CYSF 2025-2026 Logbook

Tue, Jul 29, 2025

IDEAS AND BRAINSTORMING

- Potential detection of skin cancer by building a machine or website that could detect signs of Melanoma or other skin cancers
- Skin patch to detect dehydration and fever
- Creating a simulation of a blood vessel to and creating a machine to detect blood clots in people
- Using probiotic bacteria to fight off microplastics

Wed, Jul 30, 2025

- Microbial growth in presence of Homeopathic Dilutes

Fri, Sep 5, 2025

- CRISPR Gene editing simulation for treating Genetic Disorders- using online simulation tools to design and predict edits to a gene linked to a disease
- Designing a biodegradable plastic (Antimicrobial food packaging Film)

Sat, Sep 27, 2025

CHOSEN TOPIC:

"Are Plastic Bottles Safe?" Investigating Microplastic Release and Biodegradable alternatives

In this project, we will be testing single-use plastic bottles to see if they are actually safe - seeing if they contain any microplastics, and if they do, what is the amount. Furthermore, we will test them under direct UV ray/sunlight - because that is the most prominent way that people are exposed to quantities of microplastics.

We also will design a unique Biodegradable plastic that is resilient against UV rays , using materials with easy accessibility and sustainability to test its strength, water resistance, decomposition speed, health concerns (microplastics) versus traditional plastics. We will try different ways of creating Bioplastics and create the best we can to further improve the research being done on Bioplastics and making them better.

Mon, Sept, 29/2025

MAIN QUESTION (s):

Are Single Use Plastic Water Bottles actually SAFE?

- Is it safe to drink from single use plastic bottles until the posted date?
- Does sunlight / UV rays affect the amount of microplastic (if any) in the water?
- What are its effects on the human body?
- What are the effects of this plastic on the environment and ecosystems?
- Can a different type of plastic be made to prevent contamination of these microplastic?
- Can a device be made to prevent the intake of microplastics?

Can a Biodagredable Plastic be made to prevent this issue?

- What are the different types of biodegradable plastics that exist today?
- Are any of these resilient to UV rays?
- How are Biodigradable Plastics made?
- What materials were used to make this plastic?

HYPOTHESESE:

Information for the Hypotheses-

Single-use plastic water bottles have been used all across the planet for decades. But, recent studies have proven that plastic water bottles contain a certain amount of microplastics, and this has been affecting humans and the environment in countless ways. Millions of people all across the globe are unaware of this and continue to intake microplastics by drinking from plastic water bottles. Additionally, UV rays melt the POLYETHYLENE TEREPHTHALATE (the type of plastic in a majority of plastic water bottles), which cause extremely tiny plastic pieces to get mixed within the water.

Navnir:

If we test single-use plastic water bottles, then all of them will contain some amount of nanoplastics or microplastics. This is because the plastic used (PET) is known to degrade under UV exposure and release plastic particles, and past studies have consistently shown that bottled water samples contain measurable amounts of microplastics. Overall, wIth all of these factors contributing, I feel that overall, no plastic water bottle is completely safe, and will contain some microplastic.

In terms of creating a biodegradable plastic, if we create a bioplastic using algae based polymers and starch based biopolymers, then the plastic will have better resistance against UV rays and sunlight, and a better degradation rate. This will result in little to no amount of microplastics within the test water. This is because this bioplastic will use bio polymers from biomass, rather than using traditional petroleum polymers to create strength and flexibility. This will result in close to no microplastics in the water.

Tanveer:
If traditional plastic water bottles are exposed to UV rays, and are kept in a humid and warm environment, and other water bottles of the same type kept in an environment where there is no UV radiation or hot temperatures. Then the water inside all will contain some levels of microplastics, but the ones under UV rays will have a significantly higher concentration of microplastic. This happens because of the UV radiation that accelerates the degradation of the polymer (substance where molecules are chemically bonded to give plastic strength and flexibility) mix found in these water bottles known as PET leading to higher levels of plastic in the water. While there still will be microplastic present in the water bottles with no UV rays but there will be no heat to increase the degradation of PET.

If we create a biodegradable plastic using a combination of algae-based polymers and starch-based biopolymers. Then the material will have improved UV resistance and biodegradation rates, and no microplastics in the water compared to traditional based plastics. This is because this would use bio polymers from biomass, rather than petroleum polymers to create the flexibility and strength resulting in little to none microplastics in water. In fact this plastic will be completely safe for marine life, which none of the Bioplastics right now are able to do.

BACKGROUND RESEARCH

The Big *Problem:*

Throughout recent years, tiny pieces of plastic have been found everywhere on the planet. From interweaving within our environment to occurring in our food, microplastics are a rising concern. Research from Columbia University shows that a majority of the reason why humans are being contaminated by plastic is because of single-use plastic water bottles. On average, a litre of bottled water contains roughly 240000 pieces of microplastic, and this number is expected to rise within the coming years. Not only do they affect us humans, but entire ecosystems, which is why it is crucial for humans to be aware of this crisis, and that we take action to protect ourselves and the environment around us.

What are Biodigardable Plastics?

Biodigradable plastic is plastic material that can be broken down by microorganisms into natural substances (water, carbon dioxide and biomass). They are specifically designed to decompose in a rational timeframe under specific conditions (moisture, microbial activity, temperature).

Different types of Bioplastics:

TYPE	MATERIALS	CHARACTERISTICS	EXAMPLES	DECOMPOSITION
Polylactic Acid (PLA)	Corn starch, sugar cane	Rigid, transparent, industrially compostable and brittle	food containers, disposable utensils and 3D printing	3-6 months (industrial composting)
Polyhydroxyalkanoates (PHAs)	Bacterial fermentation of plant oils and sugars	Flexible, biodegradable in soil and water	packaging, agriculture films and medical implants	2-6 months (soil and marine)
Starch-Based Plastics	Corn, potato	brittle, moisture-sensitive	Compastable bags and food service items	1-4 months (home compostable)

Cellulose-Based Plastics	Wood pulp and cotton fibers	transparent breathable	cellphone, films and textiles	1-3 months (compost or soil)
Polybutylene Adipate Terephthalate (PBAT)	Fossil fuels and biodegradable additives	flexible tear-resistant compostable in industry	bags, packaging film	3-6 months (industrial composting)
Polybutylene Succinate		Heat-resistant and durable	food packaging	3-6 months (industrial composting or soil)
Polycaprolactone (PCL)	Fossil fuels (can be bio-synthesized)	not heat resistant and elastic	medical devices, drug delivery	6 months - 2 years (soil or compost)
Oxo-Degradable Plastics	Conventional plastics and metal salts	Not fully biodegradable, degrades into fragments	plastic bags and agriculture films	Unknown (leaves microplastics)

How are bioplastics made?

1. *Choosing a Raw material:*
   Bioplastics are made from biomass, including:
   - Sugar cane
   - Potatoes
   - Cellulose/plant waste
   - Algae
   - Agricultural by-products

2. *Sugar Extraction*
   Then the sugar (glucose, sucrose) is extracted from the biomass. This involves

- Grinding the biomass
- Using enzymes or acids to break down starch into sugars

3. *Fermentation or Polymerization*

This step depends on Bioplastics you are creating

- **For PLA (Polylactic Acid):**
    1. Microorganisms ferment the sugars into lactic acid
    2. Lactic acid Molecules are chemically bonded (polymerized) to make PLA, a biodegradable plastic
- **For PHA(polyhydroxyalkanoates)**
    1. Bacteria are fed plant sugars or oils
    2. They produce PHA granules inside their cells
    3. The PHA is then harvested and turned into plastic

4, *Processing into Products*

The biopolymer is dried, melted or moulded into films, bottles, packaging and more. This is done similarly to how petroleum plastics are processed.

How can we create Bioplastics using household materials?

There are many different ways we can create Bioplastics at home

- Starch-based Bioplastic- Using starch as the base polymer, mixing it with water, acid (Vinager) and glycerin and heating it up.
- Gelatin-based bioplastic- Gelatin can also be used as a polymer, dissolving it into hot water and adding glycerin results in a flexible plastic.
- Milk plastic- Heating milk and adding an acid (vinegar) causes it to curdle and form casein (a natural polymer). When this is dried it turns into a plastic like material
- Banana peel plastic- When banana peels are boiled blender and mixed with acid (vinegar) and glycerin also makes a flexible plastic
- Algae-based plastic- Using algae biomass you can get polysaccharide (natural polymer), when mixed with glycerin and heated result in a thin plastic film

For our experiment, I have concluded that the 'best' type of plastic would be one that mixes the different types of Bioplastics materials together. My research has also told me that every plastic except Algae based plastic has been said to be not suitable for use due to weak properties, poor water resistance, low heat resistance and most importantly the food safety concerns. The Algae based plastic is still under research and looking for improvement.

Algae based plastic

Algae based Bioplastics are made from Algae biomass, specifically the polymers extracted from the algae. It has many advantages: being sustainable, biodegradable, safe for marine environments, can capture Co2, and having a lower carbon footprint.

Algae is naturally rich in macromolecules like polysaccharides (starch, cellulose, agar), proteins and lipids. These compounds can be extracted and made into Bioplastics with many advantages.

