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2 ND INTERNATIONAL SCIENCE, ENGINEERING AND TECHNOLOGY COLLOQUIUM



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PREFACE

Welcome to the 2nd International Science, Engineering and Technology Colloquium 2025 (ISETC 2025)!

It is with great pleasure that we present this year's colloquium, a distinguished gathering of scholars, researchers, and professionals dedicated to the advancement of applied sciences. Held virtually on 9th July 2025, ISETC 2025 serves as a platform to highlight cutting-edge research, foster meaningful networking, encourage collaborations, and explore innovative solutions to global challenges.

This year's theme, "The Power of Scientific Innovation: Intelligent Solutions for a Sustainable World" highlights our shared goal to solve global challenges through applied science. It celebrates innovation as a key to building a more sustainable and resilient future. We're proud to feature keynote speakers and presenters who bring fresh insights, bold ideas, and breakthroughs shaping tomorrow's world.

We would like to extend our heartfelt appreciation to the Faculty of Applied Sciences, Universiti Teknologi MARA, Perak Branch, Tapah Campus, for their outstanding support and assistance throughout the planning and execution of the event. Their dedication has been instrumental to the success of this colloquium. We would like to sincerely thank all participants and researchers for their valuable contributions. We also appreciate the reviewers for their careful evaluations and helpful feedback. Your hard work and support mean a lot to us.

As editors, we are proud to present this collection of proceedings. It is an honour to bring together the interesting and meaningful work of our speakers and authors. We hope the ideas shared will lead to new discoveries, encourage more research, and help solve global challenges through science and innovation.

Warm regards,

Dr. Emi Norzehan Mohamad Mahbob
Dr. Saiyidah Nafisah Hashim
Ms. Lili Widarti Zainuddin
Ms. Nurul Nazwa Mohammad
Ms. Rozaina Saleh

ISETC 2025 Proceedings Editors

SYNTHESIZE AND CHARACTERIZATION OF BIOPLASTIC FROM POTATO STARCH

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Abstract: Potato starch was extracted through peeling, rinsing, shredding, mixing with water, filtering, settling, and drying, then used to produce six bioplastic samples varying in starch content and glycerin/vinegar plasticizer levels. The mixtures were gelatinized by heating, molded, cooled, and stored before characterization. The main objectives of this study were to develop and synthesize bioplastic films from potato starch and to evaluate their properties using swelling, water solubility, and pH tests. Future research should aim to enhance the films' durability, water resistance, and assess their biodegradability under real-world conditions.

Keywords: *Potato starch, bioplastic film, plasticizers (glycerin, vinegar), water resistance*

INTRODUCTION

Since they can be used in practically anything, from food and home packaging materials to construction materials, textiles, agricultural tools, electronics, and car parts, plastics are widely used in modern life and have gained popularity (Abraham et al., 2020). Despite their lack of awareness regarding the origins, product usability, and overall ecological performance of bioplastics, consumers generally have a positive opinion of their use. Bioplastics may present businesses with a significant chance to improve the environmental sustainability of their goods (Brockhaus et al., 2016). Growing environmental concerns over non-biodegradable petroleum plastics have increased demand for biodegradable bioplastics derived from renewable sources such as starch, cellulose, and proteins. Starch is an abundant, cost-effective, and film-forming material ideal for bioplastic production. Enhancing glycerol and starch content can accelerate biodegradation; however, starch-based bioplastics face challenges related to mechanical strength, water resistance, and durability (Gurunathan et al., 2025). Recent studies focus on improving these properties by incorporating plasticizers, polymer blends, and adjusting filler concentrations. This research aims to sustainably produce starch-based bioplastics tailored for packaging, agriculture, and materials science by optimizing plasticizer balance to overcome previous limitations. The main objectives are to develop and synthesize bioplastics from potato starch and to evaluate their functional properties through swelling, water solubility, and pH tests. Potato starch is extracted by washing, peeling, grating, filtering, settling, washing, and drying. The starch powder is then mixed with glycerol and vinegar, heated and stirred into a homogenous gel, and cast into films. The resultant bioplastics are lightweight, fibrous, and flexible, exhibiting greater swelling in polar, surfactant-rich liquids like dishwasher detergent and greater stability in non-polar media such as cooking oil, with consistent behavior across acidic, neutral, and basic pH conditions. These findings demonstrate their suitability for sustainable packaging applications.

