Hong Kong Student Science Project Competition 2022

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

Team Number: JBBC090

Project Title: Chicken feather plastic

Project Type: Investigation

To our best knowledge and after thorough literature research, as at 25/06/2022 , there are / ~~are no~~* similar works. If there are, the reference links are as below:

Kota, K., Shaik, S., Kota, K., & Karlapud, A. (2014). Bioplastic from chicken feather waste. *Int. J. Pharm. Sci. Rev. Res*, *27*(2), 373-375.
Link: https://globalresearchonline.net/journalcontents/v27-2/65.pdf

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

We tried the method in the research with some changes according to the existing materials in the school laboratory. It was very difficult to prepare a solid plastic film with the materials available in school and with chicken feathers as the major material only. Therefore, we tried to combine them with other biomaterials, such as starch, during the process, which was simpler and could be an alternative method to prepare chicken feather plastic.

***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

Chicken feathers are waste products that have a serious solid waste problem. Every week, 400 million chickens are processed in the world and an estimated 25 billion tons of chicken feather wastes are produced. Also, chicken feathers are a threat to the environment because of the lack of effective recycling methods, so we want to think of some method that could help to reduce the waste of chicken feathers. Since the 1950s, 8.3 billion tons of plastic have been produced, which is an astonishing number. However, 79% of it ended up in the landfills. Besides, 400 million tons of plastic is produced each year and 40% of that is single-use. These show that plastic pollution is serious. Therefore, we want to make plastic products that are easier to break down, so that we can help the environment.

II. Objectives

Aim:

- To study the feasibility of making environmentally friendly plastic from chicken feathers.

Objectives:

- To prepare chicken feather extracts by hydrolysis and reduction and to compare their effectiveness in extraction and dissolution.
- To make a plastic film from chicken feathers in combination with different biomaterials and compare their properties.
- To study the effect of concentration of starch solution and concentration of chicken feathers on the properties of chicken feather plastic film, such as physical and chemical properties.

III. Hypothesis

It was expected that keratin present in the chicken feathers can be used to make bioplastic film and help to strengthen the intermolecular attraction within the bioplastic.

IV. Methodology

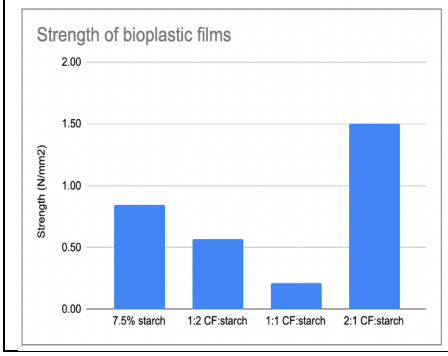
Materials used include: chicken feathers, sodium hydroxide, sodium metabisulphite, polyvinyl alcohol (PVA), corn starch, ethanoic acid and glycerol. Instruments used include mainly: electronic balance, oven, force sensor and scanning electron microscope (SEM).

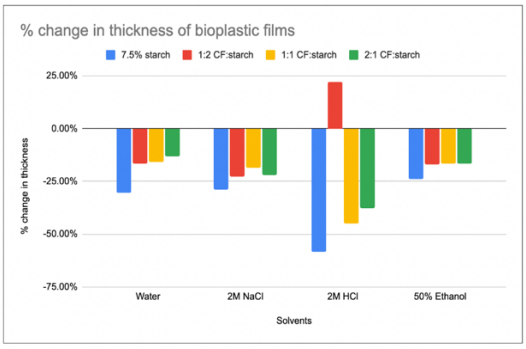
To prepare chicken feather plastic, chicken feathers was dissolved in sodium hydroxide solution. Then, corn starch was added to the mixture and stirred until a viscous mixture was formed. Ethanoic acid and glycerol were also added to facilitate the formation of the flexible film. Finally, the mixture was poured on a petri dish wrapped with baking paper and dried in the oven overnight. After that, we studied the properties of the plastic films, including strength, chemical resistance and morphology.

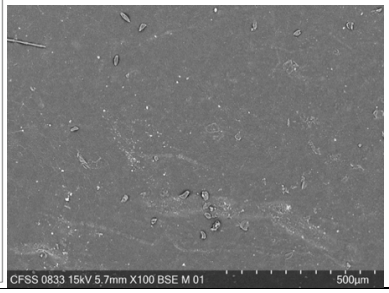
Two chemical solvents, sodium hydroxide and sodium metabisulphite, were used to dissolve the feathers, because different mechanisms and reactions were involved. Hence, their efficiencies to dissolve the feathers could be different. Also, it was expected that the properties, such as hardness, brittleness and flexibility, of the plastic could be modified when we changed the concentrations of starch and chicken feathers. Therefore, we repeated the experiments with different concentrations of them.

V. Results

Before achieving these optimal conditions, different chemical solvents to dissolve the feathers, concentrations of starch and chicken feathers were tried. At the end, sodium hydroxide was used instead of sodium metabisulphite since the feathers dissolved better in sodium hydroxide solution. On the other hand, we decided to use 7.5% starch solution because the plastic film had the most balanced properties, such as hardness, brittleness and stickiness. Starch was chosen instead of PVA as solid film could not be peeled off for PVA. 15% chicken feather solution was used because the plastic film resulted had better strength (1.50 N/mm^2) and chemical resistance than starch-based bioplastic, which can be shown in the graphs below. The change in thickness of the films remains less than 22% after soaking in different solvents. From SEM images, the film had a smooth surface without cracks and pores (see the picture on the right below). The ratio of feather: starch was then chosen to be 2:1. Regarding the limitations, the scale of the current setup was rather small and whether the plastic is safe to be used to handle food was not tested. More properties can be tested in further studies.







VI. Conclusion

After a series of experiments, we suggest making chicken feather plastic using 15% chicken feather solution (dissolved in sodium hydroxide solution) and 7.5% starch solution. The bioplastic was stronger and had better chemical resistance than starch-based bioplastic. It had a smooth surface as shown in SEM images. Besides, we suggest that the bioplastic can be applied in packaging and making disposable items such as gloves. In the future, we can increase the scale of the plastic. Also, we can look for better sources of starch as the corn starch we used was from supermarket. Besides, sodium hydroxide solution can be corrosive and harmful to the environment. Other chemicals to dissolve chicken feathers, such as hydrogen peroxide and protease, can be tried in the future.

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

N.A.