COMPARATIVE ANALYSIS OF BIOPLASTIC PROPERTIES DERIVED FROM FABACEAE AND MORACEAE: A STUDY ON MATERIAL PERFORMANCE AND ENVIRONMENTAL IMPACT

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KEYWORDS:

Plant- based bioplastics, starch- latex, biodegradability, sustainable plastic alternatives.

INTRODUCTION:

Bioplastics are environmentally friendly alternatives to synthetic plastics, which are non-biodegradable and cause pollution, particularly in marine environments where they contribute to microplastic accumulation in the food chain. Bioplastics derived from starch are gaining attention due to starch's low cost, renewability, and biodegradability. Various natural sources of starch have been identified for bioplastic production, including jackfruit seeds, tamarind seeds, raintree pods, breadfruit, cassava, potato, wheat, corn, and tapioca. Jackfruit and breadfruit have sticky and highly stretchable gum. The latex of jackfruit contains chemical constituents like cis-1, 4 polyisoprene and trans-1,4 polyisoprene, similar to natural rubber, making it a potential alternative. Jackfruit seeds contain starch that can be easily isolated, with 8–15% starch by weight of the total fruit. Jackfruit seed starch consists of 36.7g of carbohydrate per 100g, and the carbohydrate starch amount is about 94.5%. Tamarind seed starch is already utilized in textile and pharmaceutical industries and exhibits good film-forming properties. Raintree pods contain starch and are used as natural plasticizers in concrete. Starch-based bioplastics are preferred due to the abundance of starch in nature, along with its low cost and ease of processing. Corn starch is used in the production of polylactic acid (PLA), a common biodegradable plastic. Bioplastics may be biodegradable or non-biodegradable and are derived from natural resources like plants, cellulose, and organic waste. These materials find applications in food technology, pharmaceuticals, agriculture, and packaging.

OBJECTIVES:

1. To compare and study the physicochemical properties and biodegradation rates of bioplastics produced from Fabaceae and Moraceae family species under controlled environmental conditions (soil, compost, or aquatic environments).
2. To optimize the composition of bioplastics and compare the mechanical strength, flexibility, and thermal stability of bioplastics prepared from Fabaceae and Moraceae family species using different raw materials and methods.
3. To explore the feasibility of scaling up the bioplastic production process for industrial applications.

METHODOLOGY: Bio-plastic from Sago Starch Latex Blend (Moraceae Family)

(Samples used: Jackfruit latex, breadfruit latex, and sago starch)

1. Strach is gelatinised using heat and then autoclaved.
2. Post autoclaving, glycerol is added based on dry weight of starch.
3. Latex (jackfruit/ breadfruit) is mixed with starch in varying ratios and mixture is homogenised using an ultrasonic homogeniser.
4. The homogenised blend is air dried followed by overnight oven drying.
5. The dried bioplastics samples are tested for thermal stability, tensile strength, biodegradability and FTIR analysis.

Bio-plastic from Seeds (Fabaceae Family)

(Samples used: Tamarind and rain tree seeds)

1. Seeds are roasted in hot sand to remove moisture, powdered and mixed with cold water to form slurry.
2. Slurry is added to 800 ml of boiling distilled water and boiled for 20 minutes and resulting solution is stored overnight.
3. Next day, solution is centrifuged to remove impurities and supernatant is collected, mixed with excess 95% ethanol, precipitate is filtered out, dried and kept in desiccator.
4. Dried polysaccharide is ground into fine powder and then mixed with distilled water, glycerine and white vinegar.
5. Mixture heated on low flame, and hot solution is spread on a glass plate and air dried.
6. Final films are subjected to: thermal stability, tensile strength, biodegradability, and FTIR analysis.




RAINTREE SEEDSTARCH

JACKFRUITSEED STARCH

TAMARINDSEED BIOPLASTIC

RESULTS AND CONCLUSION:

- Extraction of starch from tamarind, jackfruit seeds, and rain tree seeds.
- Bioplastic from tamarind seeds.
- Preparing bioplastics from jackfruit and rain tree seed starch.
- Developing latex-starch blends using breadfruit starch for flexible applications.
- Performing thermal stability, tensile strength, biodegradability, and FTIR analysis.

PROJECT OUTCOME & INDUSTRY RELEVANCE: (expected)

A starch-latex bioplastic is likely to be flexible, water- resistant, and stronger than pure starch- based bioplastics. The addition of latex improves durability and flexibility, such as in packaging or agricultural films.

Tamarind and rain tree seed bioplastics are stronger but more brittle compared to starch- latex based bioplastics. It may degrade faster due to its natural content. This could be more suitable for uses where rigidity and biodegradability are prioritized, such as in single use packaging or agricultural products.

Industry relevance: A comparative study on bioplastics can guide industries toward more sustainable, cost- effective and performance- oriented material choices while supporting regulatory compliance and innovation ultimately benefiting both the industry and the environment.

WORKING MODEL vs. SIMULATION/ STUDY:

Not applicable.

PROJECT OUTCOMES AND LEARNINGS: (expected)

Learnings: - Successful extraction and processing of starch from tamarind, jackfruit, and rain tree seeds.

- The impact of plasticizers and drying methods on bioplastic flexibility and texture was observed and techniques like centrifugation and ethanol precipitation were effectively applied.

- Homogenization method was used for achieving uniform starch-latex blends and process variations significantly influenced the final properties of the bioplastics.

FUTURE SCOPE:

1. Optimization of bioplastic formulations from fabaceae and moraceae for better strength and durability, investigation into the use of agricultural waste as a sustainable raw material source.

2. Comprehensive life cycle assessments to evaluate environmental impacts.

3. Exploration of biodegradability under various natural conditions and development of application- specific bioplastics for packaging and agriculture.

4. Integration of nanomaterials to enhance material properties and Collaboration with industries for commercialization and product development.

5. Influence on eco- friendly packaging policies and standards.

6. Extension of research to include other plant families for wider bioplastic alternatives.