Potato Plastic

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Abstract

Plastic is a major part of modern society, however every day plastic is polluting the world's oceans and killing marine life. However, plastic made from starch is biodegradable meaning it will disintegrate after being thrown away.

In my project I was testing the properties of starch plastics. In a recipe for starch plastic glycerin is used to add flexibility. I tested the relationship between the amount of glycerine added and the flexibility it adds to the plastic.

To investigate this problem I created separate batches of plastic with differing amounts of glycerine added, I would then let them dry out and test their flexibility. I used the same recipe for plastic throughout the entire experiment so that the only variable changing was the amount of glycerin.

Overall my hypothesis was proven correct as the amount of glycerin added had a major effect on the flexibility of the plastic. Surprisingly, the glycerin also made the plastic much stronger and harder to break, plastic without glycerin was brittle and could be snapped easily. Another major impact on flexibility was size, the thicker the piece of plastic the less likely it was to bend. To get around this I made a mold so that all of my plastic pieces would be a similar volume and shape.

Plastic pollution is a large issue in the world today and biodegradable plastics could rid society of this problem permanently. I have tested everything I hoped to in this experiment and gotten all the results I needed.

Question and Hypothesis

How does glycerine affect the flexibility of starch plastics?

The flexibility of the plastic is going to be directly relative to the amount of glycerine added.

Background Research Pt 1

Plastic pollution is a major issue worldwide, plastic seems like a magic resource that humans can mold and shape into anything we need. However, in reality, because plastic is so durable, it also doesn't degrade. Plastic items are being thrown away and they will not degrade away like other products, they will stay in the environment for thousands of years killing animals and overall causing harm to the environment. Early forms of plastic were made out of natural resources such as sugars, milk, and other proteins until modern methods of plastic making were discovered (BBC, 2013). Recently scientists have been exploring these natural methods of plastic making and have made good work in the field of bioplastics (BBC, 2013). What is plastic? Plastic is a synthetic material made from polymers, this allows the plastic to exhibit characteristics of plasticity (Ebbing & Gammon, 2010). A monomer is a group of molecules bonded together, a polymer is a chain of many monomers linked together (Ebbing & Gammon, 2010). Most modern plastics are made from an assortment of fossil fuels which can negatively affect the environment along with plastic's long decay rate meaning they stay in the environment for thousands of years. However, plastic can also be made from plant-based materials like starches or even proteins from animals (BBC, 2013). A bioplastic such as this would take less time to degrade into the environment, this could still mean a couple hundred years or a week, either way, it is a big improvement. The most common sources of biodegradable plastics are made from starches, a good source of starch can be found in potatoes (BBC, 2013).

Background Research Pt 2

There are two types of starches, amylose, and amylopectin (BBC, 2013). Both of these starches are made from glucose monomers, groups of glucose molecules bound together by hydrogen bonds in hexagonal structures (Ebbing & Gammon, 2010). Amylose polymers are straight-chained, meaning the glucose monomers are bound together in a straight line (Ebbing and Gammon, 2013). Amylopectin is a branch chained polymer, meaning that additional molecular bonds create monomers branching off the original chain like on a tree (Ebbing & Gammon, 2010). Amylopectin does not make a good plastic because all of the extra branches will get in the way of the structure being uniform (BBC, 2013). Amylose is the desired starch for making plastics because all of the straight chains link up in a uniform fashion (BBC, 2013).Because amylopectin is an undesirable polymer, I will be using acid to dissolve the amylopectin so that I am left with only amylose (BBC, 2013). Another reason that plastic is so useful is because of its flexibility. To create a flexible plastic I will be adding glycerin to my plastic solution (BBC, 2013). The more glycerin added to the plastic the more flexible it will be (BBC, 2013). Water is another crucial component because it will be used to extract the starch from the plant matter, and it also aids the mixing and dissolving process (BBC, 2013).In conclusion, plastics are destroying the environment and a solution needs to be put in place soon, and bioplastics are likely going to be a key step in fixing the current plastic crisis we have. The science of plastics and bioplastics is fascinating and has many uses outside of a science lab. The studies being done today to create biodegradable products could one day prevent the destruction of our environment.

Materials & Procedures Pt 1

60 ml Water, pot, strainer, blender, knife, 4 potatoes, 5 ml liquid, glycerine, 5ml white vinegar, Large Jar, Baking Paper, Food Coloring (Optional), Potato Masher.

Procedure:

