A STUDY ON BIOBASED PLASTIC MADE FROM (*PANICUM MILIACEUM)*

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ABSTRACT

Bioplastics are man-made materials that behave like regular plastics but, because of microbial activity, decompose into water and carbon dioxide. Starch is a naturally occurring polymer that can be used to create bioplastics. Biobased polymers have the potential to replace petroleum-based plastics due to their biodegradability and renewable nature. Bioplastics reduce environmental hazards because they are non-toxic to marine life, biodegradable and compatible with humans. In this article, glycerol and vinegar were used to synthesise bioplastics from Proso millet (*Panicum miliaceum).* In order to analyse the performance of the synthetic bioplastics made from Proso millet, Bio degradability in natural soils were conducted. Further characterization was done by using UV spectroscopy- Fluorescence, FT-IR, XRD.

Key words: Bioplastics, *Panicum miliaceum*, degradability, biopolymer, environment, swelling ratio, starch, elongation, solubility.

1.INTRODUCTION

Polymers are among the most widely utilized and adaptable materials even though they were first introduced over a century ago. However, because plastics have negative environmental effects, society is inherently divided about them, which is why bioplastics are becoming more and more popular [1]. The petrochemical market information provider ICIS states that a new and exciting era of bioplastics commercialization has begun with the emergence of bio-feedstocks and bio-based commodity polymers production, rising consumer consciousness, and improving economics. Still, a number of critical considerations will determine where bioplastics fall on the commercialization spectrum: economic viability, product quality, and operational scale [2]. Beyond 300 million tons of synthetic polymers ("plastics") are produced annually; the majority of them are manufactured from petrochemicals. them materials have supplanted conventional materials including steel, concrete, wood, stone, horn, ceramics, glass, leather, and so forth [3]. These materials possess numerous qualities, including being water-resistant, resilient, affordable, and simple to handle. Their availability has made it feasible to utilize them for purposes that were previously unattainable. A range of characteristics, including hardness, density, electrical isolation, thermal insulation, and resistance to heat, organic solvents, oxidation, and microbes, characterize plastics, which are composed of polymers and additives [4]. There are hundreds of different kinds of plastics, and even within one kind, there are multiple grades (such as high viscosity PP for extrusion, low viscosity PP for injection molding, and mineral-filled grades). Polymeric materials have almost limitless uses; they are employed in architecture and construction, as colloids in paintings, as toys, furniture, appliances, and cars, to mention a few. Plastics can be formed into films, fibers, tubes, plates, and other shapes, as well as into things like boxes and bottles [5]. On sometimes, they are the best technology on the market. While some plastic products are made with long-term uses in mind, many are meant for short-term use. (Eg. plastic pipes, which are designed for lifetimes in excess of 100 years).

2.MATERIALS AND METHODS

2.1Preparation of Bioplastics

2.1.1 Extraction of Starch from Proso Millet

50 g of good quality Proso millet was powdered finely in a blender. The powdered Proso millet was then mixed with 100 mL of distilled water and stirred well, till the powder mixed well with water. It was then filtered through the muslin cloth to remove the larger particles in the filtrate. The filtrate was then allowed to stand for more than 6 hours. After that the clear solution at the top was separated by decantation, leaving the sediment starch in the bottom of the beaker. It was then dried for an hour at 120°C in a hot air oven, the fine starch was thus extracted from the Proso millet.

2.1.2 Preparation of Proso Millet Bioplastic (PMB)

3.5 g of Proso millet starch was dissolved in 10 mL of distilled water in a 50 mL beaker. To this, 5 mL of vinegar was added and stirred well. The beaker was then heated to 40°C in a hot plate. To this mixture, 4 mL of the glycerol was added and the mixture was heated in a hot plate for about 3 - 4 hours. The heating process was stopped when the mixture becomes thick paste. It was immediately poured and spread over the aluminum sheet, when it was hot. The care was taken to make the sheet with uniform thickness. After this, the sheet was exposed to sunlight for 2 days, so that it was dried completely. Finally, the bioplastic films thus formed were peeled off from the aluminum sheet. The prepared bioplastic from proso millet was named as proso millet bioplastic.