How is it made? (Industrial)

1. Algae cultivation- Algae is grown in controlled environments
2. Harvesting- The algae is collected and made into biomass (grinding and drying)
3. Blending or Direct use- Some use biomass as main polymer or it's blended with other polymers
4. Polymerization- turning the collected polymers into usable plastic forms

Research being done on Algae-based plastic

Limitations-

- **Materials-** Since bioplastics have low durability, water resistance and tensile strength when compared to petroleum- based plastic. This restricts their application for uses that require longevity and having barrier functions.
- **Cost-** the cost of making algae-based Bioplastics is higher than other non-biodegradable plastics due to expensive raw material processing and difficulty of scalability.
- **Policy-** There is a lack of global recognition of the Bioplastics sector, creating uncertainty in the market compared to the well-established fossil fuel industry.

Some examples of these studies include...

1. **MDPI Review:**

What are Microplastics?

Microplastics are microscopic pieces of plastic debris, they come from the breakdown of larger plastic. They are environmental pollutants that are present nearly everywhere from the depths of the oceans to the air we breathe and the water and food we consume. They are non-biodegradable and stay in the environment making them a global health and global concern. One thing to keep in mind, is that the tinier the microplastic, the more toxic.

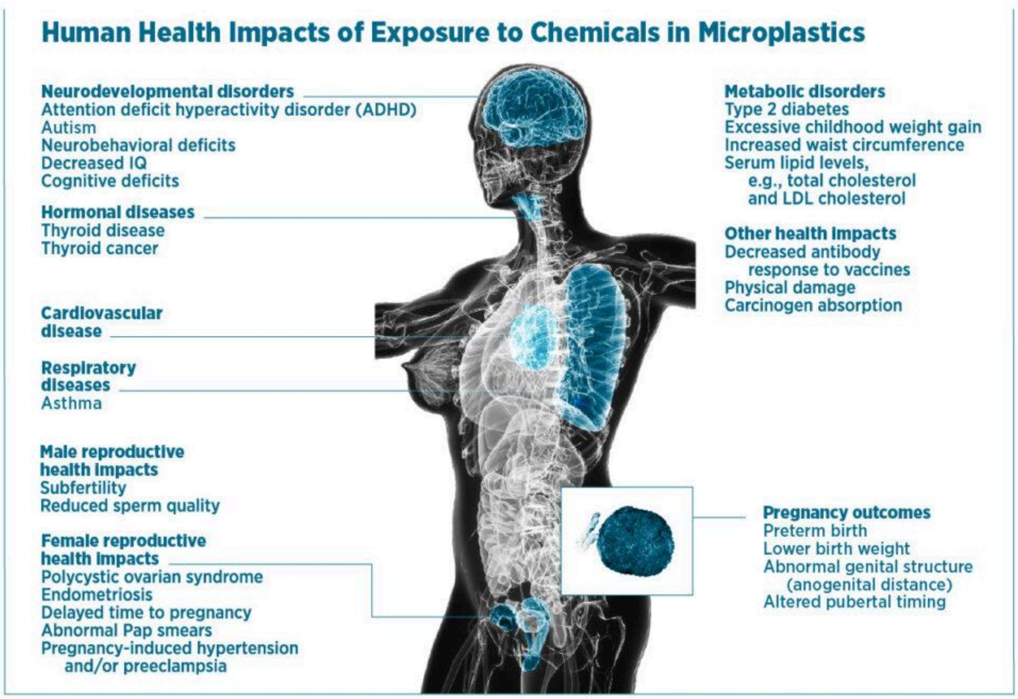
One of the most disturbing things about this issue is that countless are intaking millions of pieces of microplastics daily. This is done when people drink out of single use plastic water bottles which have been sitting in the sun for many hours. Sunlight and UV rays melt the plastic resulting in the water getting contaminated.

How do Microplastics impact humans?

Humans are exposed to microplastics in various different ways. Overall, humans are uncovered to microplastic in these 3 ways - direct ingestion, direct contact, or inhalation. This can include food packaged in plastic packaging, personal hygiene products, etc. Some exposure can also come from our household environment -including paint fragments.

The toxicity of inhaling these microplastics present in our atmosphere can result in very serious health issues. This may include chronic diseases, such as respiratory and cardiovascular illness. To add on, other variants of microplastics may cause differences in antioxidant genes and enzymes involved in generating active oxygen and oxidative stress. Furthermore, microplastics can impact various human systems, including the digestive system - when microplastics are ingested, causing irritation to gastrointestinal line, resulting in inflammation, etc- , respiratory system - causing coughing, inflammation in lungs, low O2 in lungs, etc. Microplastics can affect the endocrine system as well, affecting metabolism, hormones, development disorders and reproductive disorders.

Because microplastic intake can disrupt the natural balance of the human body, it is important that we are aware of this rising issue and how we can prevent it.



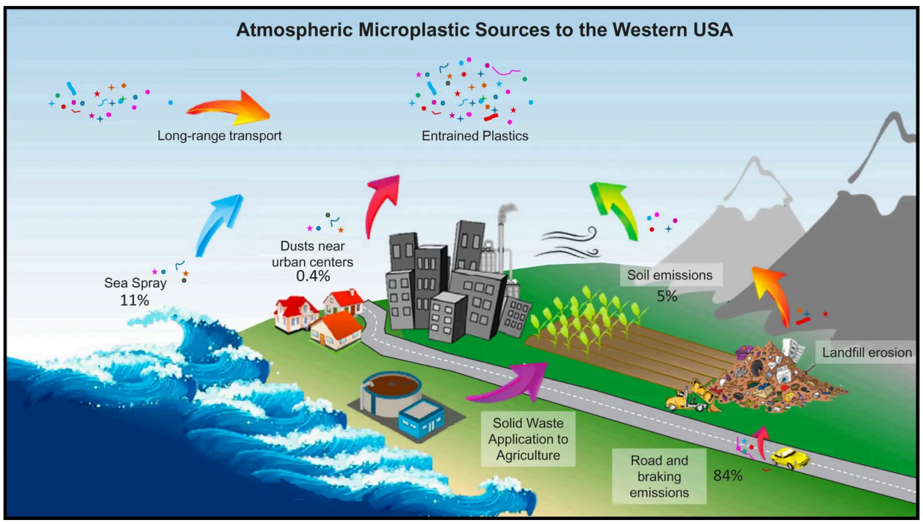
Source: Based on visuals from a 2021 report by the United Nations Environment Programme, titled "From Pollution to Solution").

Tue, Sept 30/2025

How do Microplastics impact the environment and ecosystems?

Microplastics-especially in bodies of water affect the environment and wildlife significantly. Similar to humans, microplastics enter the system mainly through direct ingestion. They block the gastrointestinal tract of wildlife, causing inflammation and irritation. Additionally, they can also leave the animal feeling full, resulting in a loss of appetite, and physical decline.

In terms of the environment, microplastics play a crucial role in plastic pollution, not only on land but also the sea. The chemical compounds and heavy metals found in plastics can be transferred into the environment, eventually affecting organisms as well. This can cause biomagnification of the toxins, eventually affecting the entire food chain.



EVIDENCE OF MICROPLASTICS ACCUMULATING ON OUR PLANET:

Humans inhale as much as 68,000 microplastic particles daily, study finds

Particles are small enough to burrow into lungs, says report, with health impacts 'more substantial than we realize'

➔ This article is from THE GUARDIAN, showing how much humans inhale microplastics daily.

Each day we breathe in tens of thousands of microplastic particles

Estimated daily average of inhaled microplastic particles (1-10 micrometers in diameter)

Guardian graphic. Source: PLOS one, Yakovenko, Pérez-Serrano, Segur, Hagelskjaer, Margenat, Le Roux and Sonke

HEALTH > WELLNESS • 7 MIN READ

Microplastics shed by food packaging are contaminating our food and drink, study finds

JUN 24, 2025

- This article is from the CNN, taking about how plastic food packaging is contaminating our food with microplastics

How do the microplastics in our bodies affect our health?

25 July 2025

Share Save

- This article is from THE BBC

One thing that we want to emphasize about these breaking news articles is that all of them are very recent. This illustrates how much of a problem microplastic pollution/contamination have become in these recent years. If you compare breaking news articles to a few years ago, there are little to no articles on microplastic pollution, but in recent years, the number has gone up. This symbolizes how microplastic contamination has spiked and is affecting us and our planet more than ever.

Overall, there are countless other recent news articles explaining this microplastic crisis. But we just wanted to share and emphasize that microplastics are a significant problem, and now it is about time that we start raising awareness and take matters into our own hands and start to come up with a long lasting solution.

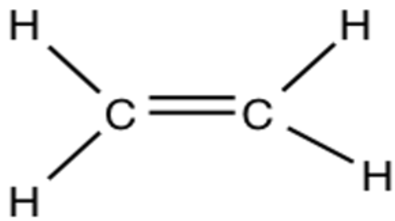
Wed, Oct, 8/2025

Chemical Composition and Additives in Microplastics:

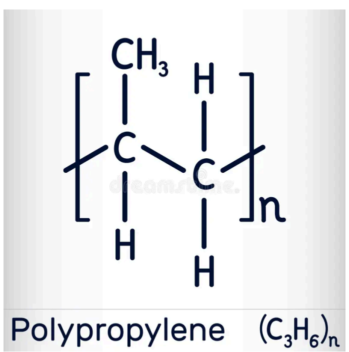
Microplastics have a wide range in sizes - 1mm to 5mm. While the size is tiny, they can contain a large amount of different additives and polymers. Because of this variety, visual inspection to identify the different plastics is a very poor method. Instead, using a variety of identification tools helps.

