Essay

Introduction

Plastics are polymers, and they are made of synthetic material that can be shaped when soft and hardened to retain the shape that was given. As per Collins Dictionary, a bag made from a very thin flexible plastic, is called a plastic bag. A plastic bag is made from a polymer material called polyethylene, which is chemical formula C2H4n (long chains of carbon and hydrogen molecules). The advantages of plastic bags are that they are easy to manufacture and they have established and wide spread use.. The disadvantages are that they are not easily biodegradable, they pollute the environment, and to be made, they use hydrocarbons from fossil fuels.

Bioplastics, on the other hand, are a biodegradable material, and will decompose unlike plastics. They are mainly made of starch, cellulose, and polylactic acid and are 100% more friendly to the environment than traditional plastic bags. The advantages of bioplastic bags are that they have minimal impact on the environment and they are made from natural materials. The disadvantages of bioplastic bags are that they have limited applications compared to conventional plastic bags and commercial production is still in early stages.

Bioplastics are a new and unique technology that was created to overcome the serious environmental issues that regular plastics cause. Plastic bags aren't good for the environment because they are made of fossil fuels, which contributes to global warming. Also, plastics are made of polyethylene so they take 20 to 500 years to decompose, or more. Bioplastics, on the other hand, minimally contribute to global warming. Therefore, landfills don't get filled even more, and global warming is slowed down.

This project aims to explore whether bioplastic bags can fully substitute regular plastic bags through standard testing of plastic strength.

Hypothesis

If bioplastic bags are stronger than conventional plastic bags, per one use, then bioplastic bags will become the overall better option, because they are stronger for the consumer and good for the environment.

Research

What is a plastic bag and what is it made of?

Plastic is described as a material produced from oil by a chemical process, which is used to make many objects. It is quite light in weight and does not break very easily. Plastic bags are made from polyethylene, which starts as ethylene, widely drawn from natural gases, then treated to become a polymer (giant organic molecules assembled from many smaller molecules), creating long chains of carbon and hydrogen atoms. However, these chains can differ, but they all help create multiple types of plastic bags. Some examples of plastic are: HDPE, LDPE, LLDPE, PET, and PE.

What is a bioplastic bag and what is it made of?

Bioplastic bags are a type of bag made from biodegradable materials, such as starch, cellulose, or polylactic acid, which is also known as PLA. These bags are designed to be more environmentally friendly than traditional plastic bags because in the right setting, such as a moist and warm environment, they will decompose naturally over time.

How does plastic decompose?

As said earlier, plastic can take a long time to decompose. Other than their molecular structures, another thing that can affect its decomposition is sunlight exposure. Just like our skin, plastics absorb ultraviolet (UV) radiation from the sun in order to break

down. This is why landfills often expose the waste to the sun to accelerate the breakdown process.

How does bioplastic decompose?

Bioplastics, on the contrary, are a decomposable material and this means that they will biodegrade naturally. Most biodegradable polymers break down into carbon dioxide and methane. Other disposal scenarios include anaerobic digestion, home composting, and industrial composting.

What tests will I be performing?

I researched different ways to test the strength of plastic and bioplastic bags, and the two most easy and favoured tests are the tensile test and the pressure test. In a tensile test, the material is gradually stretched and elongated until it breaks, and the breaking point is measured. In the pressure test I will be performing, the bag will be sealed most of the way and pumped with air. We will see how much air it takes to damage the bag. Initially, I had planned to perform three different tests, but in the interest of time, I focused only on the tensile test.

Variables

My manipulated variable is the type of plastic that is used for each test (LDPE plastic bag and Agar Bioplastic bag). My responding variable will be the tensile strength of each sample, and my control variable will be the laboratory - testing setting and the same pieces of equipment for each test, a weight holder and slotted masses.

Procedure

The objective of the experiment with agar bioplastic bags is to determine whether plastic bags or bioplastic bags are stronger. To test the strength of bioplastic and plastic bags, I conducted research and found that we can test strength with a tensile test and a pressure test. A tensile test is when the material is elongated to the point that it breaks. By using slotted masses and a weight holder to apply tension to the bags, I can then record the breaking point. A pressure test is when air is introduced into the bag until it leaks air or water. In the interest of time, I chose to conduct only a tensile test. If I were to perform the pressure test, I would have done it by pumping the bag with air and putting pressure on the bag until the air leaks, and measuring how many seconds it takes. I will be doing the tensile test thrice to make sure that the data and results are accurate. To make the bioplastic bags, I will be using an AminoLabs kit, which includes a silicone tray, two cotton swabs, two tubes of glycerol, two bags of Agar powder, a beaker, a stir stick, and 3 dyes (in colours red, blue, and yellow). In conclusion, this experiment is to find which of the two materials are stronger.

