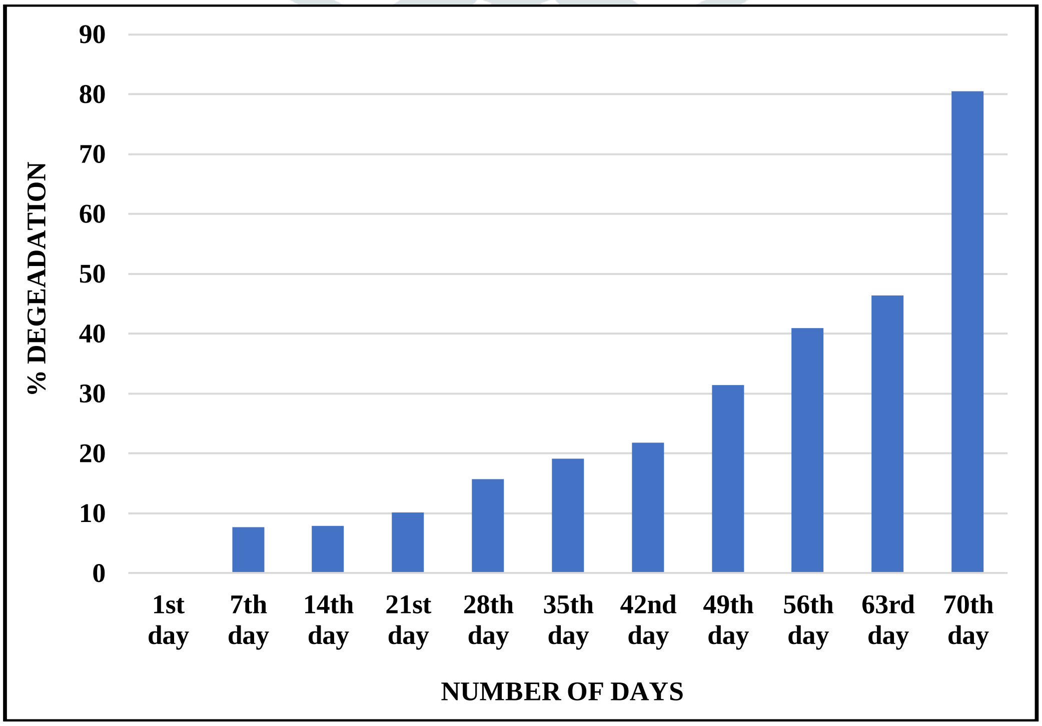

Fig 4: Bioplastic degradation

Estimation of protein and carbohydrate content of the prepared bioplastic:

Fig 5: Control plant

Fig 6: 4 grams

Fig 7: 8 grams

Fig 8: 12 grams

The protein concentration increased when compared with the control plant, but the protein concentration decreased as the concentration of bioplastic increased in the soil.

