Green Plastic Revolution: Transforming Potato and Rice Starch into Bioplastic

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ABSTRACT

Introduction: Plastic is one of the polymers that are derived from petroleum hydrocarbon. Petrochemical plastic is used worldwide for packaging, construction, transportation, electronics, healthcare and household items, due to its economic viability, flexibility and resistance to air, water and heat (Ni'mah *et al*., 2023). But one of the most grievous problems faced by the world is plastic pollution, because of its non-degradable nature. The most common approach taken by the world is to discard plastic waste in land dumps, but it only worsens the situation by introducing microplastics in the ecosystem. Studies show that these micro particles disrupt marine life, accumulate in lifecycle and enters in our bodies through ingestion and inhalation (Gawande *et al*., 2024) (Navasingh *et al*., 2023) (Imoisili & Jen, 2023). Researches show that microplastic can increase respiratory problems, cardiovascular diseases, and can affect reproductive system. So, the solution lies in transitioning to bioplastic produced from sustainable sources, providing a viable alternative to existing materials.

This study is design to give the insight about the use of bioplastic over conventional plastic and to utilize various agricultural wastes to produce a bioplastic. Production of bioplastic made from agriculture wastes is an ecofriendly approach as it provides the sustainable waste management, other than that bioplastics have plenty of advantages like; when it degrades it will increase soil fertility.

Objective: The aim of the present study was to extract starch from potato peels and rice grains and use the starch for the development of biodegradable plastic.

Methodology: Bioplastic was prepared from potato peels starch and rice starch, taking research grade starch as control.

First, starch was extracted from potato peels and rice, potato peels were collected, washed and grinded with distilled water, followed by sieving, then the filtrate was left for 24 hours at 4 ºC to allow starch sedimentation. After 24 hours, starch was separated by decantation. Finally, the starch was allowed to dry at 37 ºC for 24 hours. The dried starch was stored in sealed bag. For extraction of starch from rice, rice was soaked in sterilized water overnight. After 24 hours, rice was grinded with water, and sieved. The filtrate was then left at 4 ºC for 24 hours to allow starch sedimentation. After 24 hours, starch was separated by decantation. Finally, the starch was allowed to dry at 37 ºC for 24 hours then the dried starch is stored in sealed bags.

For the preparation of bioplastic film, starch in different concentration was treated with 25ml of de-ionized and 2.5ml of plasticizers including glycerol and sorbitol. Then, it was heated on the magnetic heating plate until the thick paste was formed. The paste was then poured on to the petri plates lined with aluminum foil. This was then allowed to dry at 37 ºC for 4 days. Once the plastic film was dried it was peeled off from the foil and stored at 4 ºC until further analysis. After the formation of bioplastic film, characterization was performed including water solubility, alcohol solubility, and moisture content, absorption of water and biodegradation rate.

Result: The above results show that glycerol-based bioplastics have higher water and alcohol solubility, moisture content, water absorption and biodegradation rate while sorbitol-based bioplastics have lower

water and alcohol solubility, moisture content, water absorption and biodegradation. Bioplastics made with the incorporation of both plasticizer glycerol and sorbitol have properties moderately like both glycerol-based and sorbitol-based bioplastics.

Conclusion: In conclusion, this research gives insight about the potential of bioplastics from starch-based material as a greener substitute for plastics in several areas of research. Although these starch-based bioplastics show promise, challenges remain in achieving mechanical properties comparable to petroleum-based plastics. Future research should focus on finding other biopolymers, as well as cross-linking agents and reinforcement fillers to increase longevity without compromising on biodegradability. Overall, this work contributes to the understanding of the sustainable bioplastic production and shows the potential of the agricultural waste as an eco-friendly material for the production of bioplastic.

Keywords: Bioplastic, Eco-Friendly, Potato Starch, Rice Starch, Glycerol, Sorbitol.

Table 1. Characterization of Bioplastic Film Synthesized with Research Grade Starch.

Plasticizer	Starch Concentration (g)	Solubility In Water (%)	Solubility in Alcohol (%)	Moisture Content (%)	Absorption of Water (%)	Biodegradation (%)
Sorbitol	1g	79%	66%	3.4%	26%	80%
	2g	78%	58%	5%	50%	82%
	3g	61%	46%	4%	85%	70%
Glycerol	1g	-	-	-	-	-
	2g	95%	81%	14%	92%	90%
	3g	35%	41%	15%	92.5%	40%
Glycerol + Sorbitol	1g	-	-	-	-	-
	2g	65%	60%	15%	92%	64%
	3g	74%	65%	11%	79%	72%

Table 2. Characterization of Bioplastic Film Synthesized from Potato Starch.

Plasticizer	Starch Concentration (g)	Solubility in Water (%)	Solubility in Alcohol (%)	Moisture Content (%)	Water Absorption (%)	Biodegradation (%)
Sorbitol	0.5g	79%	73%	4.7%	75%	81%
	1g	74%	62%	4.8%	51%	78%
	1.5g	64%	75%	3.4%	57%	49%
Glycerol	1g	-	-	-	-	-
	0.5g	-	-	-	-	-
	1.5g	80%	93%	5.7%	53%	76%
Glycerol + Sorbitol	0.5g	-	-	-	-	-
	1g	86%	71%	9.9%	41%	79%
	1.5g	68%	66%	13%	131%	65%

Table 3. Characterization of Bioplastic Film Synthesized from Rice Starch.

Plasticizer	Starch Concentration	Solubility in Water (%)	Solubility in Alcohol (%)	Moisture Content (%)	Absorption of Water (%)	Biodegradation (%)
Sorbitol	1.5g	82%	78%	5%	57%	72%
	2g	78%	75%	3%	55%	70%
Glycerol	1.5g	-	-	-	-	-
	2g	83%	80%	6%	60%	76%
Glycerol + Sorbitol	1.5g	-	-	-	-	-
	2g	73%	70%	5%	90%	72%

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