3.RESULTS AND DISCUSSION

3.1 Synthesis of Proso Millet Bioplastic (PMB)

The plant-based starch was prepared from good quality pure Proso millet. The prepared starch was used to fabricate bioplastic by using vinegar and glycerol. The thick paste was spread over the aluminum sheet, with uniform thickness and dried in shade for 2 days and then in hot air over for 2 hours at 120˚C. Finally, the bioplastic films thus formed were peeled off, successfully obtained a thin sheet of bioplastic for further testing.

Figure 3.1 Thin Sheet of Bioplastic (PBM)

3.2 Characterization

3.2.1 XRD Analysis

XRD diffraction with a 2θ $45^0$of Bioplastic, using CuK alpha (1.54060A^0). The2θ formed is 45.55^0. Based on the XRD diffractogram showing based on JCPDS Card No. 96-411-9773 regarding hkl (211). The crystal phase of this system orthorhombic with a lattice parameter of a axis -12.28420A^0, b axis - 7.65370A^0, c axis – 7.51510A^0 respectively, the addition of high temperature influences the crystanality and structural phase of material. The crystalline size was Calculated by Debye-Scherer formula,

$$D = \frac{K\lambda}{\beta\ cos\theta}$$

Where**,** **D** - Average crystalline diameter in nanometre (nm);**K** - Scherer constant equal to 0.9;

λ - Wavelength of the X ray radiation used and is equal to 1.5406A^0;**θ**- Bragg diffraction angle of the concerned diffraction peak.

Table 3.2.1: Determination of Crystalline Size (D)

2θ	θ	$Cos\theta$	β	D
45.5508	22.7754	0.9220	0.4080	3.8489

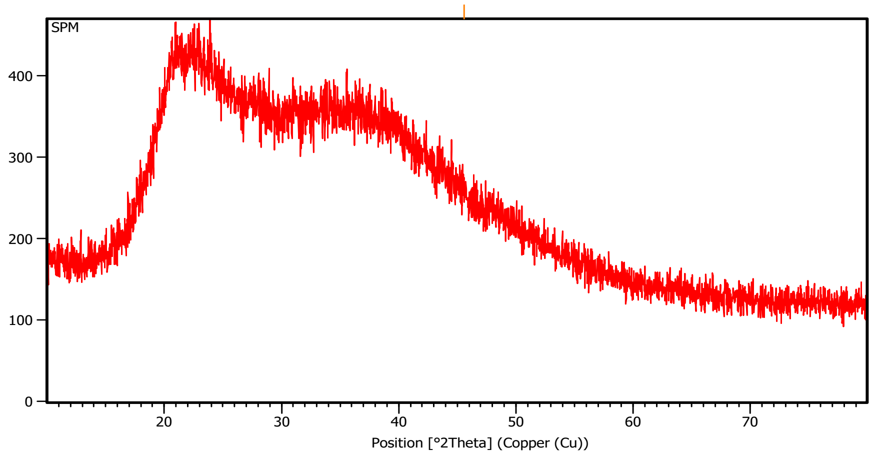

Figure 3.2 XRD for PMB

3.2.2 FT- IR Absorption Spectroscopy

The FT-IR spectrum of PMB was shown in the figure 5.6 in the spectrum the sharp band at 1026.15 cm^{-1} corresponding to the stretching vibration C-O bond. The band around 3278.99 cm^{-1} is O-H stretching vibration for carbohydrate protein and polyphenols. The band around 2931.80 cm^{-1} can be referred to the C-H stretching vibration in presence of alkane.