Different chemicals in Microplastics............

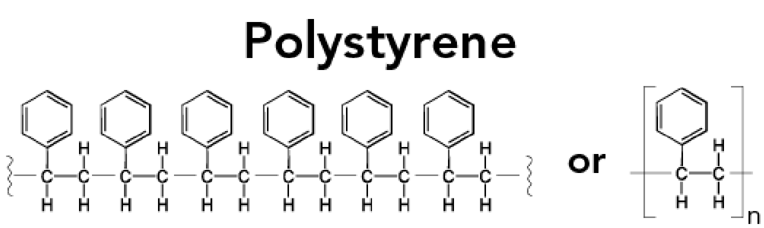
Polyethylene (PE)



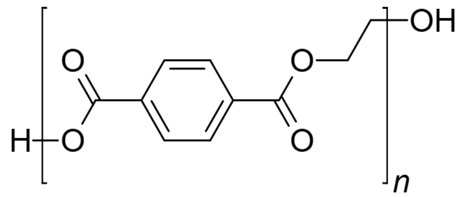
Polypropylene (PP)



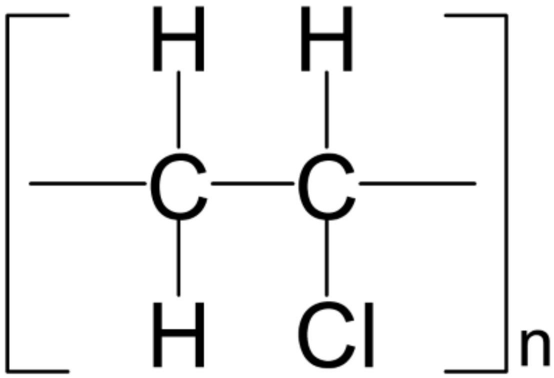
Polystyrene (PS)



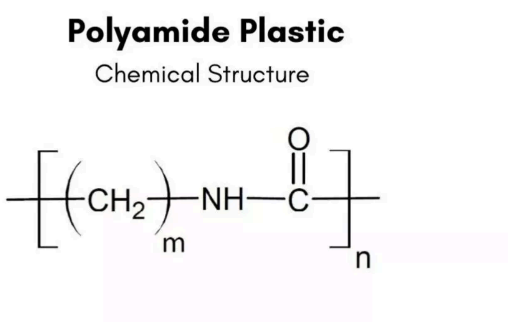
Polyethylene terephthalate (PET)



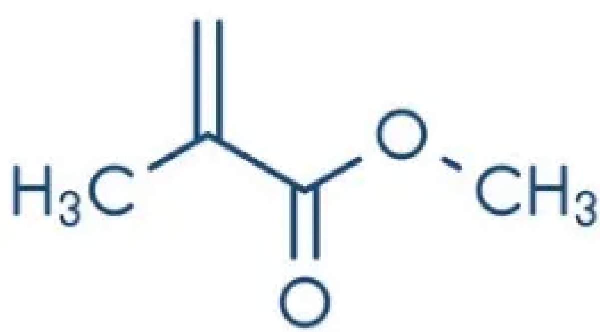
Polyvinyl chloride (PVC)



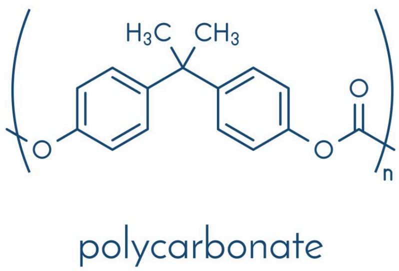
Polyamide (PA, aka Nylon)



Acrylics (PMMA, etc.)



Polycarbonate (PC)



The different polymer types help with thermal properties. For example, different plastics react differently and degrade at different temperatures.

Additives include...

- Plasticizers (helps with elasticity)
- Stabilizers (prevents breakdown through heat/UV)
- Flame retardants (Reduces flammability)
- Colourants/pigments(Gives colour)
- Antioxidants(Prevents degradation)

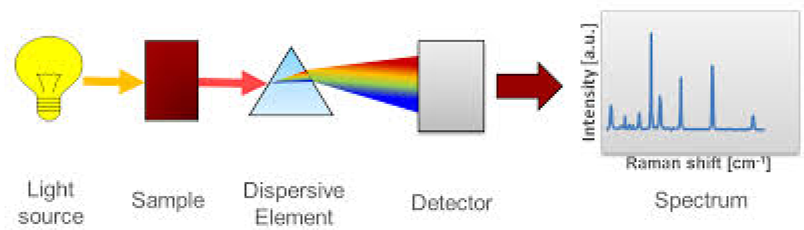
There also can be various amounts of contaminants that plastics get from factories, the environment, etc. This can include heavy metals, organic pollutants, and more.

Methods to detect Microplastics:

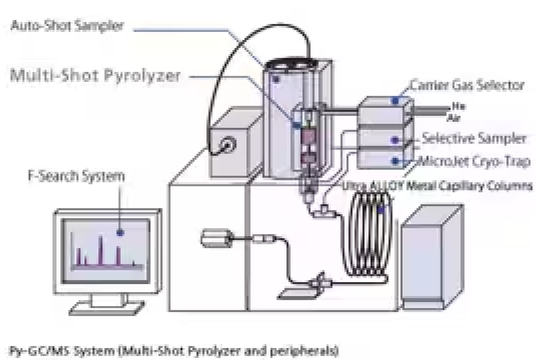
In today's world, the majority of microplastics are found in water.
There are three main microplastics identification methods used to find microplastics in water;**FTIR SPECTROSCOPY, py-GC/MS, and Raman Spectroscopy.**
FTIR and Raman are used to determine the number of microplastic particles. They do this by identifying the plastic type and size range. py-GC/MS Quantifies concentrations of a specific type of microplastics in milligrams per liter.

These detection methods help environmentalists to not only identify but also understand the health of the ecosystem and understand the severity of plastic pollution in a specific area. Overall these methods help enhance scientists' understanding of micro plastic pollution. Over time this will help mitigate and reduce this issue, in turn helping ecosystems and the environment thrive.

Raman:



py-GC/MS:



Technologies to Prevent Microplastics:

Throughout the years, Scientists have been working together and developing new ways and Technologies to prevent the contamination of microplastics in our environment.

Some of the most popular methods include filtration systems like membrane bioreactors and ultrafiltration. These systems physically trap microplastics, similar to sieves. Another method is physical separation methods such as hydrocyclones and whirlpools. These methods physically separate the microplastics from contaminated bodies such as water and soil. Lastly, nature-based solutions like rain gardens and bioretention systems. These methods use technologies which are integrated within infrastructure, such as sewers, gardens, drains, etc.

Thur, Oct 9/2025

Impact of UV radiation on Microplastics:

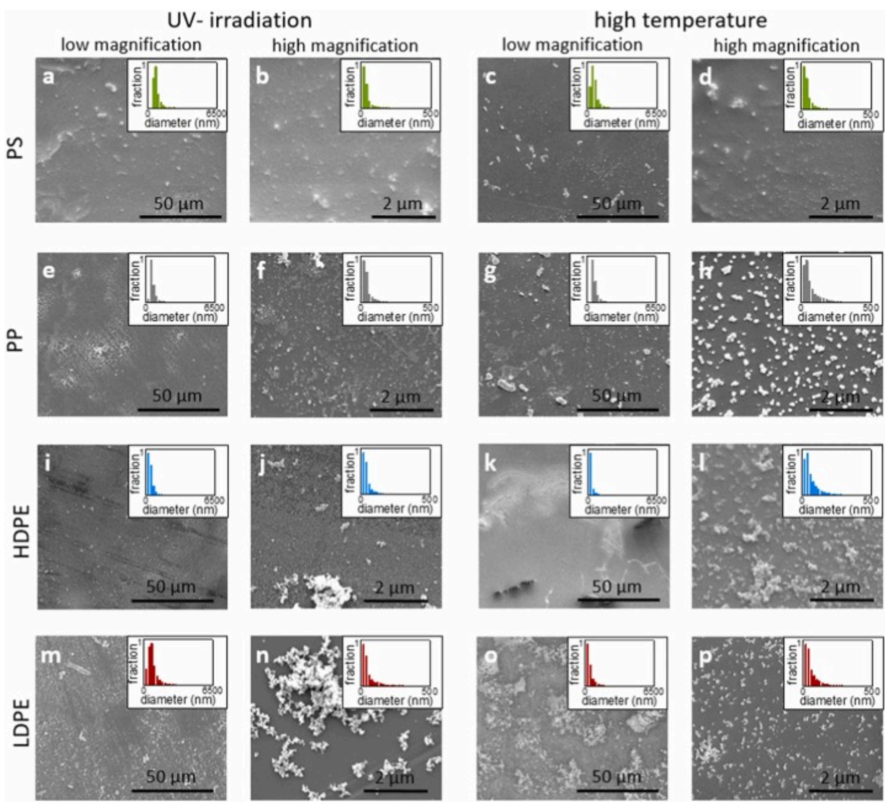
The impact of UV rays and thermal energy on plastics is very significant. Past studies have tested this out and have found immense data showing how heat and sunlight contribute to the degradation of plastics.

