Hong Kong Student Science Project Competition 2023

Template of Extended Abstract (Investigation)
(Word Limit: 1,600 words, Pages: 3 pages only)

Team Number: SBBC179

Project Title: Investigation of Chitin-Bioplastic

Project Type: Investigation

***To our best knowledge, there <u>are / are no</u> * similar works in the field*; (if there are,) related research links are as below:**

1. Chitin - an overview | ScienceDirect Topics
2. Understanding the structural diversity of chitins as a versatile biomaterial | Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences
3. Influence of deproteinization and demineralization process sequences on the physicochemical and structural characteristics of chitin isolated from Deep-sea mud shrimp (Solenocera hextii) - ScienceDirect
4. Progress in bioextraction processes of chitin from crustacean biowastes | Applied Biological Chemistry
5. Effect of chitin addition on water resistance properties of starch-based bioplastic properties - IOPscience
6. Antibacterial activity of chitin, chitosan and its oligomers prepared from shrimp shell waste - ScienceDirect
7. Chitin extracted from various biomass sources: It's not the same - ScienceDirect.
8. Preparation and Properties of Corn Starch/Chitin Composite Films Cross-Linked by Maleic Anhydride
9. Chitin and Chitosan: Production and Application of Versatile Biomedical Nanomaterials
10. Polymer Matrix - an overview | ScienceDirect Topics.
11. Dyeing to Degrade - a bioplastic experiment
12. Modification of Chitosan-Chitosan Phthalate Anhydrides Matrices

I. Background

The problem of increasing food wastes has been a major concern in recent years. In order to find more ways to treat food wastes, the feasibility of recycling food wastes into plastic is investigated in this study. After research and literature review, our focus is put on crustaceans. This project attempts to extract chitin from shrimp shells followed by converting them into bioplastic. Also some properties including water permeability, melting and burning behaviour of the product material are tested.

II. Objectives

- Extract chitin from shrimp shells
- Convert it into bioplastic
- Test the properties of such bioplastic

III. Hypothesis

The substance, chitin, can be extracted from shrimp shells. Based on the knowledge of organic chemistry, through several chemical reactions and a few artificial processes, chitin can be converted to a bioplastic which possesses some utilisable properties.

IV. Methodology

Materials Used:
Hydrochloric acid(1.00M), sodium hydroxide solution(1.25M), shrimp shells
Hot plates, mortars and pestles, 500mL beakers, magnetic stirrers, stands and clamps, filter funnels, filter paper, glass rods, pH paper, forceps

Experiment 1: Extraction of Chitin from Shell Materials by
a) Decarbonization/Demineralization
b) Deproteinization

Experiment 2: Conversion of Chitin to Bioplastics

Experiment 3: Testing of properties of Bioplastics made with Chitin
a) Water Resistance of Chitin
b) Melting and Boiling Behaviour
c) Flammability

V. Results

Result

Mass:

	Mantis shrimp	**Red shrimp**	**White shrimp**
Initial Mass of Shells (g)	10	10	10
Mass of Chitin it made (g)	1.4	1.75	2.23

Water resistance:

Material	**Recycled paper**	**Common paper**	**Bioplastic**
Time taken for water to make a translucent spot on the filter paper below the material	7 seconds	22 seconds	>20 minutes

Hence, the water resistance follows the order:

Bioplastic > Common paper > Recycled paper

(Highest) (Lowest)

Melting behaviour:

Material	**LDPE**	**HDPE**	**Bioplastic from pure chitin**	**Bioplastic from shrimp shell**
Order of melting (arbitrary unit: 1-slowest 3-fastest)	3	3	2	1
Observation	Softens and melts quickly	Softens and melts quickly	Does not melt after long time of heat	Does not melt after long time of heat

Flammability and sootiness of flame:

Type of plastic	Plastic cling	PE plastic bag	Bioplastic from pure chitin	Bioplastic from shrimp shell
Flammability (arbitrary unit: 1-lowest 4-highest)	3	4	2	1
Sootiness of flame (arbitrary unit: 1-lowest 4-highest)	4	3	2	1

VI. If your team will compete the Sustainable Development Award, please indicate the specific sustainable development goal the project is related to, and provide justification for competing for this award. *(Word limit: 300 words)*

Starch-based bioplastics have the advantage of being eco-friendly and non-toxic, however starch-based bioplastics cannot be used in food packaging due to its lack of resistance to water. Rather than adding non-biodegradable artificial polymers such as PE and HDPE, adding Chitin which is a 100% biodegradable polymer naturally found in shells of crustaceans can not only enhance the water resistance of starch-based bioplastics, but also ensure the resulting starch-based bioplastic is fully biodegradable, reducing land waste.

During industrial processing of marine crustaceans such as crab, shrimp and lobster, large amounts of their shells are thrown away as solid waste. By using these shells for the major source of chitin extraction, another source of land waste can be eliminated as the shells are utilised and recycled. Meaning formation of chitin bioplastic reduces crustaceans' shell waste on its own and also the usage of non-biodegradable plastics.

VII. If your team will compete the Social Innovation Award, please list the target group or social issue the project focuses on, and provide justification for competing for this award. *(Word limit: 300 words)*

N/A

VIII. Conclusion

Chitin can be extracted from shrimp shells and can be converted into bioplastic.

The bioplastic in our project exhibit the following properties:

1. It is non-porous to water and resists water better than common paper and recycled paper.
2. It does not melt or soften readily on heating. The melting point range is much higher than common plastic e.g. HDPE, LDPE.
3. It has lower flammability and produces less sooty flame than LDPE, HDPE.

□ **Our project is developed based on previous project and the enhancement is below:**