

September 26th - Planning begin

- How different membranes affect the speed of toxin removal during Hemodialysis
- CRISPR: Exploring the effects of CRISPR on Genetic Modification
- BioPlastic alternatives

September 28, 2025 - Background Research and bibliography

What are Bio Plastics?

BioPlastics are materials made from renewable sources such as starch, milk proteins, or seaweed instead of petroleum. Unlike plastics such as ABS, derived from fossil fuels and often persist for centuries, bioplastics are biodegradable and can break down naturally in soil. They can be designed to mimic the strength, flexibility, and durability of conventional plastics, making them promising for packaging, agriculture, and consumer goods.

Types of Bio Plastics

- Protein- Based (Casein): made from milk proteins, can form hard, moldable plastics
- Polysaccharide-Based (Starch, Agar) – renewable, biodegradable, and flexible when mixed with glycerol.
- Synthetic Biodegradable (PVA blends) - based on polyvinyl alcohol (found in school glue), biodegradable under certain conditions and stronger than starch-only plastics.

Why do we need Bio Plastics?

1. Plastic Pollution: Conventional plastics like ABS do not biodegrade, creating long term waste in oceans and landfills.
2. Fossil Fuel use: ABS and similar plastics are petrol based, linking them to climate change.

3. Eco-Friendly Alternative: Bioplastics can be produced from renewable or waste sources (like spoiled milk or cornstarch).
4. Real World Impact: If Bioplastics can replicate the useful properties of ABS, they could replace it in certain applications like packaging or disposable items, greatly reducing environmental harm.

What is ABS?

ABS stands for Acrylonitrile-Butadiene-Styrene. It's a petrol based thermoplastic, meaning it softens when heated and hardens when cooled. It can be molded into many shapes. ABS is strong and durable, lightweight but rigid, heat resistant, easily molded, delicate and good looking.

However, the main reason this has been brought up is not for its benefits, but also because ABS is not biodegradable, meaning it stays in the environment for hundreds of years, affecting our wildlife and us too.

Environmental Impact of ABS Plastic

Non-Biodegradability

Acrylonitrile Butadiene Styrene (ABS) is a non-biodegradable plastic that can persist in the environment for hundreds of years. Because it resists microbial breakdown, ABS accumulates in landfills and natural ecosystems, contributing to long-term pollution. Over time, it can fragment into microplastics that contaminate soil and waterways, posing risks to wildlife and potentially entering the human food chain.

Petroleum-Based Composition

ABS is made from three monomers—acrylonitrile, butadiene, and styrene—all derived from petroleum. These are non-renewable resources whose extraction and processing release significant greenhouse gases. The European Chemicals Agency classifies some of these monomers as toxic and potentially carcinogenic, making the production process harmful to both the environment and human health.

Pollution from Production and Disposal

During production, ABS manufacturing emits volatile organic compounds (VOCs) and styrene fumes, both of which are regulated air pollutants. When burned or incinerated, ABS releases hazardous substances such as carbon monoxide and hydrogen cyanide. These emissions contribute to air pollution, climate change, and health hazards, especially in areas without proper waste management systems.

Challenges in Recycling

Although ABS is technically recyclable, practical recycling rates are very low. Its frequent use in mixed-material products, such as electronics and toys, makes separation and reprocessing difficult and economically inefficient. As a result, most ABS waste ends up in landfills or is incinerated, perpetuating the cycle of pollution and resource depletion.

Microplastic Pollution

As ABS products degrade physically under sunlight or mechanical stress, they form microplastic particles that persist in marine and terrestrial environments. Studies have detected ABS fragments in marine sediments, demonstrating its role in microplastic pollution. These particles

can harm aquatic organisms, accumulate in the food web, and transport toxic chemicals across ecosystems.

Overall, ABS poses significant environmental challenges due to its persistence, fossil fuel dependency, emissions, and contribution to plastic pollution.

Bibliography

My resources:

<https://pmc.ncbi.nlm.nih.gov/articles/PMC10747977/>

<https://www.mdpi.com/2071-1050/17/19/8742>

<https://pmc.ncbi.nlm.nih.gov/articles/PMC11401513/>

<https://pmc.ncbi.nlm.nih.gov/articles/PMC7240402/>

<https://www.mdpi.com/1996-1944/18/18/4247>

<https://www.mdpi.com/1422-0067/24/9/7696>

<https://pmc.ncbi.nlm.nih.gov/articles/PMC6801152/>

<https://pmc.ncbi.nlm.nih.gov/articles/PMC10990045/>

<https://www.canada.ca/en/environment-climate-change/services/evaluating-existing-substances/science-assessment-plastic-pollution.html>

<https://www.mcgill.ca/oss/article/environment-general-science/breaking-down-bioplastics-benefits-and-problems>

<https://www.theguardian.com/environment/2025/may/13/starch-based-bioplastic-petroleum-plastic-study>

September 29th - Hypothesis

Experiment Overview

Hypothesis

If a safe, cheap, kitchen based bioplastic is developed, then it can provide a renewable and biodegradable alternative to conventional ABS plastic, potentially replacing petroleum based materials in everyday applications, therefore lessening plastic pollution.