On average, popular plastics such as Polystyrene & Polypropylene, tend to begin degrading under high temperatures - usually over 37 degrees celsius. Additionally, the environment for this to happen also needs to be exposed to moderate levels of UV rays (sunlight).

Typically, the amount of nanoplastics released by these plastics varies. But all plastics usually release up to 10^8–10^9 particles/mL of nanoplastics after 18 weeks in this environment.

Even though the plastics remained in this environment for a very long time, the chemical structure and properties of the released particles were the exact same as before. This proves that the nonplasticity came from the plastic itself and was not sourced from any other external source.

Additionally, knowing this information has allowed environmentalists to study the areas that nanoplastics might be contaminating and take action because if microplastics have the same chemical structure as before, then the toxicity will remain the same as well.



Laura M. Hernandez a , Joel Grant a , Parvin Shakeri Fard a , Jeffrey M. Farner a b , Nathalie Tufenkji. "Analysis of ultraviolet and thermal degradations of four common microplastics and

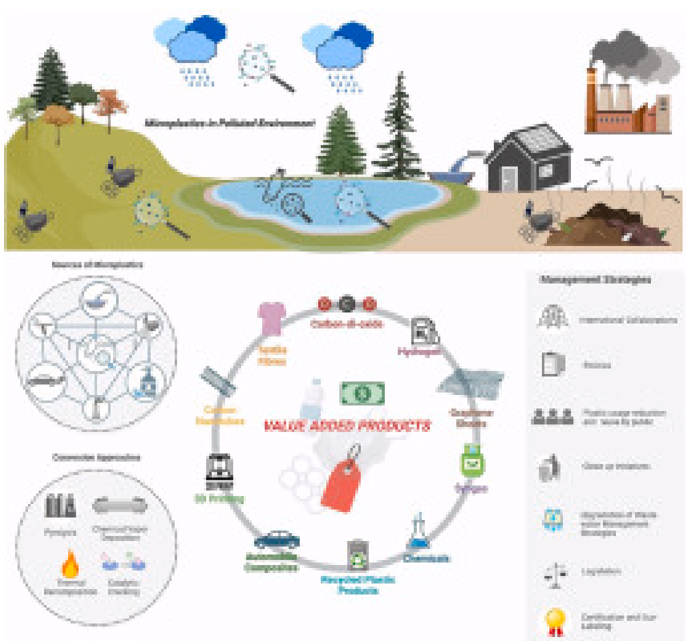
evidence of nanoparticle release." ***ScienceDirect*****,**
https://www.sciencedirect.com/science/article/pii/S2666911023000047. Accessed 9 10 2025.

Regulations existing on Microplastics and Plastics to prevent contamination in Environment:

In Canada and many other countries around the globe, there are countless policies put in place to prevent the contamination of microplastics in the environment and ecosystems. For example, many countries in North America have banned certain single-use plastic items and have banned plastic microbeads.

In Canada specifically, the regulations have banned the manufacture, imports and sale of certain single use plastics. An example of this is that many grocery stores don't have the plastic bags that they used to have a few years ago, instead they have reusable ones that you can buy and use over and over again. This helps limit not only the production of plastics but it also helps limit the plastic waste that Canada has as a whole.

These rules and regulations are a part of Canada's plan to address the plastic pollution problem and meet 0 plastic waste Target by 2030. This will not only help reduce greenhouse gas emissions, but it will also decrease Canada's contribution to climate change. in time, these changes and our society will help save many ecosystems and save the habitats of many Innocents organisms



★ **BEHAVIORAL AND SOCIAL REACTIONS TO CONTAMINATION = RESEARCH AND IN APPLICATION!!**

CREATING BIOPLASTICS:

VARIABLES

INDEPENDENT VARIABLES:

- Bioplastics/ Bioplastic mixture
  - Number, type and amount of polymers (cornstarch, algae powder, agar powder)
  - Amount of glycerin
  - Amount of water
  - Use or removal of vinegar
  - Changes made in between each trial to improve the strength, clarity and overall quality of plastic
- Heating Conditions
  - amount of heat applied
  - Duration of heating time

CONTROLLED VARAIABLES:

- Testing Methods-
  - Same strength testing (string, bag/cup, coins)
  - Same bending method and angle for flexibility test
  - Same water submersion method for water resistance test
- Materials used for testing-
  - Same type of coins (2-dollar coins)
  - Same string, tape, and plastic bag
- Environmental Conditions-
  - Room-temperture during drying and testing
  - Air drying time (24-48 hours)
- Water Resistance Test Conditions-
  - Same bowl
  - Same amount of water
  - Water at room temperature
- Measurement criteria
  - Failure defined as tearing, cracking or breaking

- Observations recorded at consistent time intervals

DEPENDENT VARIABLES:

- Strength of the Bioplastic-
  - Number of 2-dollar coins held before tearing
- Flexibility of Bioplastic-
  - Number of 180-degree bends before cracking or breaking
- Water Resistance-
  - changes in texture, shape, strength after being submerged in water for 48< hours
- Physical properties of Bioplastic
  - Clarity
  - Color
  - Presence of lumps
  - Firmness after drying
  - Malleability

December 3, 2025

PROCEDURE FOR EACH TEST:

STRENGTH TEST

<u>Materials:</u>

- Bioplastic created
- Coins
- String
- Small plastic bag or cup
- Tape

<u>Procedure</u>

1. Cut or tear Bioplastic into equal shapes
2. Tape one end of the Bioplastic to a table edge
3. Create a small hole in the other end of the Bioplastic using a pencil or small nail
4. Tie string into the hole
5. Add coins one at a time
6. Record the number of coins when it tears

FLEXIBILITY TEST

Materials

- Bioplastic

Procedure

1. Take one piece of the Bioplastic
2. Bend it 180 degrees back and forth
3. Count how many 180 degrees bends before it cracks or breaks

WATER RESISTANCE

Materials

- Bioplastic created
- Water
- Small bowl

Procedure

1. Place one piece of Bioplastic into a bowl submerged with water at room temperature
2. Observe texture, shape and strength of plastic after day 1, day 2, day 3 and so forth

Trial #1:

MATERIALS:

1 tbsp cornstarch
½ teaspoon algae powder
½ teaspoon agar powder
1 teaspoon white vinegar
60ml water

Why these materials?

- **Cornstarch-** cornstarch is a polymer made of long chains of glucose () (amylose and amylopectin), when it is heated with water it gelatines, and releases polymer chains. The cornstarch

1 medium-sized piece of aluminum foil

PROCEDURE

1. **Mix ingredients**
   In a bowl add cornstarch, algae powder and agar powder
   Pour in the water.
   Add the glycerin and vinegar.
   Stir until the mixture is smooth with no lumps.
2. **Heat the mixture**
   Pour the mixture into a small saucepan
   Heat on low to medium heat
   Stir constantly for 4-8 minutes. ⚠️**DON'T LET IT BOIL**
   What should happen- Goes from liquid to a thick and gel like substance
3. **Pour and shape**
   When it looks thick and like a gel, carefully pour it onto aluminum foil or a silicone mat
   Spread it evenly with a spoon, creating a rectangular shape.
4. **Dry the Plastic-**
   Leave it to air dry for 24-48 hours
   Once dry, gently peel it off.

RESULTS

#1 #2 #3

In picture #1 The bio polymer mixture is heated, causing the molecules to have kinetic energy. While this was happening I could smell burnt plastic with a hint of algae in the air. In the picture you can see big lumps forming of the materials forming.
In picture #2 The polymer gel-like substance is layered out in a rectangular shape while it's still wet. At this state, the mixture remains flexible and malleable, allowing it to be spread and be layered. You can see the lumps of materials that were formed from the heat.
In picture #3 After air-drying for 48 hours, the biopolymer has lost most of its moisture and transitioned into a solid plastic.

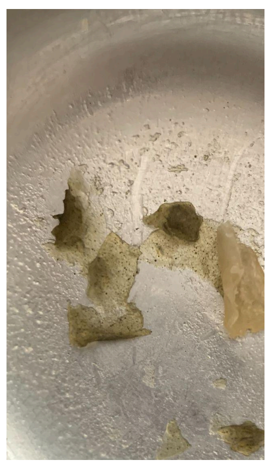
QUALITY OF PLASTIC

To compare the results...

One Canadian $2 coin (toonie) has a mass of 6.99 grams
PET plastic (commonly used in plastic water bottles) can withstand between 50 to over 150 2-dollar coins in this strength test. Conventional plastic bags generally do. not break, but become long and thin before failure within 100+ coins.

Petroleum-based plastics can typically withstand dozens to hundreds of 180degree bends without any signs of damage, while some flexible plastics can even endure thousands of bends without any stress on the material.

TEST	TRIAL #1
STRENGTH TEST (Due to uneven thickness in the Bioplastic, 2 strips -1 thick, 1 thin-were tested.)	**Thinner Part of the Bioplastic-** The plastic lasted until 10 of the 2 dollar coins. It started to tear and fell down at the floor all within 10 seconds of the 10th coin being placed into the bag. This compared to the PET's 50-150+ coins is a very weak plastic.   **Thicker Part of Experiment-** The thicker plastic withstood the weight of 16 two-dollar coins which is 111.84g. After the placement of the 16th coin, the plastic began to tear and failed within 20 seconds of, causing the bag of coins to fall to the floor. Compared to PET plastic, which can hold 50-150 coins this indicates that the plastic has very low tensile strength and is much weaker than petroleum plastics.  
FLEXIBILITY TEST	The plastic withstood 50 consecutive 180 degree bends, when visible tearing was present. This indicates the plastic has moderate flexibility while maintaining its firmness, allowing it to bend repeatedly before mechanical failure.