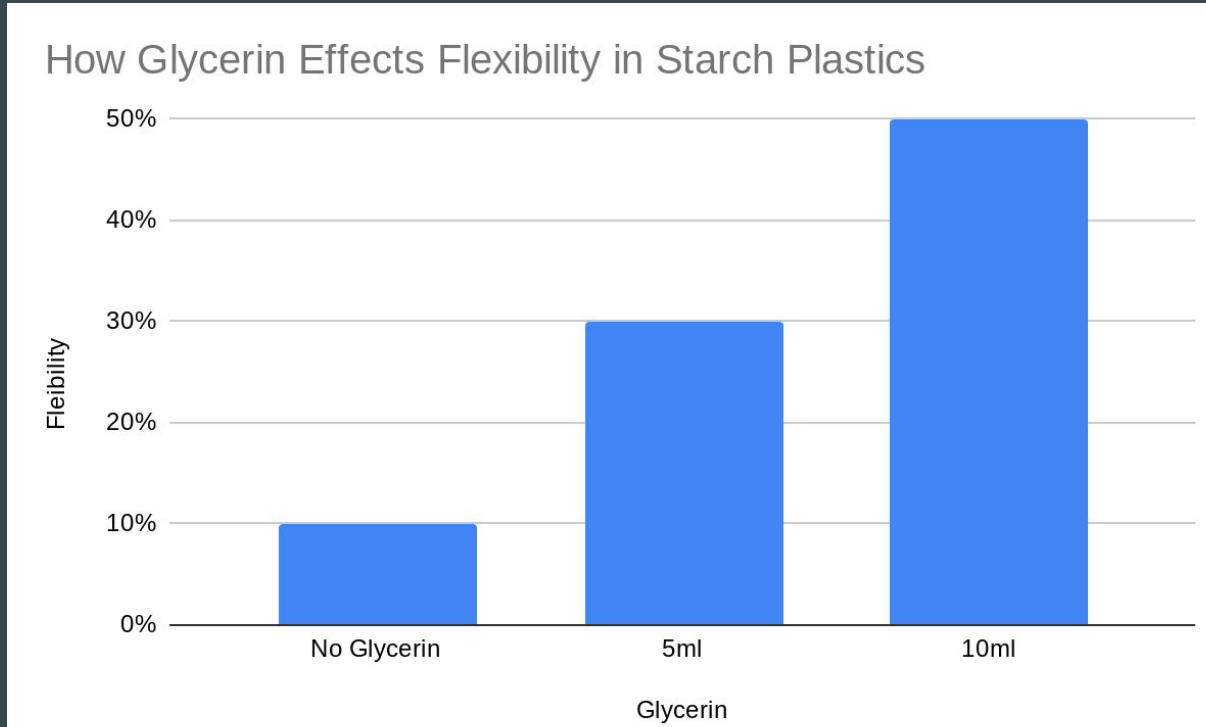
1. Wash potatoes thoroughly
2. Cut potatoes into chunks your blender can handle
3. Blend potatoes until all matter is less than one square inch wide
4. Remove potato bits from blender and put in a large bowl
5. Fill the bowl with water until the potato bits are all submerged
6. Use potato masher and mash potato-water mixture thoroughly, white bubbles should appear on the water's surface
7. Strain water into a large jar, be sure to remove all solids from the mixture
8. Leave the jar to sit for 5 hours, white starch should form on the bottom of the jar
9. Pour water from the jar into the sink (you will not be needing it anymore) the starch should stick relatively firmly to the bottom of the jar however still be careful not to spill any
10. Remove potato starch from the jar and put it in a pot

Procedures Pt 2

1. Add 60ml of water to the starch and then put the pot on heat
2. As the starch is heating add 5 ml of white vinegar to the pot and stir
3. Add 5 ml of liquid glycerine to the pot and keep stirring
4. If you prepared food coloring then stir a tablespoon of food coloring into the mixture
5. Continue stirring, the mixture should start to thicken up pretty quickly and once all of the mixture forms into one clump then remove the mixture and spread onto a baking sheet, thickness matters, spread it relatively evenly
6. Leave the plastic-to-be to set for a day, and do not touch it after placing it on the baking sheet
7. It should form a mildly flexible sheet of plastic, if it does not and it is slime-like and easily breakable, then it most likely still has water in it and you will want to bake or microwave the water out of it.
8. This is the control plastic, for the brittle plastic, follow every step except do not add any glycerin to the mixture, for the more flexible plastic add twice as much glycerin (10 ml)
9. The flexible plastic should be not quite as firm as the control, and also much more flexible
10. The plastic without glycerin should be hard, yet brittle, and you should be able to snap it with your hands

Data, Graphs and Results

I made three different batches of plastic. I made one without any glycerin, I made one with 5 milliliters of glycerine, and one with 10 milliliters of glycerine. Their flexibility is measured from 0-100% with 0 being completely inflexible and 100 being the flexibility of a plastic bag.



Conclusion

Glycerin proved to have a major effect on the plastic, the more glycerine you add the more flexible it is, the less you add the more firm it is. I tested other things as well, in the earlier experiments I used starch that I extracted from potatoes myself and in the later experiments I used store bought potato starch. The effects of the different types of potato starch were unnoticeable and I would even guess that store-bought is better due to there being less impurities. I also tested corn starch however the store-bought corn starch had some extra preservatives added to it which might affect the process however I didn't get to test that due to my lack of other types of corn starch.

Overall my hypothesis was correct, when I added no glycerine to the mixture it would be extremely brittle and easy to break, and too much glycerine would make the plastic wobbly and easily flexed and torn. This is exactly what I predicted happening in my hypothesis. My experiments ran relatively smoothly with few unexpected occurrences in the process. The most notable was when I turned the heat on too early and burned the plastic mixture.

Suggestions for Modifications in the Experiment

If I were to change something in the experiment it would be to add a wider variety of tests, for example I might test how different materials affect the acidity of the substance. Overall the experimentation process ran smoothly to the exception of the burnt plastic. I would have liked more time to further experiment with the subject, however I have gotten the information that I needed.

References

1. Ebbing, Darrel, Gammon, Steven. (2010). *General Chemistry*

2. BBC. (2013, March 5) *Can We Make Plastic from Potatoes?* Youtube. https://www.youtube.com/watch?v=Lhigu23NQlw

3. Summer Time Science. (2020, Aug 19) *Making biodegradable plastic from potatoes*, Youtube. https://www.youtube.com/watch?v=3A-lLOunRoE