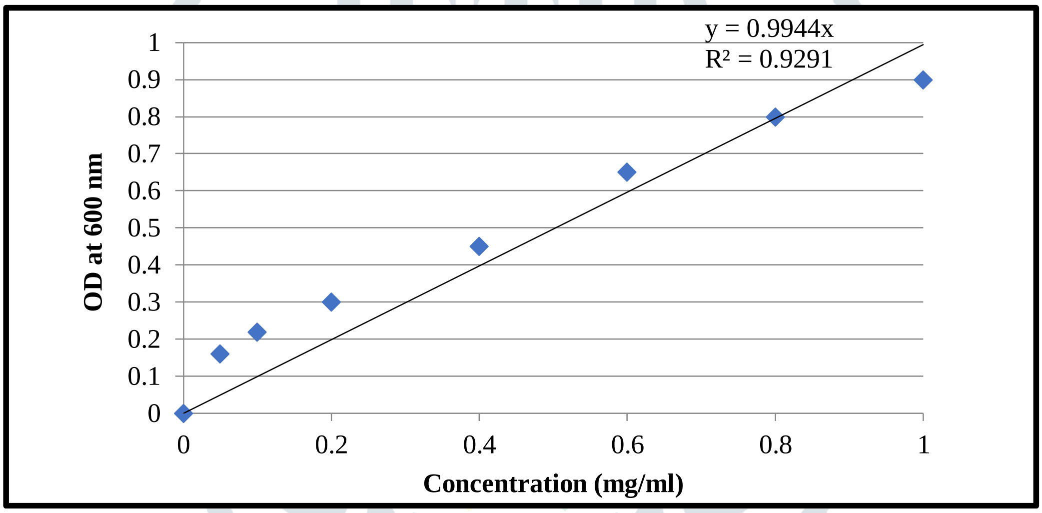

Fig 9: Standard graph of protein estimation

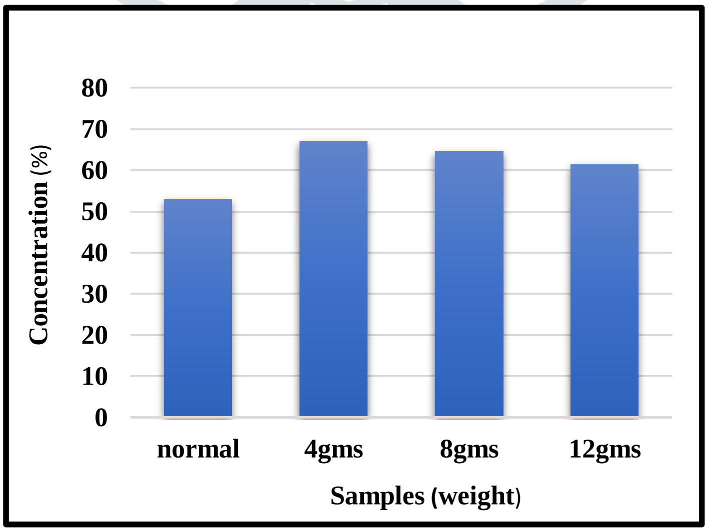

Fig 10: Sample graph of protein estimation

The carbohydrate concentration increased when compared with the control plant and carbohydrate concentration increased as the concentration of bioplastic increased in the soil.

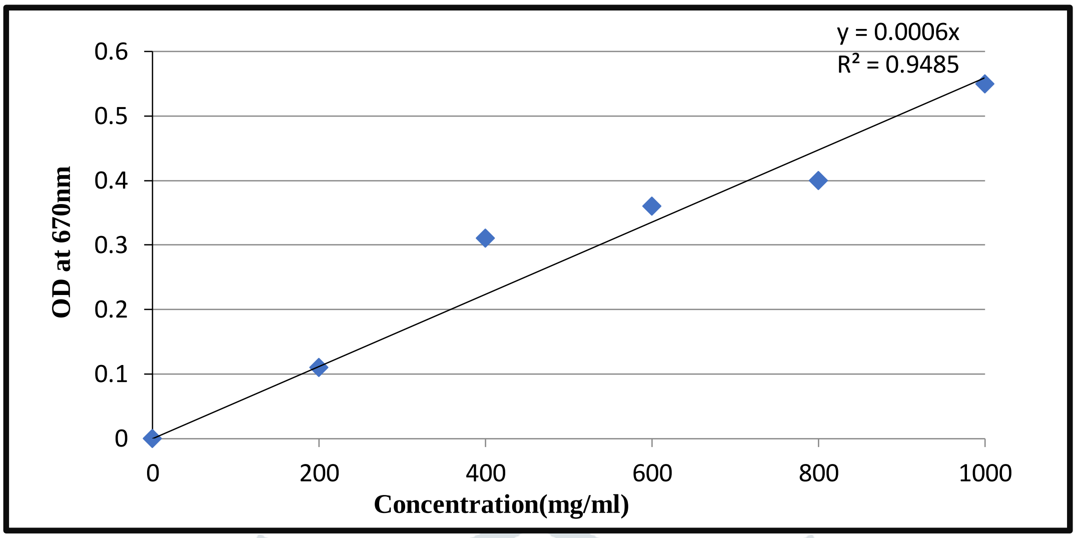

Fig 11: Standard graph of carbohydrate estimation

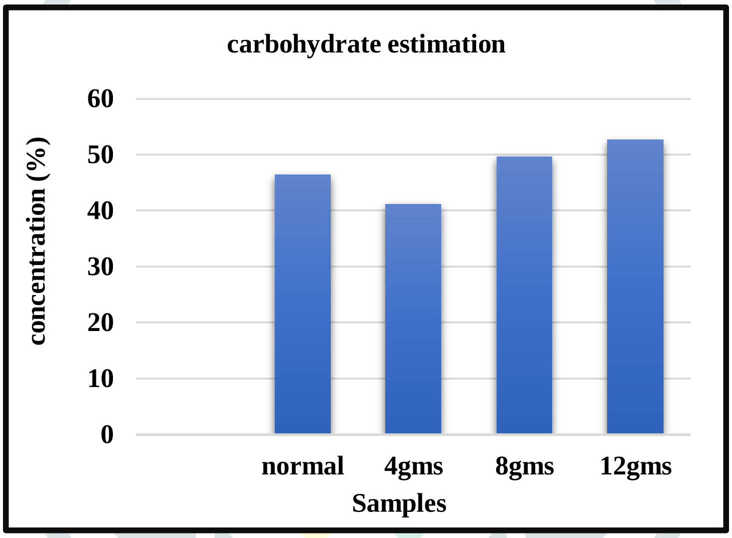

Fig 12: Sample graph of carbohydrate estimation

Estimation of minerals in the plants grown and the soil containing bioplastic:

Phosphorus content of soil and plant

The phosphorus content of control soil was found to be 35.37 ppm and when compared with the soil containing 4 grams of bioplastic, the phosphorus content increased to 58.20, similarly the soil containing 8 grams of bioplastic contained 41.41 ppm of phosphorus but in soil containing 12 grams of bioplastic the phosphorus content decreased to 33.58 compared to control soil.