	
WATER RESISTANCE TEST	In the **first picture** you can see the plastic submerged in water after 1 day, where the plastic is clear and very weak to the touch, even breaking into pieces when slightly touched. This indicates this plastic is not meant for any water use, while it also says that it is made to be very easy to decompose in bodies of water. In the **second picture** the water has evaporated on the 4th day and the plastic has now become more green and shriveled up into different pieces, on the surface of the bowl we see particles of the plastic actively sticking to the surface of the bowl.  

Trial #2

For Trial #2, the goal was to improve the clarity and strength of the Bioplastic. In Trial #1, the plastic had a deep green color and tore easily with an average of 13 coins/ 90.87g indicating weak polymer bonding and poor molecular structure. To address these issues, additional polymers with the same amount of water other than algae powder (the cause of the deep green color) are added to improve the number of polymer chains. The mixture was also heated for a longer period of time to increase molecular kinetic energy, allowing the polymer chains to interact and move freely.

MATERIALS:

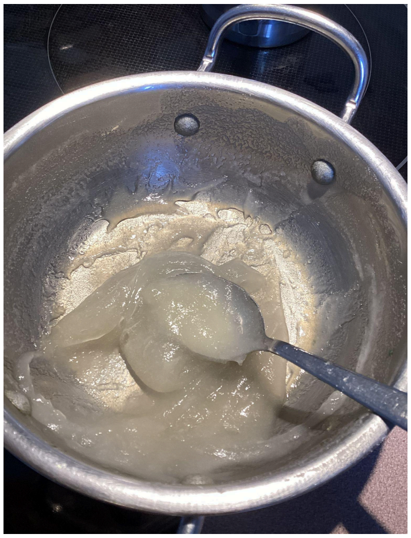
2 tbsp cornstarch
1 tbsp agar powder
1 teaspoon vinegar
1 tbsp glycerin
40ml water
1 medium sized piece of aluminum foil

PROCEDURE

1. **Mix ingredients**
   In a bowl add cornstarch, and agar powder
   Pour in the water.
   Add the glycerin and vinegar.
   Stir until the mixture is smooth with no lumps.
2. **Heat the mixture**
   Pour the mixture into a small saucepan
   Heat on low to medium heat
   Stir constantly for 4-8 minutes. ⚠️**DON'T LET IT BOIL**
   What should happen- Goes from liquid to a thick and gel like substance
3. **Pour and shape**
   When it looks thick and like a gel, carefully pour it onto aluminum foil or a silicone mat
   Spread it evenly with a spoon, creating a rectangular shape.
4. **Dry the Plastic-**
   Leave it to air dry for 24-48 hours
   Once dry, gently peel it off.

RESULTS:

Picture #1.



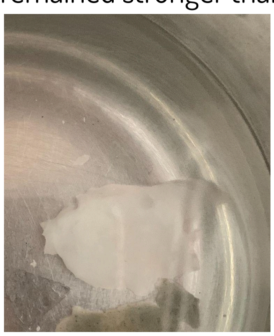
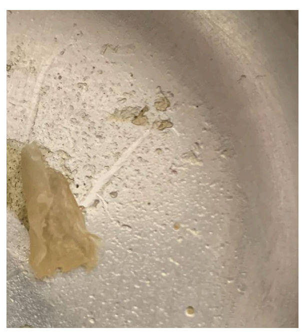
Picture #2

In picture #1, the bioplastic mixture appears like melted wax, exhibiting a smooth, stretchy texture. This consistency suggests that there are strong interactions between the polymer chains, resulting in an elastic mixture. The mixture is white to transparent in appearance.

In picture #2, After air-drying for 48 hours, the Bioplastic solidified into a thin sheet. After the drying process the mixture was spread to thin and stuck to the aluminum foil. This made it harder to remove the Bioplastic. Resulting in the small amount of plastic. The plastic appeared to be very firm, strong and flexible.

*The picture of the layered Bioplastic was accidentally lost

TEST	TRIAL #2
STRENGTH TEST	The plastic lasted until 31 two-dollar coins 216.6g of mass. It started to tear and fell down on the floor very slowly. This is a great improvement from the 1st trial that was an average of 13 coins, inducting the addition of more polymers and heating increased the tensile strength of the plastic. 

FLEXIBILITY TEST	The flexibility test was the most successful and no damage was done even at 100 degree bends. This was a great improvement from the last test that had viable tearing and damage at the 50th bend. This indicates the plastic has great flexibility and firmness similar to petroleum plastic. 
WATER RESISTANCE	In the **first picture** the plastic was in water for 1 day and we see the plastic has turned from transparent to a pale white color. When the plastic was touched it was much stronger than the first trial while it did break into smaller pieces and it felt soft and like jelly to the touch. In the **second picture** the water is spilled out after 4 days of being in water. The plastic shriveled up and turned into a yellowish color and you can see the smaller pieces of the plastic. The surface of the bowl had sticky plastic remains. These results were similar to the first trial while the strength of this plastic remained stronger than the first trial.  

For the third trial, my goal was to increase the strength of the plastic while continuing to use and test all allergy powder and experimenting with different polymers to see whether they perform better or worse. Since adding more polymers and applying heat for a longer duration of time was effective in the second trial, I decided to build on this idea. In this trial, I increased the amount of each polymer and applied additional heat to further strengthen the blinds between the materials. I also added a greater amount of glycerine to improve flexibility, as glycerine apps as a plasticizer that reduces brittleness, I stored using vinegar since it was not helping the plastic. These changes were made to create a bioplastic that was stronger and more flexible than previous ones.

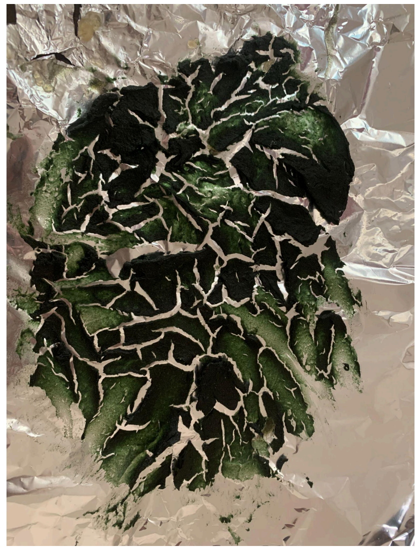
Trial #3

MATERIALS

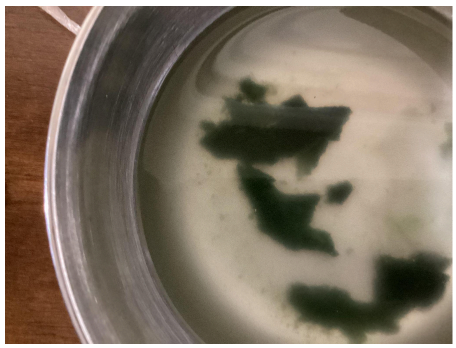
2tbsp cornstarch
2tbsp algae powder
2tbsp agar powder
40ml water
1 tbsp glycerin
1 medium sized piece of aluminum foil

PROCEDURE

1. **Mix ingredients**
   In a bowl add cornstarch, algae powder and agar powder
   Pour in the water.
   Add the glycerin.
   Stir until the mixture is smooth with no lumps.
2. **Heat the mixture**
   Pour the mixture into a small saucepan
   Heat on low to medium heat
   Stir constantly for 4-8 minutes. ⚠️**DON'T LET IT BOIL**
   When the mixture looks like wax keep stirring and bring it on and of the heat
   What should happen- Goes from liquid to a thick and gel like substance
3. **Pour and shape**
   When it looks thick and like a gel, carefully pour it onto aluminum foil or a silicone mat
   Spread it evenly with a spoon, creating a rectangular shape.
4. **Dry the Plastic-**
   Leave it to air dry for 24-48 hours
   Once dry, gently peel it off.



TEST	TRIAL #3
STRENGTH TEST	The plastic lasted until 35 two-dollar coins, 244.65g of mass. The theatre started to tear through the plastic and the bag of coins landed on the ground very slowly. This is an improvement from trial #2 that was 31 coins (216.6g), concluding that the algae powder did not help the plastic have more tensile strength.  
FLEXBILITY TEST	The flexibility test was a demotion from the second trial, 60 180 degree bends were done before visible tearing and damage was present. This indicates that the algae powder has not helped the plastic in any way, and the flexibility and firmness had deteriorated compared to the previous trial.

	
WATER RESISTANCE	  In the **first picture** the plastic has been submerged for 2 days and it has become very flexible, soft, and weaker than before. Some of the plastic particles are swimming in the water, indicating early signs of early degradation. In the **second picture** the water has evaporated down the 4th day and a lot of the plastic residue has stuck to the bowl , and the plastic has separated into multiple parts

For the fourth trial, I used my new knowledge from all the previous experiments to improve the plastics clarity, strength, and flexibility by focusing on polymer chemistry. Allergy powder was not added because its pigments interfered with the clarity and the parliament structure did not increase the molecular bonding. Vinegar was also excluded after the results in trial three, the acidic level of the vinegar helps breakdown, stares, and promotes responding between polymer chains leading to a better plastic. I added a higher amount of glycerine as a plasticizer, commercial molecules, helped the polymer chains connect and increase flexibility.

