Bioplastic properties of agar-agar and potato essay sample

Bioplastic is a form of plastic derived from renewable biomass sources rather than fossil-fuel plastics which are derived from petroleum. Two main ingredients are commonly used in the production of bioplastic: starch and seaweed. The study aimed to compare the properties of bioplastic made from agar-agar, a species of seaweed, and potato starch. Through the study, the researchers attempted to discover which bioplastic would be more viable for both industrial and personal use, in terms of its tensile strength, flexibility, water resistance and mouldability.

In the procedure, for the first set-up, vinegar, glycerol and water were mixed in a bowl together with potato starch. The second set-up had a similar mixture, although instead of adding potato starch, agar-agar was used. Both mixtures were heated until they reached about 95 C. Thereafter, half of the solutions were poured separately onto two different drying pans and were left to dry.

The final products were then subjected to four tests that aimed to determine which plastic had all of the properties mentioned above. Both plastics were proven to be flexible and mouldable. However, the agar-agar plastic had greater tensile strength compared to the potato starch plastic. After 26 hours of soaking in water, the agar-agar plastic was proven to be water-soluble, instead of water resistant, while the potato starch plastic maintained its shape and weight.

Based on the results of the experiments, the researchers concluded that both plastics are useful. The agar-agar plastic may be used as a packaging

material that can carry heavy but dry items, while the potato starch plastic may be used as a packaging material for both wet and dry items.

CHAPTER I

INTRODUCTION

As concern for the use of petroleum-based products and their effects on the environment increases, industries have started to investigate several other sustainable resources for the creation of bioplastic. Bioplastic covers approximately 10-15% of the total plastics market toady and is estimated to increase its market share to 25-30% by 2020. Over 500 bioplastic processing companies already exist worldwide. The group investigated these alternative sources, specifically agar-agar (Gelidium amansii) and potato starch, that would provide a better and more practical plastic. These two ingredients were selected by the researchers because they can be easily acquired and are abundant in the Philippines. The study’s first goal was the creation of such plastics for testing. The second was to test the two plastics in the following categories: water resistance, flexibility, tensile strength and mouldability.

This research aimed to bring awareness to the consumers, as well as to the manufacturers on the feasibility of using these biodegradable plastics that could eventually spawn a bioplastic industry in the Philippines. This would provide an environment-friendly alternative to the non-biodegradable plastics that fill dumps, clog waterways and whose production emits high amounts of greenhouse gases. It was the researchers’ hypothesis that both

plastics would be strong enough to bear a reasonable amount of weight and that both would be waterproof, flexible and mouldable.

The study was based on previous scientific researches stated below and an Experimental Research Design regarding the production of agar-agar plastic conducted by First Year High School students of La Salle Green Hills (David, 2011). An instructional video about making plastic from starch (Sweeny, 2008) and a website on production of green plastic out of agar-agar (Stevens, 2010) were also used as references. Quantities of the materials were adjusted in both the potato starch and agar-agar experiments. The amount of potato starch was modified, so it would be equal and consistent in amount to the agar-agar experiment. Only half of the amount of each ingredient was used in order to save resources and conduct more experiments. The rest of the procedure and ingredients mentioned from the above sources were kept constant and similar to the previous studies conducted. A website containing methods of testing plastics was also referenced; however, only the simpler methods were adopted in the product’s testing (Tinus Olsen, 2008). The researchers hope to produce a bioplastic with similar properties to existing products in the Philippines, such as the new generation PET biodegradable plastics and biodegradable garbage bags that easily decompose when disposed.

CHAPTER II

MATERIALS AND METHODS

A. Materials

Plastics are composed of three basic parts: polymers, plasticizers and additives. Polymers give plastic its strength, plasticizers give it its bendable and mouldable qualities, and additives give it other properties (color, durability). For the research's materials, the potato starch and agar-agar serve as the biopolymers while the glycerol serves as the plasticizer. No additives were used.

B. Methods

For the potato starch procedure, 1 and 1/4 tsp. potato starch, 117 ml or 1 cup of 1% glycerol solution, 90 ml cup water, 1 and ¼ tsp of vinegar were all measured with a measuring spoon and placed in a mixing bowl. The potato starch, vinegar, glycerol and water were mixed and stirred in the bowl using a spatula. The solution was stirred until there were no clumps left. The solution was then poured into a sauce pan and heated on a stove and was stirred during the process. The pan was removed from the stove once it reached a temperature of 95 C, at which point the solution began to froth and was further mixed. Excess froth was scooped out with a tablespoon, making sure that there were no clumps. Half of the solution was then carefully poured into a drying pan, spread out evenly using a spatula and the rest was poured into a baking mold pan. It was then allowed to dry. The plastic formed was removed from the drying and baking mold pans once it was dry (at least 24 hours).