The phosphorus content of control plant was found to be 4.2084 ppm and when compared with the plant containing 4 grams of bioplastic in the soil, the phosphorus content increased to 5.3284, but in both the plant *i.e.* 8 grams and 12 grams of bioplastic in the soil, the phosphorus content decreased to 2.378 and 1.4999 ppm of phosphorus respectively.

Iron content of soil and plant

The iron content of control soil was found to be 6960.81 ppm and when compared with the soil containing 4 grams of bioplastic, the iron content increased to 8684.44, similarly the soil containing 8 grams of bioplastic contained 7454.5 ppm of iron but in soil containing 12 grams of bioplastic the iron content decreased to 6407.05 compared to control soil.

The iron content of control plant was found to be 8.3895 ppm and when compared with the plant containing 4 grams of bioplastic in the soil, the iron content increased to 16.7671, but in both the plant *i.e.* 8 grams and 12 grams of bioplastic in the soil, the iron content decreased to 7.9607 and 6.5874 ppm of iron respectively.

Table 2: Iron and phosphorus content

Sample	Phosphorus content in ppm	Iron content in ppm
Control soil	35.37	6960.81
4 grams	58.20	8684.44
8 grams	41.41	7454.5
12 grams	33.58	6407.05
Control plant	4.2084	8.3895
4 grams	5.3284	16.7671
8 grams	2.378	7.9607
12 grams	1.4999	6.5874

TRYPSINIZATION

The viability of live animal cells was performed to determine whether it is toxic or not, trypsinization method was performed on live chick liver cells and it was found that all the liver cells were viable and the bioplastic did not impact the cells in negative manner.

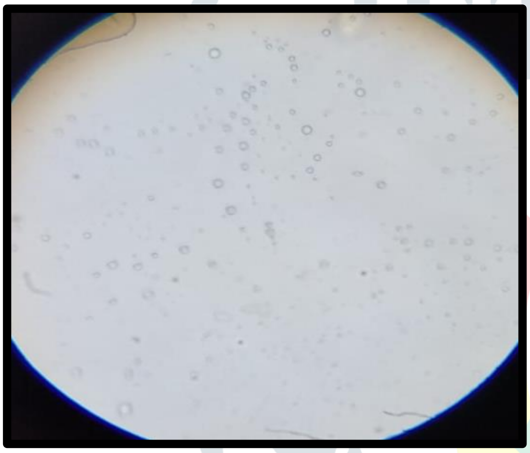

Fig 13: Chick liver cells without bioplastic

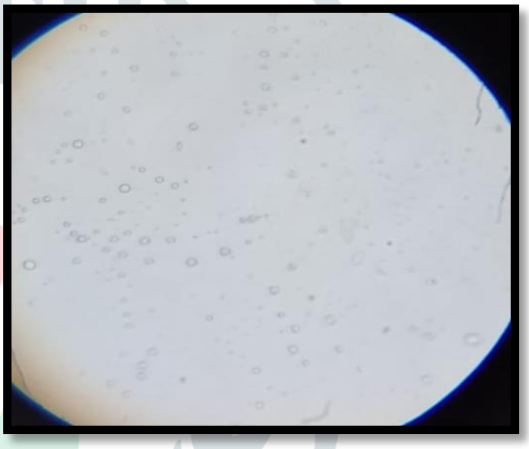

Fig 14: Chick liver cells with bioplastic

CONCLUSION

Plastic pollution is a worldwide concern today. Various scientists, researchers have been trying to find alternatives to the plastic that we use today, that's highly toxic on burning, is non bio degradable, and a huge burden on this planet.

Finding other nontoxic, biodegradable materials that can fulfil the uses that plastic has been used for, and is still economical, is very important for mankind today. And this project was just a step forth.

The bioplastic made from banana peels in this experiment was able to be molded and used in a way that plastic was used. If further processing will be possible sometime in the future, this bioplastic seems a promising replacement to the toxic form of petroleum-based plastic. It was comparatively easy to make, and the eco-friendly nature of it can be portrayed by the fact that moong plants were able to grow healthily in the same soil in which it was degraded, with the advantages of increased carbohydrate and protein levels. This bioplastic also, does not require a very heavy manufacturing system. Considering the economic aspect, the cost went into producing this plastic is less because it practically uses waste to produce something useful. A lot of work and processing still needs to go into this project, but it still is reassuring enough for us to move forth with the future that it holds. After all, it's our future, and it's our responsibility to make it secure, peaceful and safe.

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