Trial #4

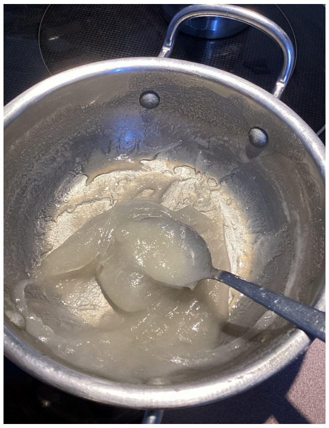
MATERIALS

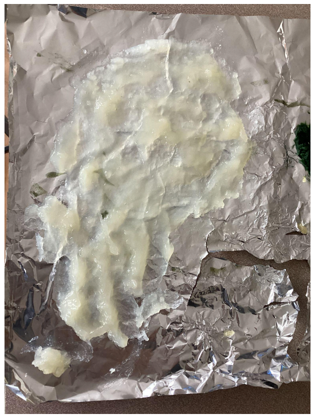
3tbsp cornstarch
3tbsp agar powder
40ml water
3tbsp glycerin
1 medium sized piece of aluminum foil

PROCEDURE

1. **Mix ingredients**
   In a bowl add cornstarch, and agar powder
   Pour in the water.
   Add the glycerin and vinegar.
   Stir until the mixture is smooth with no lumps.
2. **Heat the mixture**
   Pour the mixture into a small saucepan
   Heat on low to medium heat
   Stir constantly for 4-8 minutes. ⚠️**DON'T LET IT BOIL**
   When it turns into a stretchy substance keep taking the mixture on and off the heat
   What should happen- Goes from liquid to a thick and gel like substance
3. **Pour and shape**
   When it looks thick and like a gel, carefully pour it onto aluminum foil or a silicone mat
   Spread it evenly with a spoon, creating a rectangular shape.
4. **Dry the Plastic-**
   Leave it to air dry for 24-48 hours
   Once dry, gently peel it off.

#1 **#2** **#3**



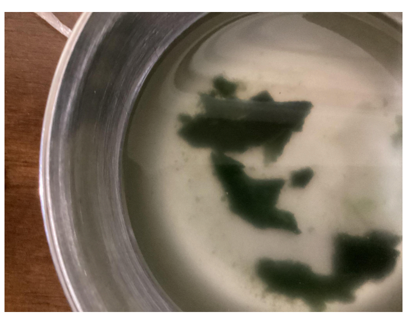


In picture #1 The bioplastic mixture that she looks almost like melted wax, and it was very sticky. This tells me the material is very malleable and easy to move, which is a great sign. It appears as a smooth and stretchy texture, and it indicates their strong bonds between the polymer chains resulting in this elastic mixture.

In picture #2 You can see the elastic mixture laid out in a rectangular shape. It does have clumps of thickness, but it mostly appears smooth and transparent.

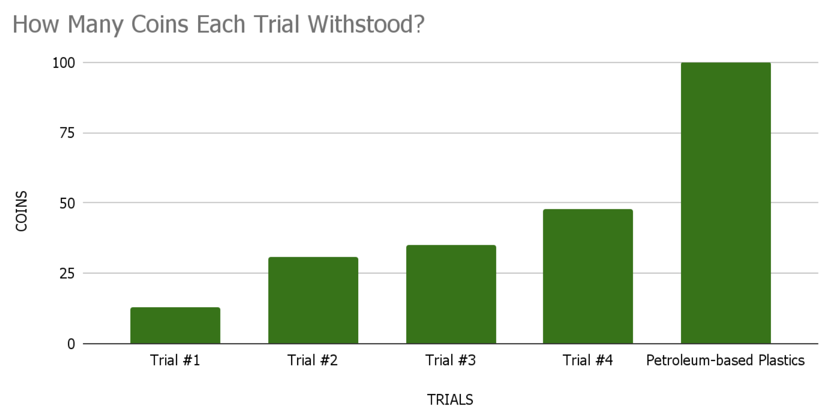
I**n picture #3** the transparent make sure now has become a pale yellow and and it feels very elastic, smooth and malleable to the touch.

TEST	TRIAL #4
STRENGTH TEST	This was the most successful plastic in the strength test. It lasted until the 48th coins and 321.54g. When the 45th coin was placed the plastic started to tear, but stopped at the bottom of the plastic (in picture #2), after placing 3 more coins then it started to tear as well and fell to the floor. When looked into the bottom of the plastic I saw a dried white thick clump of polymers (in picture #4). #1 #2   #3 #4

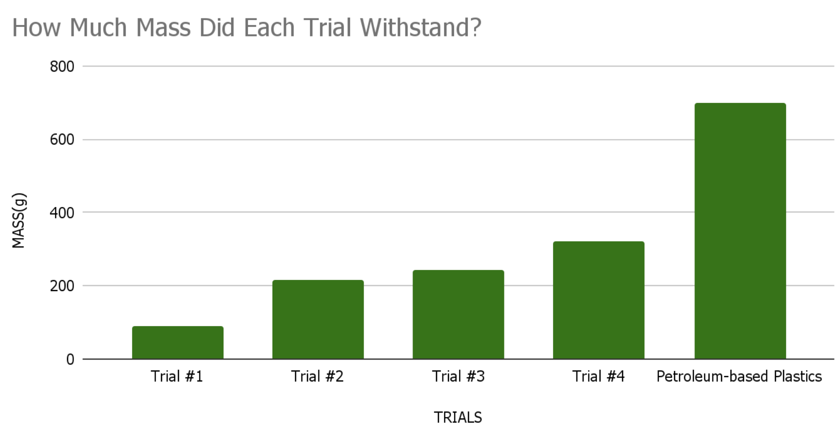
	 
FLEXIBILITY TEST	This plastic had a successful flexibility test with no signs of tearing or damage even after 100 180 degree bends, this was a great improvement from the previous plastic. The plastic is firm, and elastic. 
WATER RESISTANCE	In the **first picture** the plastic has been submerged in water for 2 days (it is to see but it is at the centre right) the plastic has become more flexible than before, but it is firm compared to the other plastic. In the **second picture** we can see the plastic is still firm and has kept its shape, and some residue of the plastic has stuck itself to the bottom of the bowl  

Sun, Dec 14/2025

ANALYSIS

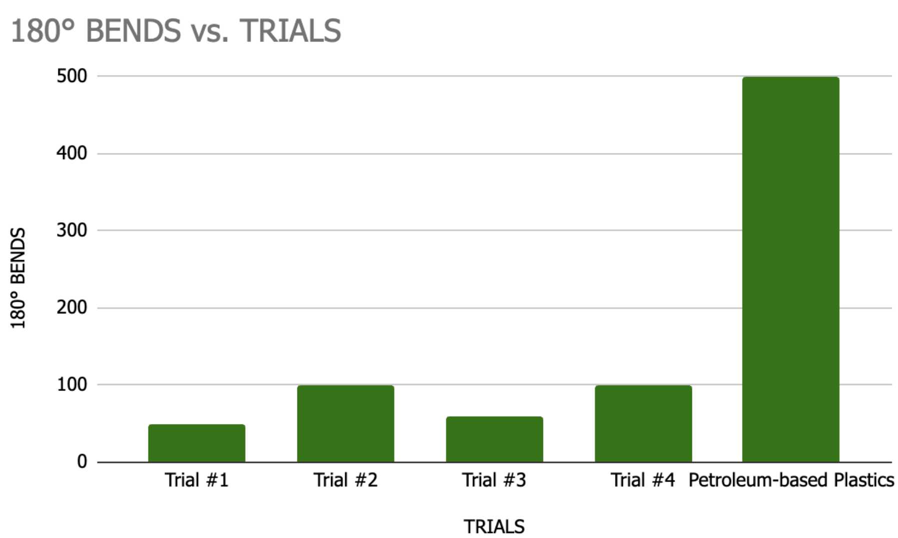


This graph tracks the performance of four experimental trials against how many coins each one of them could uphold. Similar to the mass measurements, there is a consistent upward trend across the trials, with the number of coins supported rising from roughly 13 in Trial #1 to nearly 50 by Trial #4. However, the petroleum-based plastic still demonstrates superior strength, withstanding 100 coins, which is exactly double the capacity of the final experimental trial.

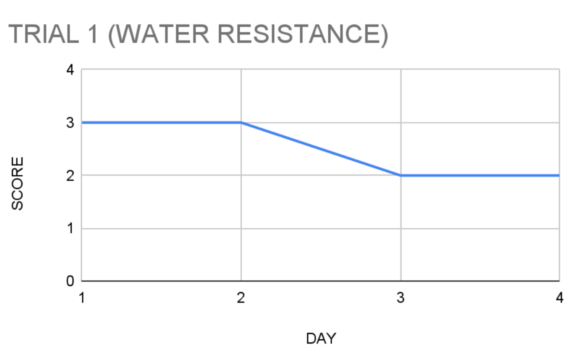


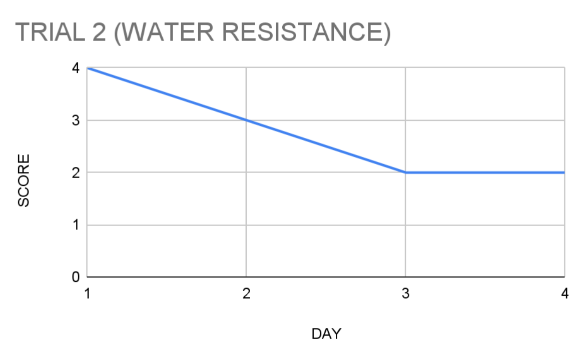
This compares the durability of four experimental trials against a petroleum-based plastic benchmark. The data shows a clear improvement across the experimental phase, with the mass supported increasing steadily from approximately 100g in Trial #1 to 325g by Trial #4. Despite this progress, the petroleum-based plastic remains significantly stronger, withstanding roughly 700g, which is more than double the capacity of the most successful experimental trial.