In the Agar procedure, the same steps were followed except for the substitution of the agar for the potato starch.

C. Record Keeping

First, the materials were sourced and the amounts of ingredients to be used were carefully measured using measuring tools for accuracy.

The end-products of each trial were compared and evaluated to see whether similar characteristics inherent in plastics such as: 1. tensile strength; 2. Flexibility; 3. Moldability; and 4. Water resistance were present or absent. The researchers tested the plastic's strength by holding apart and securing the plastics with two G-clamps and aluminum bars and carefully dropping coins (weighed by electronic scale) on the plastic until it tore. The plastic's flexibility was tested by folding the sheet in the middle, and observing whether or not the plastic would break. The plastic's ability to be molded was tested by forming shapes out of the plastic through a Teflon molding pan. The plastic's water resistance was then tested by observing if the plastic samples would increase in weight when soaked in water for 26 hours, and completely dried. Variables and conditions were kept constant. The results were presented in tabular form.

D. Variables

The researchers controlled the following variables in the experiment: heating time, temperature of heating, cooling time, size of drying pan, time and location of experiment, thickness of produced plastic. The same amount of ingredients was used in every trial.

The independent variable is the main ingredient used in forming the plastic, potato starch or agar-agar powder. The dependent variables are the properties or characteristics of the formed plastics.

CHAPTER III

RESULTS AND RECOMMENDATIONS

Results

The plastic made from the agar-agar was proven safe, affordable and easy to produce with the help of everyday household materials and a small amount of glycerol. The potato starch on the other hand, showed positive results and turned out to be a plastic substitute that produced a translucent, flexible and lightweight material.

Table 1. Comparison of Potato Starch Plastic and Agar-Agar Plastic | Plastic Sample | Flexibility | Mouldability | Tensile Strength | Water Resistance | | | (Yes or No) |(Yes or No) |(Weight that broke the plastic) |(Yes or No) | | Potato Starch | Yes | Yes | 7. 32 kilograms | Yes | | Agar-agar | Yes | Yes | 8. 88 kilograms | No |

The plastic made from potato starch was thicker, yet tore under a less amount of weight (7. 32 kilograms) than the thinner plastic from agar-agar, which could take up to 8. 88 kilograms. As shown in Table 1, both plastics were flexible enough to be folded in half and creased without tearing. After equally sized sections of the remaining samples were soaked in water for 26 hours, the agar-agar plastic dissolved into a slimy, semi-solid substance, while the potato starch plastic showed no changes in weight or strength. After being poured into specially shaped metal pans, both plastics assumed the shapes of their moulds and were removed without sticking or deformities. All variables were kept constant throughout the four experiments.

Agar-Agar Plastic Sample Potato Starch Plastic Sample

Discussion

Both plastics were mouldable and flexible since they contained the same amount of glycerol which acts as the plasticizer in the bioplastic. Plasticizers work by embedding themselves between the chains of polymers, spacing them apart thus making it softer and loose. The agar-agar plastic is hydrophilic, meaning that it interacts strongly with water; in powder form and when made into plastic, it is not water resistant. The molecules in the water can easily bind to the molecules found in agar-agar due to their chemical composition.

The agar-agar had a greater tensile strength as compared to the potato starch plastic because it had higher fiber content. Fiber is known and used by many industries to increase the tensile strength and durability of plastic. 160g of potato starch contain approximately 9. 4 grams of fiber while 160g of agar-agar powder contain 12 grams of fiber. (based on nutrition facts found in the ingredients packaging)

The researchers’ hypotheses on the properties of the produced plastic were all supported by the results of the experiment; however, the hypothesis that the agar-agar plastic was water-resistant was rejected, as the agar-agar almost completely dissolved in the water. Based on the data gathered, the researchers concluded that both plastics are viable for industrial and personal use due to the fact that the bioplastic produced have similar characteristics to regular petroleum based plastic . However, these two

plastics may serve different functions, due to differences in tensile strength and the fact that the agar-agar plastic was proven to be water-soluble.

The potato starch plastic may be used as reusable containers for food, water, or liquids in general, while the agar-agar plastic may be a good packaging material for dry goods. Future studies similar to this research may aim to confirm if these two plastics can be formed into plastic bags, boxes, or bottles or to further refine the bioplastic produced by the given procedures. Other starches, like rice starch, cornstarch, or tapioca starch may also be tested. The experimental design’s purpose was to address the hypotheses stated above, and all conditions (containers, time, locations of experimentation, quantities, measuring equipment, temperature, size of clamps and aluminum sheets, etc.) were kept controlled and constant throughout all of the procedures. However, given more time and resources, other experiments to test tensile strength, flexibility, mouldability, water resistance, and even biodegradability could have been conducted.

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