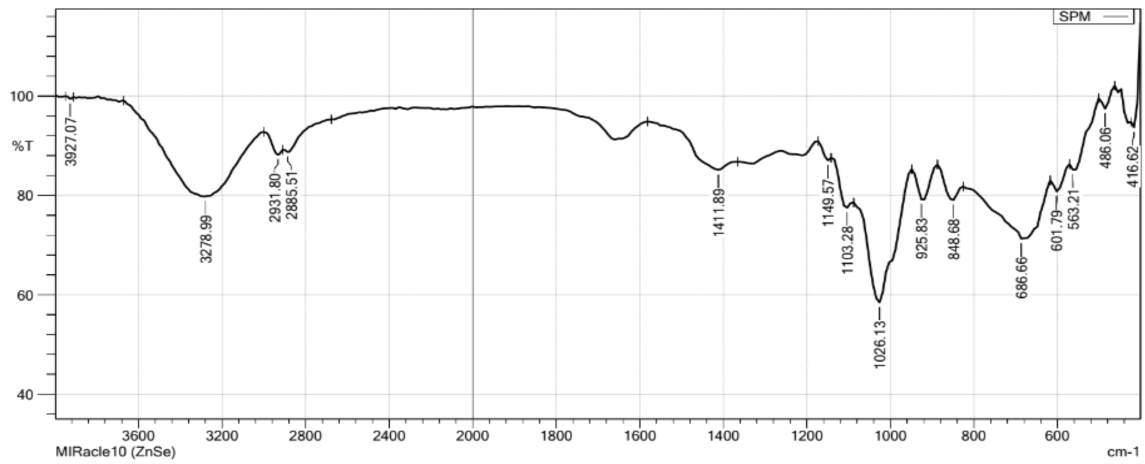

Figure 3.3 FT-IR spectrum of PMB

3.2.3 UV-Visible Spectroscopy

The UV visible spectrum of PMB was shown figure 5.7. The spectra was recorded in the range of 200-900nm. For PMB sample, the maximum absorbance obtained at 454nm. The value is similar to the UV absorbance of starch-based bioplastics. This indicates the bioplastic absorbed UV light especially in UV- A region.

Table 3.2.3 UV-Visible Spectra Data for PMB

Sample	Absorbance	Wavelength(nm)	Energy
PMB	0.500607	220	5.6364
	0.67321	243	5.1029
	0.930797	366	3.3879
	1.0396	454	2.7313

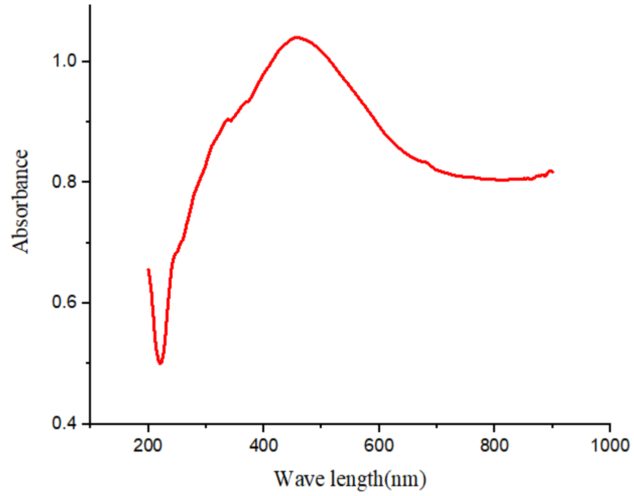

Figure 3.4 UV-Visible Spectrum of PMB

Calculation ofBand gap energy

The band gap energy in a bioplastic could be obtained from the absorption maxima. According to quantum confinement theory, electrons in the conduction band and holes in the valence band are spatially confined by the potential barrier of the surface. Form the absorption peak the energy band gap of PBM has been calculated using the formula.

$\mathbf{E_{gn} = hc / \lambda gn}$

Where,

h – Plank's constant

E_{gn} - Energy band gap of the semiconducting nanoparticles in the optical spectra.

Thus, the calculated band gap energies for PMB were 5.6364, 5.1029, 3.3879 and 2.7313 eV.

3.2.5 UV-Visible Fluorescence

The fluorescence spectrum for synthesized Proso millet bioplastic recorded between the range excited at 200 – 900nm and excited at 534nm. The synthesized polymer film sample forms the emission band with high intensity 220.