LITERATURE REVIEW

Bioplastics, made from renewable plant-based biomass like starch, cellulose, proteins, and lipids, offer eco-friendly, cost-effective, and non-toxic alternatives to conventional plastics by naturally degrading and reducing carbon emissions by 30-70% (Alobi et al., 2017). Starch-based bioplastics are particularly promising due to their abundance, low cost, and sustainability but face challenges such as poor water resistance and mechanical strength, which can be improved by adding plasticizers and polymer blends (Marichelvam et al., 2022). Potato pulp and peels serve as excellent raw materials for starch extraction, with pulp containing 50-70% starch and peels rich in fiber, enabling production of flexible and water-resistant bioplastics while offering an environmentally friendly way to manage potato waste and reduce costs (Ali et al., 2023). However, research lacks comprehensive evaluation of swelling behavior,

water solubility, and pH stability together. This study addresses that gap by characterizing these properties in potato starch-based bioplastic films to better predict their real-world performance (Kalita et al., 2021).

MATERIALS AND METHODS

The extraction of starch from potatoes involved peeling, rinsing, and shredding them to increase surface area for starch release. The shredded pulp was mixed with distilled water and strained through a muslin cloth to remove fibrous residues. The filtrate was left undisturbed for three hours to allow starch to settle, after which the supernatant was decanted and the sedimented starch was collected and ground into fine powder for bioplastic production. Six bioplastic samples were prepared by varying the amounts of key ingredients: samples A, B, and C had a constant 10 g of starch with differing glycerin and vinegar contents (A: 3 mL vinegar, 2 mL glycerin; B: 5 mL each; C: 7 mL vinegar, 8 mL glycerin), while samples D, E, and F had constant glycerin and vinegar (5 mL each) but varied starch masses (5 g, 10 g, and 15 g, respectively). Glycerin and vinegar acted as plasticizers to enhance flexibility and reduce brittleness (Nagaraj V. *et al.,* 2023). The mixtures were mixed to a uniform paste, heated on a hot plate with stirring to gelatinize the starch and activate the plasticizers, thickened until translucent (5–10 minutes), poured into molds ensuring uniform thickness, and cooled at room temperature until solidified. The bioplastics were then removed from molds, cut, and stored in a cool, dry place prior to swelling, solubility, and pH testing. The swelling test was formed by immersing the samples into two solutions: cooking oil and dishwasher liquid for 3 hours (Imoisili & Jen, 2022). The water solubility test was done by were fully submerged the samples in the 100 ml distilled water for 3 hours (Thakkar et al., 2025). To assess the pH stability, each film piece was soaked in 50 mL of vinegar, distilled water, and dishwashing liquid solution in beaker and were permitted to soak for 24 hours at room temperature (Subramanian et al., 2022).

RESULTS

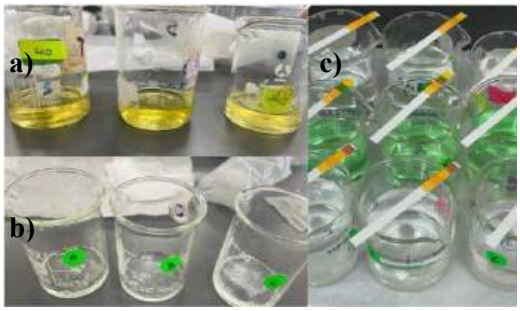


Figure 1. a) Swelling Test, b) Water Solubility Test, c) pH Test

For pH test all the samples were tested in three different solutions. For A, B, and C the pH values were 3 in acid (vinegar), around 6 in neutral (distilled water), and between 7 to 8 in base (dishwasher liquid). Specifically, Bioplastic A and B showed pH 3 in acid, 6 in neutral, and 8 in base, while C had pH 3 in acid, 5 in neutral, and 8 in base. However, D, E, and F all showed consistent pH values of 3 in acid, 6 in neutral, and 7 in base.

