

RESEARCH PROPOSAL

Title: Value Addition of Silkworm Pupae Oil for the Production of PHA-Bioplastics for Development of Sustainable Food Packaging Material

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Field of Study & Field of Study Discipline: Biotechnology & Process Engineering

Research Proposal Objective: The objective of this research proposal is to investigate the valorization of silkworm pupae oil (SWPO) as a sustainable feedstock for the microbial production of polyhydroxyalkanoates (PHA), followed by the development of biodegradable food packaging materials derived from PHA-bioplastics.

Silkworm pupae, a by-product of the sericulture industry, are rich in lipids that serve as excellent carbon sources for PHA-producing microorganisms. Utilizing SWPO for PHA synthesis not only supports waste valorization but also aligns with global sustainability goals aimed at replacing petroleum-based plastics with biodegradable, environmentally safe alternatives.

The proposed research focuses on extracting high-quality oil from silkworm pupae, optimizing microbial fermentation conditions for maximum PHA yield, designing an efficient downstream polymer recovery process, and fabricating bioplastic films suitable for food packaging applications.

Key Research Questions:

1. How can silkworm pupae oil be efficiently extracted and characterized for use as a carbon substrate for PHA-producing microbes?
2. What fermentation strategies maximize PHA yield using SWPO, and which microbial strains demonstrate the highest conversion efficiency?
3. How can the extracted PHA be processed into durable, biodegradable, and food-safe packaging films?
4. How do the resulting PHA-based films compare with conventional plastics in terms of mechanical, thermal, and barrier properties?

Research Gaps and Challenges:

1. Limited studies on SWPO as a carbon source for PHA production.
2. Need for optimization of fermentation parameters to enhance microbial lipid assimilation.
3. Challenges in achieving mechanical strength and flexibility in bioplastic films comparable to commercial plastics.
4. Cost-effective downstream recovery and purification of PHA.
5. Ensuring food safety compliance for packaging materials derived from natural biomass sources.

Rationale for Using Silkworm Pupae Oil in PHA Production:

1. **Waste Valorization:** SWPO is a low-cost, nutrient-rich by-product, contributing to circular bioeconomy practices.
2. **High Lipid Content:** Enhances microbial PHA accumulation efficiency.
3. **Eco-friendly Processing:** Reduces dependency on synthetic carbon sources such as glucose and fatty acids.
4. **Sustainability:** Supports green materials development for packaging industries facing increasing environmental regulations.
5. **Biodegradability:** PHA produced offers complete biodegradability, making it ideal for food packaging.

Anticipated Outcomes:

- Development of an efficient SWPO extraction and refinement protocol.
- Optimization of fermentation conditions to obtain high PHA yield using SWPO.
- Production of PHA polymers with desirable physicochemical properties for packaging.
- Fabrication and characterization of PHA-based food packaging films.
- Establishment of a sustainable model linking waste biomass to high-value biodegradable products.