Hong Kong Student Science Project Competition 2022

Template of Extended Abstract (Investigation)
(Word Limit: 1,000 words, Pages: 2 pages only)

Team Number: SBBC224

Project Title: The production of biodegradable plastics using starch-based materials

Project Type: Investigation

To our best knowledge and after thorough literature research, as at 28/6/2022, there are similar works. If there are, the reference links are as below:

1.https://www.researchgate.net/publication/304533585_Biosynthesis_of_silver_nanoparticles_from_Actinomycetes_for_therapeutic_applications
2.https://www.researchgate.net/publication/352299941_Effect_of_Polyvinyl_Alcohol_Starch_and_Modified_Bee_Wax_on_Properties_of_Sweet_Lime_Pomace_Based_Biodegradable_Containers
3.https://www.jmaterenvironsci.com/Document/vol11/vol11_N5/JMES-2020-1163-Gadhave.pdf

The enhancement our project has made for the existing related products or research is summarized as below:

We tried to use banana peels, a kind of food waste as a source of starch to make the bioplastics instead of just using soluble starch and corn starch. We also investigated the effect of citric acid and carried out additional tests to study the properties of the films such as the test for biodegradability.

***Please delete if not applicable. HKSSPC values the originality of works. Students must conduct literature research thoroughly to ensure that their works are unique, and to list relevant reference materials to complement the research or invention.**

I. Background

Plastic pollution is a serious environmental problem in Hong Kong and is further intensified during the COVID-19 pandemic. Our project aims at using starch-based materials, different alcoholic-based plasticizers and food waste to create economical biodegradable plastics which can be used as packaging materials and face masks, alleviating plastic pollution problem. From existing research of making bioplastics, glutaraldehyde is used as a cross-linking agent. We would like to replace it with citric acid as it is irritant. We would also like to investigate the effect of different alcohol-based plasticizers on the outcomes and identify the best composition for making bioplastics for packaging films and masks.

II. Objectives

To investigate the production of biodegradable bioplastics using food waste and to test their properties.

III. Hypothesis

Food waste can be used for production of biodegradable plastics as they contain a high content of starch that has an inherent biodegradability and can therefore fulfill the required qualities of packaging materials and face masks. They can be tested by carrying out the investigations on tensile strength, water absorption and biodegradability.

IV. Methodology

Materials:
[Face mask] Banana peels, 1% CH_3COOH, 0.5M NaOH, 1% corn starch solution, 15% propane-1,2,3-triol (glycerol), 0.5M HCl, 8% polyvinyl alcohol (PVA)
[packaging materials] Corn starch, acetate buffer solution (pH 7), PVA, alcohol-based plasticizer (propan-1-ol, propane-1,2-diol, glycerol, hexan-1-ol, benzyl alcohol), citric acid

Experimental protocol:
For the production of biodegradable face masks, we have tried to adjust the ratio between banana peels

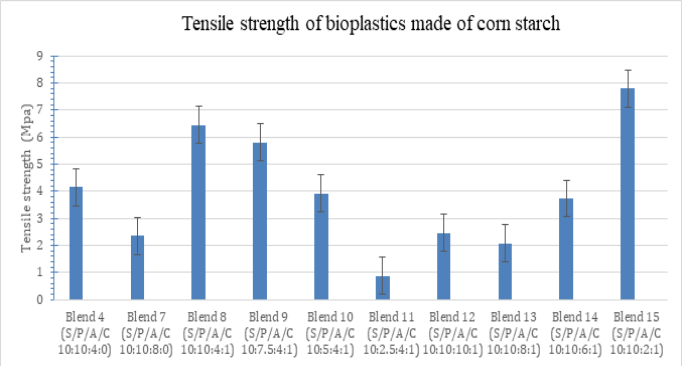
to glycerol to PVA. 5 blends were produced in total.
For the production of cornstarch films, we have tried to adjust the ratio between starch to PVA to glycerol to citric acid. 15 blends were produced in total.
Tests on tensile strength, water absorption and biodegradability will then be carried out as good packaging materials require high tensile strength, water resistance and be able to biodegrade quickly so it can be a substitute for plastic.

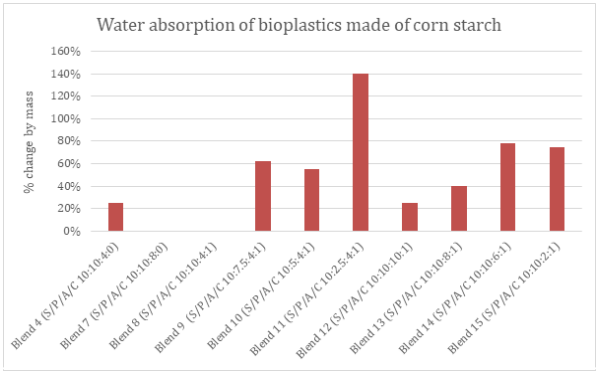
Analysis:

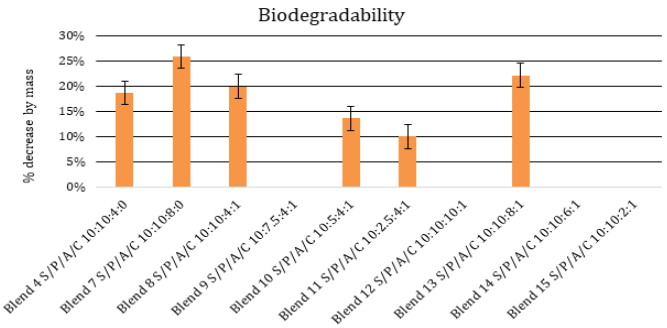
The higher the tensile strength, the greater the protection to the package during transportation. While the lower the water absorption ability, the higher the water resistance which implies the damage to the content can be minimized. As for biodegradability, a higher biodegradability allows the film to be degraded in a shorter period of time, which increases its effectiveness in lessening the burden of landfill sites. Based on the tests, we will give marks to each blend, so the best blend can be selected.

V. Results

Data analysis:







Flexibility increases due to increase in glycerol percentage, but too much glycerol added will cause the plastic to become brittle and crack and with higher percentage of glycerol added, the bioplastic shows a higher ability of water absorption. Hence, the film with glycerol added as the alcohol-based plasticizer shows the best effect in improving the flexibility. With the presence of both citric acid as cross-linker and glycerol, mechanical strength of the bioplastic is enhanced.

Limitation:

1. Only a few films can be baked once at a time, which is time consuming for mass production.
2. Due to time constraints and school suspension, no investigation using other acids such as maleic acid.
3. Difficult to fix the ripening stage of banana as different stages contain different content of starch.

Importance:

To alleviate plastic pollution that is worsened by covid-19 and online shopping, we would like to investigate on making biodegradable plastics for packaging materials and face masks using starch-based materials.

VI. Conclusion

Based on all the results above, blend 8- S/P/A/C(Glycerol) 10:10:4:1 of cornstarch films and blend 3 – B/G/P 100:0.6:0.32 of banana peel films have the best performance in the tests. They were shown to have good tensile strength and high water resistance ability, and most importantly being biodegradable hence they are good alternative for packaging films made of polyethylene and face masks in reducing plastic pollution problem.