Observation

LDPE Tensile Strength Data and Observations (1)

	Weight added	Observations
	50 grams	Mild tension
	500 grams	Sagging
	100 grams	Sags a little bit more
	100 grams	Sags very little

	50 grams	Sags very little
	50 grams	Much the same
	50 grams	Still looks almost the same
	20 grams	Not much difference
	20 grams	Basically same tension
	20 grams	Almost same tension
	20 grams	Looks the same
	20 grams	Almost the same
	10 grams	No difference
	200 grams	The breaking point
Total	**1210 grams**	**Breaks**

LDPE Tensile Strength Data and Observations {2}

	Weight Added	**Observations**
	50 grams	Mild tension
	500 grams	Sagging
	200 grams	Deeper sagging
	200 grams	Breaks
Total	**950 grams**	**Breaking Point**

LDPE Tensile Strength Data and Observations {3}

	Weight Added	Observations
	50 grams	Mild tension
	500 grams	Sagging
	200 grams	Sags some more
	200 grams	Sags a little bit more
	200 grams	Sags even further
	200 grams	Breaks/tears
Total	**1350 grams**	**Breaking Point**

Agar Bioplastic Bags Tensile Strength Data and Observations {1}

	Weight Added	Observations
	50 grams	Mild tension
	50 grams	Same
	50 grams	Tears
Total	**150 grams**	**Breaking Point**

Agar Bioplastic Bag Tensile Strength Data and Observations (2)

	Weight Added	Observations
	50 grams	The bag tears right away.
Total	50 grams	Breaking Point

Agar Bioplastic Bag Tensile Strength Data and Observations (1)

	Weight Added	Observations
	50 grams	The bag breaks right away.
Total	50 grams	Breaking Point

Analysis

We can conclude that my hypothesis was incorrect. The bioplastic bag was much weaker than the plastic bags, as I originally thought. I did the tensile test three times on each bag. The result of the LDPE trial 1 was that after 1210 grams, the bag tore. The result of LDPE trial 2 was that the bag tore after adding 950 grams of weight. Finally, for LDPE trial 3, the bag tore after applying 1350 grams to it. Based on the three trials, the average amount of weight necessary to tear an LDPE bag is 1170 grams. After testing LDPE tensile strength, I tested a bioplastic bag's tensile strength. The result of Agar trial 1 was that the bag tore within 150 grams of weight. The result of Agar trial 2 was that the bag tore within 50 grams of weight. The final result of Agar trial 3 was that the bag tore after applying 50 grams of weight to it.

Based on the three trials, on average, the amount of weight necessary to tear the bioplastic bag is 83 grams.

Conclusion

We can conclude that the LDPE plastic bag was stronger than the Agar bioplastic bag. In fact, the average weight necessary to tear the LDPE bag is 1087 grams more than the average weight necessary to tear the Agar bioplastic bag. It was quite clear that the plastic bags were much stronger than the bioplastic bags. The objective of this experiment was to determine which of the two materials were stronger, and whether we could substitute plastic bags with bioplastic bags. Obviously, if I used a whole bag, the results would have changed, because the strength of a whole bag compared to a strip of a bag is a lot stronger. Overall, I learned that while we may not be able to put heavy things in a biodegradable bag, we can still put lighter things, like chips, popcorn, and more.

Applications

Throughout this experiment, I have learned a lot, and I can apply this knowledge to many other projects. Perhaps I could go deeper into this topic, finding ways to improve the strength of bioplastics and and other biodegradable materials.

Sources of Error

The main sources of potential error in this experiment may occur in the procedure and testing steps. The first step that was performed was making the bioplastic sheets and bags. There may have been human contamination through unsterilized handling of the supplies, or chemical contamination through chemical residues left on the supplies from prior lab experiments. During testing, there could possibly have been equipment errors, faulty weights, incorrect scales or incorrect shape, or human error, incorrect measurements. Overall, there are limited sources of potential error in this experiment.

Citations

Harper Collins Publishers. (2025). *Plastic bag definition and meaning | Collins english dictionary*. Collins Dictionary. https://www.collinsdictionary.com/dictionary/english/plastic-bag

Admin. (2021b, July 30). *What are plastic bags made out of?*. Action Health. https://actionhealth.com/what-are-plastic-bags-made-out-of/

Polyethylene (PE): How to select the right grade?. Polyethylene (PE Plastic) - Structure, Properties & Toxicity. (2025). https://omnexus.specialchem.com/selection-guide/polyethylene-plastic#:~:text=Low-Density%20Polyethylene

Admin. (2022, July 22). *High density polyethylene - structure, properties, and uses*. BYJUS. https://byjus.com/chemistry/high-density-polyethylene/#structure

The Science Dictionary. (2016). *Science dictionary - online science term finder*. Science Dictionary - Online Science Term Finder. https://www.thesciencedictionary.com/

Skouborg, T. B. (2025, January 21). *Bioplastic bags*. Scanlux Packaging. https://scanlux-packaging.com/bioplastic-bags/

Chariot Energy. (2024a, May 28). *How long does it take for plastic to decompose?* https://chariotenergy.com/blog/how-long-until-plastic-decomposes/

How to dispose of Bioplastics. Golden Arrow Home. (2024). https://www.goldenarrow.com/blog/how-dispose-bioplastics#:~:text=BioPlastic%20Disposal%20Methods&text=Most%20biodegradable%20polymers%20break%20down,home%20composting%2C%20and%20industrial%20composting.&text=The%20key%20to%20biodegrading%20is,the%20right%20microbes%2C%20and%20heat.

Acknowledgements

I would like to thank Dr. Soares for being my mentor, Ms. Dawn for her support, Ms. Sarah for her lunch-time help, and Dr. Shahin for her help as well. A special thanks to Sophia for helping me edit and revise my essay. And finally, thank you to all other teachers, family, friends, and my parents for their continuous day-to-day support, especially my dad for his encouragement.