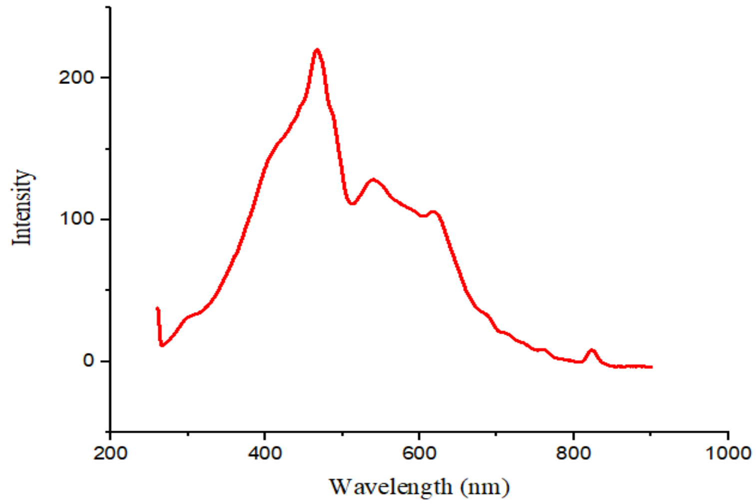

Figure 3.5 Fluorescence spectrum of PMB

3.3 Application

Food Preservation

A bioplastic was prepared, and two similar apples were acquired for the test. One apple was coated with the freshly made bioplastic, while the other apple was left uncoated to serve as a control. Both apples were placed in a controlled environment for 10 days. After this period, it was observed that the uncoated apple started drying out and showed signs of decomposition. In contrast, the apple coated with bioplastic remained fresh throughout the entire period, displaying no visible signs of rot or decay. This experiment highlights the effectiveness of the freshly prepared bioplastic in preserving the freshness of the apple and suggests its potential as a promising food packaging solution to extend the shelf life of perishable items.

Figure 3.6 Bioplastic Coated for Food Prevention

CONCLUSION

Proso Millet Bioplastic (PMB) was successfully synthesized from Proso millet by using vinegar and glycerol. The synthesized PMB was analyzed to find out the physical properties such as degradation in soil and characterized by UV-Visible Spectroscopy, Fourier Transform-Infra red Spectroscopy (FT-IR), X-Ray Diffraction analysis.

- XRD diffraction with a 2θ $45^0$of Bioplastic, using CuK alpha (1.54060A^0). The2θ formed is 45.55^0. Based on the XRD diffractogram showing based on JCPDS Card No. 96-411-9773 regarding hkl (211). The crystal phase of this system orthorhombic with a lattice parameter of a axis -12.28420A^0, b axis - 7.65370A^0, c axis – 7.51510A^0 respectively, the addition of high temperature influences the crystanality and structural phase of material. In the FT-IR spectrum, the sharp peak at 1026.13 cm^{-1} corresponding to the stretching vibration C-O bond. The band around 3278.99 cm^{-1} is O-H stretching vibration for carbohydrate protein and polyphenols. The band around 2931.80 cm^{-1} can be referred to the C-H stretching vibration in presence of alkane.
- The UV spectrum was recorded in the range 200-900 nm. For PMB sample the maximum absorbance obtained at 454 nm. This is similar to the UV absorption of starch-based bioplastics. This indicates that the bioplastic absorbed UV light especially in the UV-A region.The fluorescence spectrum was recorded between the range excited at 200-900 nm. The high intense emission peak excited at 534 nm. polymer film sample emission peak at with high intensity, form the emission spectral studies the sample PBM has high intensity.
- The biodegradability test in the soil shows that the PMB completely decomposed within 7 days. Hence PMB has high degradability nature the natural soil within a

week. This result is environmentally friendly and possesses no harm to the eco system.

- My test results supported its use for food packaging, underscoring its safety and potential as a beneficial packaging option.

4. REFRENCES

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