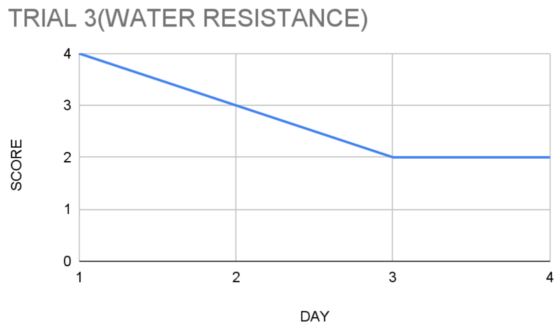
Trial	Coins	Mass(g)
Trial 1	13 coins	111.84g
Trial 2	31 coins	216.6g
Trial 3	35 coins	244.65g
Trial 4	46 coins	321.54g

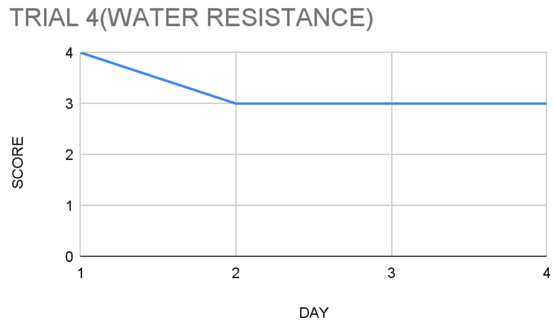


This graph tracks the progress of the trials against 180degree bends each experiment withstood without any signs of damage. Trial 2 and Trial 4 had the highest amount of bends withstood, at 100 bends with no signs of damage, while trial 1 and trial 4 had similar low results below 50 bends. The petroleum-based plastic had much higher results with 500 bends with no damage.









SCORE SCALE

4-fully intact, firm, no changes

3- Soft, flexible, weaker

2- Very weak breaking

1- decomposed

These graphs show the score of the degradation of the trials in water throughout 4 days, using the score scale above. Trial 1 has the worst results, starting at a score of 3 (soft, flexible, weaker) for the first 2 days and 2 (very weak and breaking) at the last 2 days. Trial 2 has better progress starting at 4 (fully intact, no changes) but quickly making its way down to 2 (very weak breaking). Trial 3 has the exact same results as Trial 2, starting at 4 and making its way down to 2 (very weak, breaking). Trial 4 has the best results, starting at 4 (fully intact, no changes) and then keeping at a steady 3 (soft, flexible, weaker).

Tue, Oct, 14/2025

EXPERIMENTAL PLANNING:

For the experiment we will...

- Use a single-use plastic water bottle
- Put one water bottle in a control environment (no sunlight, moderate humidity,etc)
- Put one in a highly humid, hot and high exposure to UV RAYS
- Keep both tests in these two environments for ***x*** amount of time
- Check both water samples under 400x microscope to see the degradation and to see if any micro/nanoplastics exist.

MATERIALS:

MATERIALS NEEDED FOR THE EXPERIMENT:

- 3 plastic water bottles [one control and two manipulating]
- UV light [can be a UV light or can be the sun]
- Warm and moist environment
- Cool environment (freezer)
- Control environment [What the storage advice is on the water bottle packaging]
- Microscope

PROCEDURE (s):

2. Gather all three of your water bottles and place them into the three different environments.
3. Wait approx. 2-3 weeks before checking on them again
4. After, take a sample of each and drop 1-2 drops into the microscope slide.
5. Look at the sample through the microscope (MICROSCOPE MUST BE SET AT 400X!)
6. Record your observations

OBSERVATIONS OF THE EXPERIMENT:

INTRODUCTION:

The primary focus of this experiment was to observe how different environments affect the release of microplastics into bottled water over time. Three plastic water bottles (from the same brand/type) were placed in different environments: a control environment following the storage instructions on the bottle, a cold environment (freezer), and a warm, moist environment exposed to UV light. After 2–3 weeks, samples from each bottle were examined under a microscope at 400x magnification to observe any differences in microplastic amounts/structures.

WHEN WE TOOK THE SAMPLES FROM THE TESTS, WE TOOK A LARGE AMOUNT. THEN WE LOOKED AT EACH TEST MULTIPLE TIMES (5 different times using different samples) UNDER THE MICROSCOPE TO INSURE OUR RESULTS WERE ACCURATE!!!

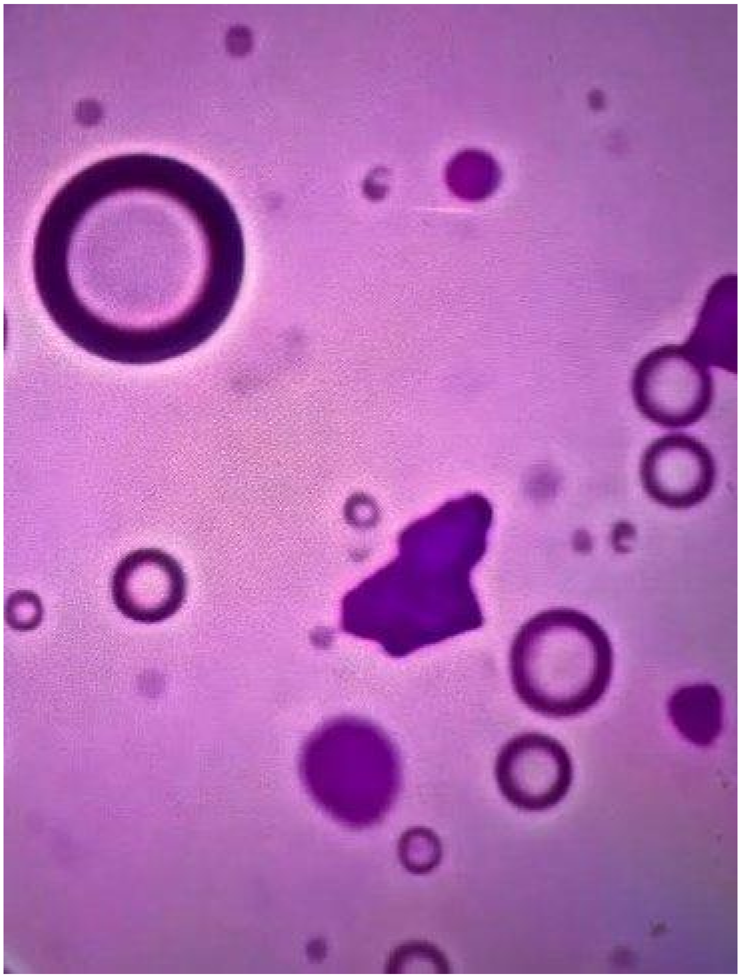
OBSERVATIONS:

Control Sample (Stored as Recommended on Packaging)

Under 400x magnification, the control sample appeared mostly clear with a small number of scattered particles. Several small circular, ring-like structures of varying sizes were observed (most likely gas bubbles). A few thin, fiber-like structures and a rectangular dark particle were also present. These are most likely the microplastic particles, larger the size, larger the particle of the plastic. The particles were evenly distributed and no clustering or dense groupings were observed.

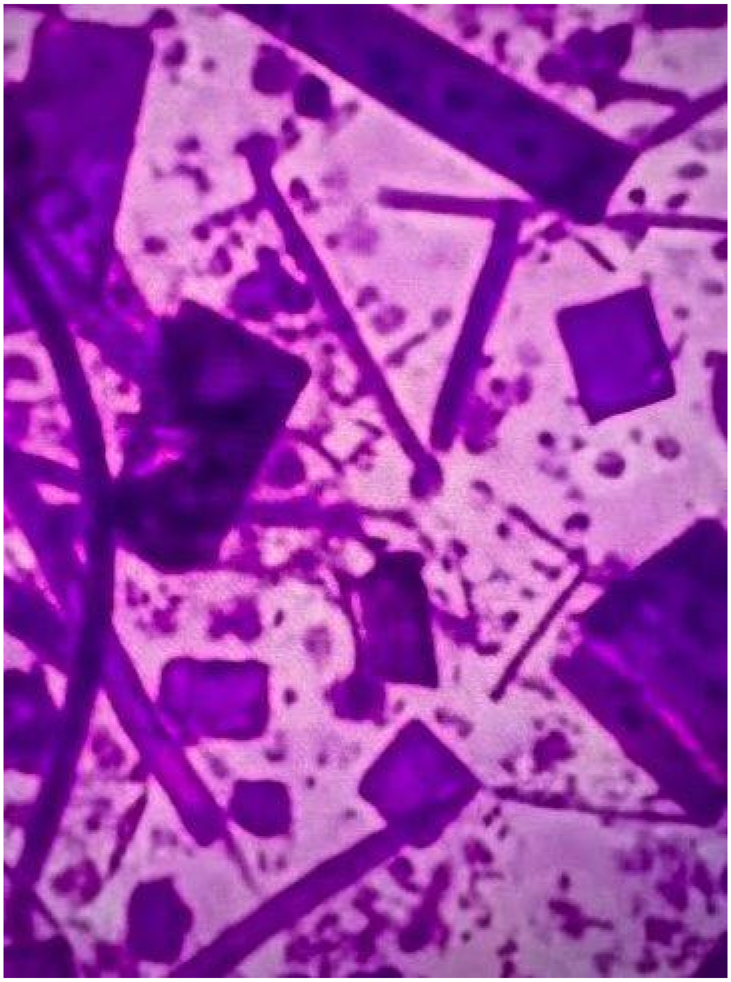
Cold Environment Sample (Freezer)

The cold sample also appeared clear under the microscope. Several circular ring-like structures were visible (again, most likely air bubbles), similar to the control sample, but fewer particles overall were observed. One larger, irregularly shaped dark particle was present. These are most likely microplastics, seeing that there is a very less quantity of them in this sample. The particles were widely spaced and were not clustered in any way.