October 4th, 2025 - Material and a bit of procedure

Materials

- Whole Milk (500 ML)
- White Vinegar (50 ML)
- Agar powder (40 g)
- Cornstarch (40 g)
- School glue (PVA) (100 ML)
- Glycerol (vegetable glycerin, 50 ml)
- Heat resistant beaker or measuring cup
- Digital kitchen scale
- Thermometer
- Soil container
- Trifold board for display

Procedure

Step 1: Prepare the bioplastics

- Casein plastic: Heat 250 mL milk, add 25 mL vinegar, collect curds, press into a mold, and dry 48 hours.
- Agar plastic: Mix 20 g agar, 10 g glycerol, 250 mL boiling water, pour into mold, dry 48 hours.
- Starch plastic: Mix 20 g cornstarch, 10 g glycerol, 250 mL boiling water, pour into mold, dry 48 hours.
- PVA plastic: Mix 50 mL school glue, 10 g cornstarch, 10 g glycerol, stir, pour into mold, dry 48 hours.

October 6th 2025 - Finishing up Procedure

Step 2: Standardize samples

Pour mixtures into rectangular silicone molds (about 8 cm x 2 cm x 0.5 cm). Make 3 samples of each type.

Step 3: Test properties

- Tensile strength: Clamp each end of a strip and add weight until it breaks. Record maximum mass supported.
- Flexibility: Bend each strip over a fixed ruler curve until it cracks. Record bend angle.
- Heat resistance: Place samples in water baths at 40°C, 60°C, and 80°C for 10 minutes. Observe deformation.

- Water resistance: Submerge samples in water for 24 hours. Measure mass change and note structural integrity.
- Biodegradation: Bury samples in soil for 3 weeks, checking weekly for mass loss and visible breakdown.

October 6th - Variables

Variables

1. Manipulated variables

Types of bioplastic recipes used (Agar, cornstarch, etc).

2. Dependent variables

Strength, flexibility, heat resistance, water resistance, and biodegradability.

3. Controlled variables

Temperature, drying time, testing conditions, ingredient ratios, and test methods.

October 10th 2025 - Results and observations

Results and observations

Casein plastic:

Day 1: The casein plastic was rubbery, and it had a similar texture and look to cheese. It was still not hardened and could not be called plastic.

Day 2: The casein plastic had hardened on one side and was starting to feel more like plastic.

The other side still had to be dried and hardened.

Day 3: The casein plastic was fully dried and hardened, however it was not smooth at all and the sample size was much smaller than expected. The casein plastic had to have been retried.

Agar plastic:

Day 1-3:

The agar plastic started out as a liquid, but after cooling for about an hour, it developed a jello-like texture and couldn't yet be split into samples. After 3 hours, it became more rubbery and plastic-like, though still fragile and not fully hardened. By the next day, the agar plastic felt malleable and somewhat thick, with uneven sides ranging from 1–2 mm to 3–4 mm.

Day 4-7:

The agar plastic continued drying and became much harder, shrinking to nearly half its original size. Each day, it was flipped to ensure even drying, and with every observation, it had shrunk slightly more. Its surface became firmer and smoother, showing clear signs of solidification and moisture loss over time.

Day 7-10:

Over the final 3 days, the agar plastic was shrinking every new day. Most parts hardened especially the edges but the middle was still soft.

October 13th 2025 - Purpose/ Real-World Application /Conclusion

Purpose

The purpose of this experiment is to create and test different types of homemade bioplastics to determine which formula provides the best combination of strength, flexibility, and biodegradability. By comparing plastics made from materials such as agar, starch, milk protein (casein), and PVA, the goal is to identify a safe, eco-friendly alternative to petroleum-based plastics like ABS that could help reduce plastic pollution and reliance on fossil fuels.

Real-World Application

If developed further, bioplastics could replace petroleum-based plastics in certain areas, reducing waste and dependence on fossil fuels.

- **Starch or Agar plastics** – could be used for disposable food packaging or single-use items that need to biodegrade quickly.
- **Casein plastics** – could be used for small molded products like buttons or decorative items.
- **PVA blends** – could be used where higher strength and water resistance are needed, such as packaging or coatings.

Widespread use of bioplastics would contribute to a circular economy, where materials are renewable, biodegradable, and environmentally sustainable, helping reduce pollution and protect ecosystems.

Conclusion

The experiment demonstrated that homemade bioplastics can replicate some properties of conventional ABS plastics, though no single recipe excelled in all areas.

- Agar-based plastics had the best flexibility.
- PVA-based plastics had the highest strength.
- Starch and casein plastics were more biodegradable.

This shows that bioplastics can be engineered for specific purposes: stronger types for packaging, faster-degrading types for single-use products, and water-resistant types for durable applications. Overall, bioplastics present a promising, eco-friendly alternative to petroleum-based plastics, with potential to reduce plastic pollution and fossil fuel dependence.