Hong Kong Student Science Project Competition 2022
Template of Extended Abstract (Investigation)
(Word Limit: 1,000 words, Pages: 2 pages only)

Team Number: SABC166
Project Title: Playtics
Project Type: Investigation
To our best knowledge and after thorough literature research, as at 28/6/2022 , there are no* similar works. If there are, the reference links are as below:

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

*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

Provide background information of project and/or state the problem to tackle
Provide highlights of the literature review with the support of pertinent and reliable references
Provide an overview of work and mention the research gap that the project is trying to fill

Plastic pollution is a serious problem nowadays, one of the major contributors to this problem is the use and disposal of plastic utensils and non-biodegradable plastic bags. In this project, we aim to reduce plastic pollution by creating remoldable plastic utensils.

According to other relevant reports, starch-based bioplastics show high water solubility and are fairly biodegradable. Due to these properties, starch-based bioplastics are suitable for replacing synthetic polymer plastic bags as they are more environmentally-friendly.

However, the reports do not show whether the bioplastics are remoldable. Therefore, our project aims to test the moldability of different starch-based bioplastics after adding in various materials, in order to see what proportions and materials are best for making remoldable bioplastics. We hope to utilize these remoldable bioplastics to make utensils that can be remolded on heating to a certain temperature, for example, spoons that can be remolded into forks under high temperature. This will lead to greater convenience of the usage of reusable utensils.

II. Objectives

State the aim(s) of project

To create remoldable bioplastic; enhance water resistance and strength of bioplastic

III. Hypothesis

Propose an explanation for a phenomenon and stating how the hypothesis can be tested by experiments

Amylase helps to hydrolyse large starch molecules to smaller ones. If the glycosidic bonds at the branches are broken and the starch molecules become more linear, the intermolecular forces between the molecules will become stronger and hence the bioplastic made will be stronger.

If the glycosidic bonds in the main chain are broken to give shorter molecules, the bioplastic formed will be weaker. It is anticipated that with careful control of the amount of amylase added and the time of reaction, a remoldable bioplastic with reasonable strength can be obtained.

IV. Methodology

List out the materials used
Describe the experimental protocol including the set-up of control experiment (if any), repeated experiment (if any), and its scientific theory
Indicate with the support of reasons, the analysis used in the investigation

Materials: Starch, glycerine, vinegar (Heinz), amylase, marshmallows (Rocky Mountain), bubble gum (Wrigley's), flour, salt, water, sodium alginate, calcium chloride, hydrochloric acid, sodium hydroxide, beeswax

Experiment procedures for making a starch-based bioplastic with amylase:

1. Mix and stir starch, glycerin, vinegar and amylase together in a beaker over a magnetic stirrer for 10 minutes (for control, no amylase is added) (for repeated, add additives in the mixture)
2. Heat the mixture over a heating pan until it becomes a paste
3. Spread the paste on a flat surface and let dry

Product testing:

i) Effect of heating on remoldable of the samples

The samples were put in a beaker of 50mL water and heated over a heating pan at 70°C for 15 minutes. The water was drained away and the remains of the samples were dried. We then tried to remold the

remains.

ii) Solubility in water

Each of the samples (2cm x 3cm) were put in a beaker of 50ml water. After 10 minutes, the water was poured away and the samples were observed. After that, they were let dry for 1 week and observed.

iii)Strength

We used a glass rod to flatten the samples until they have the same thickness as 2 dollar coins. After that, we cut the material into 2cm x 3cm to ensure a fair test and attached clips at both ends of the sample. After that, pull the bottom end of the clip until the sample breaks. The force at which the sample breaks is then recorded.

Iv) Waterproof/Water resistance

Place five droplets of water onto each plastic and set a timer for ten minutes. Check if the water is absorbed and if it is able to slide off the plastic easily.

V. Results

Present the data with figures, tables or photos

Data analysis (if any, with emphasis on data reliability and the reproducibility based on statistics)

Interpret the results and its implication

Discuss limitation and compare with existing related works (if any)

Discuss the importance or impact of the research and how it is applicable to real problems

(B1: control, B2: with amylase, B3: with amylase & marshmallows, B4: with amylase & bubble gum, B5: with amylase, flour and salt, B6: with amylase & sodium alginate, B7: with amylase, sodium alginate and calcium chloride, B8: with amylase, sodium alginate and hydrochloric acid)

Results and Observations

	Texture	After put in water	Moldability	Waterproof	Force
B1	Soft, brittle			X absorb water	14N
B2	Soft			X absorb water	5N
B3	Flexible, stretchy		slightly remoldable after warmed in hand	X absorb water	10N
B4	Stretchy, very sticky		remoldable after warmed in hand	X absorb water	N/A
B5	Thick, very soft		remoldable without warming	X absorb water	12.5N
B6	Hard		not remoldable	X absorb water	>25N
B7	Tough, foldable		not remoldable	water slides off	>25N
B8	Hard		not remoldable	water slides off	>25N

The results show that adding amylase during the production of bioplastic does make the product softer and more remoldable. However, solely adding amylase does not improve its texture and water resistance to an ideal state as B2 is soft and breaks in half when put into water. Therefore different additives are added. Among all the prototypes, B3 with marshmallows added shows the best performance as it is remoldable and it is very flexible and stretchy. It also dissolves partially after being soaked in water but hardens when it is left to dry for a while.

Limitations: The water resistance and strength of B3 with amylase and marshmallows added has to be improved . In the future, we may combine beeswax or sodium alginate with B3 bioplastic. However, the correct ratio has to be found in order to retain moldability while improving the water resistance and strength of it.

Applications: The bioplastics made can be used to make remoldable food containers and utensils. In our research, we discovered how to make bioplastics with high moldability, flexibility and rigidity. This enables the production of remoldable bioplastic utensils that can be moulded into different forms on heating, for example, from a spoon to a fork or from a large lunch box into a small ball, which will be more convenient to those who wish to bring their own utensils or food containers.

I. Conclusion

Make a data-driven conclusion of the project and the way forward of the research

Justify if the proposed project meets the objective(s)

Adding amylase during the production of bioplastic does make the bioplastic softer thus more remoldable.
Adding marshmallow or bubble gum to the amylase bioplastic makes it more elastic and stretchy, but also makes the bioplastic more sticky .
Adding sodium alginate makes the amylase bioplastic waterproof, but also restricts its moldability.
Our project does meet the objectives as a remoldable bioplastic is created by adding amylase. The water resistance of the bioplastics are improved by adding beeswax or sodium alginate, both prototypes show water resistance as water slides off when added to them. The bioplastics also showed strength when sodium alginate is added as they are able to withstand force greater than 25N.

□ Our project is developed based on our school's previous project and the enhancement is as below: