

Hong Kong Student Science Project Competition 2022

Team Number: SBBC296

Project Title: Good Night Show - Plastic Maker 全民造膠

Project Type: Investigation

To our best knowledge and after thorough literature research, as at 25/6/2022, there are / are no* similar works. If there are, the reference links are as below:

- [1] Masterdude. "Easy Biodegradable Plastic." *Instructables*, 24 Feb. 2009, <http://www.instructables.com/Easy-Biodegradable-Plastic/>.
- [2] University of Hawaii. "Biodegradable Plastic", *Kohala Center*, 201, <http://www.kohalacenter.org/HISGN/pdf/Lesson2BioplasticsFinal.pdf>.
- [3] Marialilokyee. "Make Your Own Bioplastics!" *Instructables*, 8 Feb. 2018, <http://www.instructables.com/Make-Your-Own-Bioplastics/>.
- [4] Wilde, Danielle. Your DIY Guide for Creating Bioplastics FOOD for THOUGHT, http://www.daniellewilde.com/wp-content/uploads/2018/10/SDU-Design_FoodForThought_24June2018.pdf.
- [5] Sabrina, Smoke. "DIY Bioplastics!" *Educational Innovations Blog*, 14 Aug. 2020, <http://blog.teachersource.com/2020/08/14/diy-bioplastics/>.

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

We tried out various preexisting recipes, modified them to prevent the products from molding, and compared their following properties:

- Heat resistance: how long it can maintain its shape for in a certain temperature
- Hardness: how hard it is / how much force it can withstand without breaking
- Flexibility: whether it can bend
- Transparency: whether it is transparent or not
- Effect on plant growth: whether its presence will cause the plant to grow faster

I. Background

Here we explore bioplastics – a sustainable replacement to fossil-based plastic, using organic and renewable raw materials. Bioplastics generally take half a year to completely decompose, way less than their traditional counterparts that require several hundred years.

In the literature review, we noticed that homemade bioplastics mainly use ingredients like cornstarch, glycerin and gelatin. They all involve mixing the mentioned ingredients at certain ratios and letting them sit in the open until they harden. There was however rarely any mention of the properties of the products, with some only saying that they are more flexible. We thus want to look into some other properties of the bioplastics, namely heat resistance, hardness, flexibility, transparency and whether it can facilitate plant growth.

In the process of producing the bioplastics, we encountered some problems, which we were not warned by the online resources about. Hence, we will be stating them here and providing solutions to them.

II. Objectives

- investigating the properties of the bioplastics, namely heat resistance, hardness, flexibility, transparency and whether it can facilitate plant growth
- identifying common errors when making bioplastics and ways to fix them
- investigating the relationship between flexibility and durability of bioplastics

III. Hypothesis

- plastics of a higher glycerin-gelatin ratio should have higher flexibility but lower hardness and endurance, as it is said in [3] that gelatin acts as a hardener while glycerin acts as a softener
- by adding starch, the transparency of the bioplastic will be lowered, as light will be scattered by the starch

IV. Methodology

Materials:

Utensils: bowls, sticks to mix the ingredients with and molds for the mixtures to harden in

Raw materials: cornstarch, gelatine, water, glycerin, vinegar, baking powder, cooking oil and rosemary extract

Recipe /Ingredient (1tp)	Cornstarch	Gelatine	Water	Glycerin	Vinegar	Baking Powder	Cooking oil
A [1]	1	/	10	/	/	/	5 drops
B [2]	3	/	10	1	1	1	/
C [4]	/	4	10	1	/	/	/
D [4]	/	2	10	3	/	/	/
E [3]	4	/	10	1	1	1	/
F [5]	/	3	10	2	/	/	/

Table 1: Ratio or amount of raw materials used in each recipe

Raw materials were mixed separately according to the recipes given and let harden for 20 days.

As the ingredients used were mainly organic, 3 drops of rosemary extract was introduced to each mixture for anti-molding purposes.

Bioplastics were cut into uniform discs and tests were then performed on them to compare their properties. The methods used are as follows:

Heat resistance: Uniform 0.5mm x 0.5mm discs of samples were heated at fixed temperatures for 2 minutes. The temperature in the table is the highest the sample can survive for 2 minutes in without disintegrating.

Transparency: A paper full of words was being put under the plastics and to observe if words can be seen clearly.

Hardness: A PosiTector SHD Shore Hardness Durometer with Shore A configuration was used. The sample was placed on a hard horizontal surface, and the indentor of the durometer was touched on it. The Shore A hardness reading was then displayed on the durometer. The higher the reading, the harder the sample is.

Effect on plant growth: bioplastics were buried in soil to grow with bean, sunflower and cress seeds separately. A control group with only seeds and no bioplastic was used to show the effect of bioplastics on plant growth, if any. A month was given for the seeds to germinate and grow into plants.

V. Results

The plastics produced by recipe A and C were too crumbly and not dense enough. They were thus excluded from the testing of properties.

Recipe /Property	Heat Resistance (°C)	Hardness	Foldable?	Transparency
B	80	70	No	Low
D	60	55	Yes	High
E	50	30	No	Low
F	70	80	No	High

Table 2: Properties of plastics made

Recipe E that uses the most cornstarch has the poorest performance, with lowest values in every domain. If less cornstarch is used (recipe B), the heat resistance is significantly higher. These two cornstarch based recipes also have low transparencies. D and F are not cornstarch based but gelatin and glycerin based instead. They both have high transparencies. D uses more glycerin than F, and is thus more foldable but is less hard and resistant to heat. This shows how flexibility comes with the price of lowered durability.

All bioplastics had no effect on plant growth, as the increase in dry mass in plants of the control group and experimental group were similar.

Limitations:

Heat resistance could not be measured accurately as the test was not done in the laboratory doing the HDT (heat distortion temperature) test.

The test for transparency was also hindered by the bubbles formed on the surface.

VI. Conclusion

Adding rosemary extract to bioplastics is necessary to avoid the bioplastics from molding. The more glycerin used, the less heat resistant and durable but more flexible the bioplastic is. Bioplastics made from cornstarch / glycerin / gelatin have no effect on plant growth.