Table 1. Swelling Test

Variable	Constant mass of starch, different volumes of glycerin & vinegar			Constant volumes of glycerin & vinegar, different mass of starch			
	Cooking Oil						
Beaker	**Wi**	**Wf**	**WΔ**	**Beaker**	**Wi**	**Wf**	**WΔ**
A	0.4603 g	0.6447 g	0.1844 g ± 2.828×10^{-4}	D	0.2837 g	0.5149 g	0.2312 g ± 0.06520
B	0.5909 g	0.8354 g	0.2445 g ± 2.121×10^{-4}	E	1.4542 g	1.7927 g	0.3385 g ± 0.2614
C	1.2342 g	1.5650 g	0.3308 g ± 2.828×10^{-4}	F	1.5448 g	1.8970 g	0.3522 g ± 0.04193
	Dishwasher Liquid						
A	0.2954 g	1.4315 g	1.136 g ± 0.07905	D	0.6458 g	2.698 g	2.052 g ± 6.403×10^{-4}
B	0.5491 g	1.6191 g	1.070 g ± 7.708×10^{-3}	E	1.331 g	2.844 g	1.513 g ± 1.300×10^{-3}
C	0.9869 g	2.131 g	1.144 g ± 0.1015	F	2.200 g	5.066 g	2.866 g ± 0.1071

Table 2. Water Solubility Test

Variable	Constant mass of starch, different volumes of glycerin & vinegar.			Constant volumes of glycerin & vinegar, different mass of starch			
	Distilled Water (H_2O)						
Beaker	**Wi**	**Wf**	**WΔ**	**Beaker**	**Wi**	**Wf**	**WΔ**
A	0.7566 g	1.0927 g	0.3361 g ± 8.204×10^{-3}	D	0.5953 g	0.9085 g	0.3132 g ± 2.236×10^{-4}
B	1.0891g	1.2977 g	0.2086 g ± 0.02878	E	1.0242 g	1.5856 g	0.5614 g ± 2.236×10^{-4}
C	1.3674 g	1.8035 g	0.4361 g ± 2.900×10^{-3}	F	2.7923 g	4.0998 g	1.3075 g ± 2.236×10^{-4}

DISCUSSION/ANALYSIS

The swelling test showed starch-based bioplastics swelled significantly more in dishwasher liquid than in cooking oil due to the detergent's polar which promotes water uptake and dissolution. Increasing glycerin and vinegar or starch content raised the swelling effect, especially in dishwasher liquid. In contrast, cooking oil's hydrophobic environment limited swelling and helped maintain bioplastic stability. The highest absorbance value obtained was 2.886 g subtracting the final mass and initial mass. This aligns with studies where starch films swell in water (a polar solvent), while films modified with genipin showed no swelling and behavior like exposure in cooking oil, highlighting how the chemical environment affects bioplastic durability (Vallejo et al., 2025). While the water solubility test revealed that starch-based bioplastics swell and dissolve in distilled water, with both initial and final masses increasing. Increased volumes of glycerin and vinegar (with constant starch, Beakers A, B, C) led to higher swelling and solubility, as these plasticizers enhance molecular mobility and water uptake. Similarly, increasing starch mass (with constant plasticizers, Beakers D, E, F) resulted in greater water absorption and solubility with the highest solubility of 1.3075 g. This indicates that starch is highly hydrophilic, and plasticizers like glycerol (due to its hydroxyl groups) and vinegar promote water interaction, leading to increased water absorption over time (Imoisili & Jen, 2023). Also in pH tests, starch-based bioplastics remain stable in acidic to neutral pH but swell and break down more in basic, surfactant-rich environments, showing pH-dependent behavior affecting their stability and applications (Lei et al*.,* 2025).

CONCLUSIONS

In a nutshell, potato starch was successfully made into bioplastic films. Swelling and solubility were highest in starch-rich, surfactant-exposed Beaker F and lowest in hydrophobic or low-plasticizer samples like Beaker A and B. All samples showed neutral to slightly acidic pH, indicating good stability. Future work should enhance durability, water resistance, and test real-world biodegradability.

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