Warm Environment Sample (Warm, Moist, UV Exposure)

The warm environment sample showed a high concentration of particles. Under 400x magnification, many darkly stained particles of various shapes were observed, including rectangular, triangular, and irregular forms. Numerous elongated, rod-like and fiber-like structures crossed the field of view. Small dark dots were densely scattered, with noticeable clustering and overlapping of particles. This sample appeared significantly more crowded and complex than the control and cold samples.

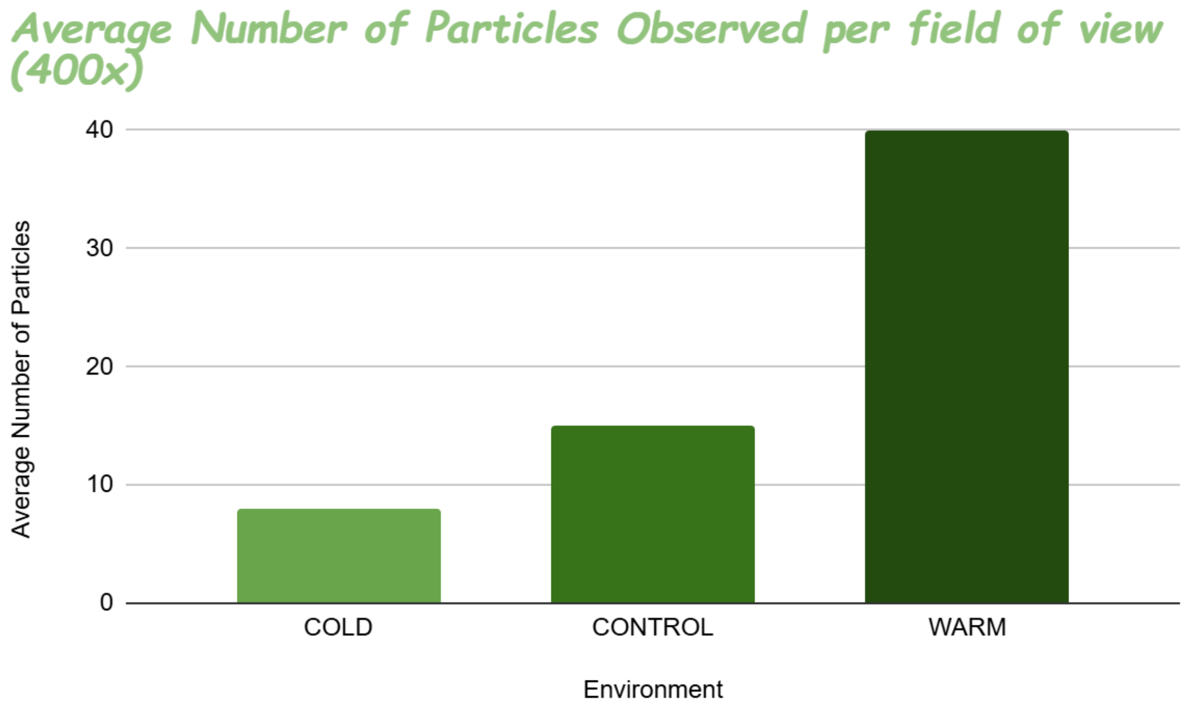


COMPARISON OF THE RESULTS:

When comparing the three samples, the warm environment showed the greatest number and variety of particles, while the cold environment showed the least. The control sample was in-between. The warm, moist conditions combined with UV exposure likely promoted changes in the water, such as increased particle formation or contamination, due to the thermal energy increasing chemical reactions. On the other hand, the cold environment likely slowed down these processes, resulting in fewer observable particles. The control environment maintained relatively stable conditions, leading to minimal changes over time.

IMPORTANT DISCALMER: While some particles may be microplastics, microscopy alone cannot confirm their composition. Additional tests (such as spectroscopy) would be required to definitively identify plastic particles.

A GRAPH(s) SHOWCASING OUR EXPERIMENTAL RESULTS:



The table shows the average number of particles observed per microscope field of view at 400x magnification for each environmental condition

Mon, Dec, 17/2025

ANALYSIS OF THE EXPERIMENT:

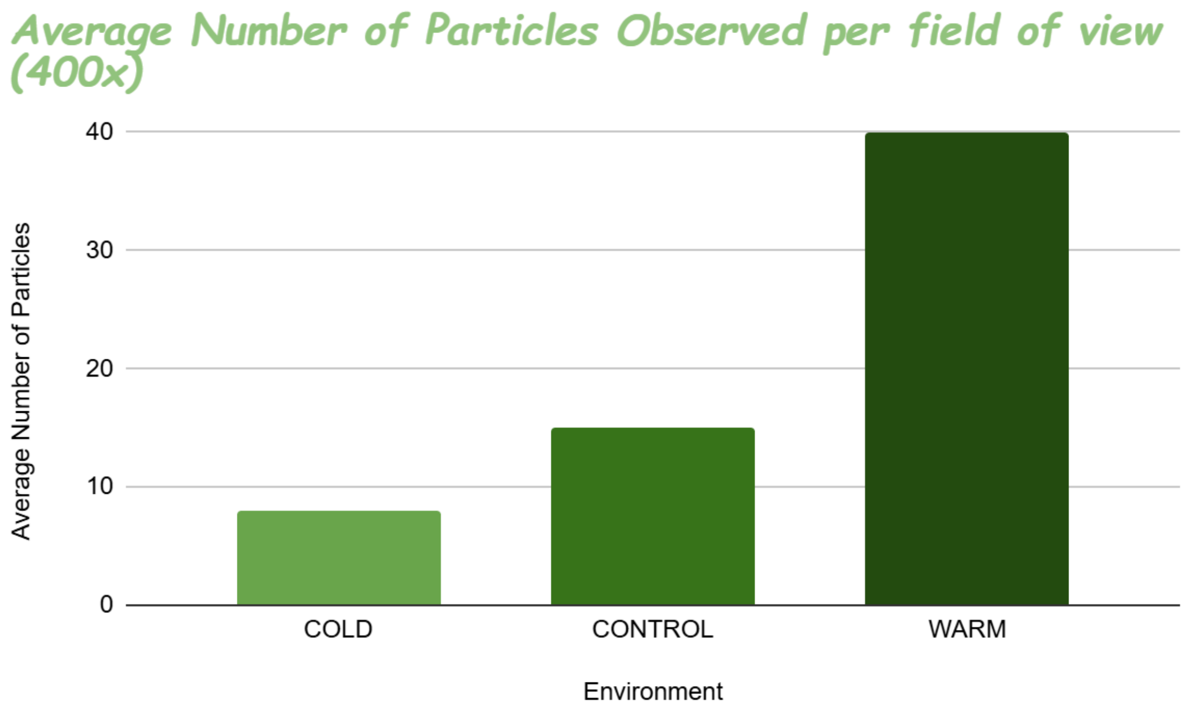
TRENDS AND OBSERVATIONS:

- Control Environment: The control sample - which was stored according to the original manufacturer instructions - showed a low number of particles (about 5-10 per microscope field of view). The particles were evenly distributed, mostly small fiber-like or rectangular shapes. This indicates minimal microplastic release under recommended storage conditions.
- Cold Environment: The cold sample displayed the fewest particles (about 3-5 per field), widely spaced out, with only a few larger particles here and there. This proves/suggests that low temperatures slow down and/or obstruct microplastic formation by slowing chemical and mechanical degradation of the plastic.
- Warm & UV-Exposed Environment: This sample showcased the highest particle count (about 20-30 per field) and the highest variety of different shapes, including fibers, rods, irregular

shapes, etc. There was dense clustering and heavy overlapping of the particles, indicating that heat, moisture, and UV exposure significantly accelerate/increase microplastic release.

Quantitative and Visual Evidence:

The particle counts were visualized in bar graphs and scatter plots, showing a clear gradient: cold < control < warm. Additionally, the microscopic images confirm these trends, with the most cluster and the most amount of shapes in the warm environment.



This bar graph visually displays the *AVERAGE* number of particles in every test per field of view.

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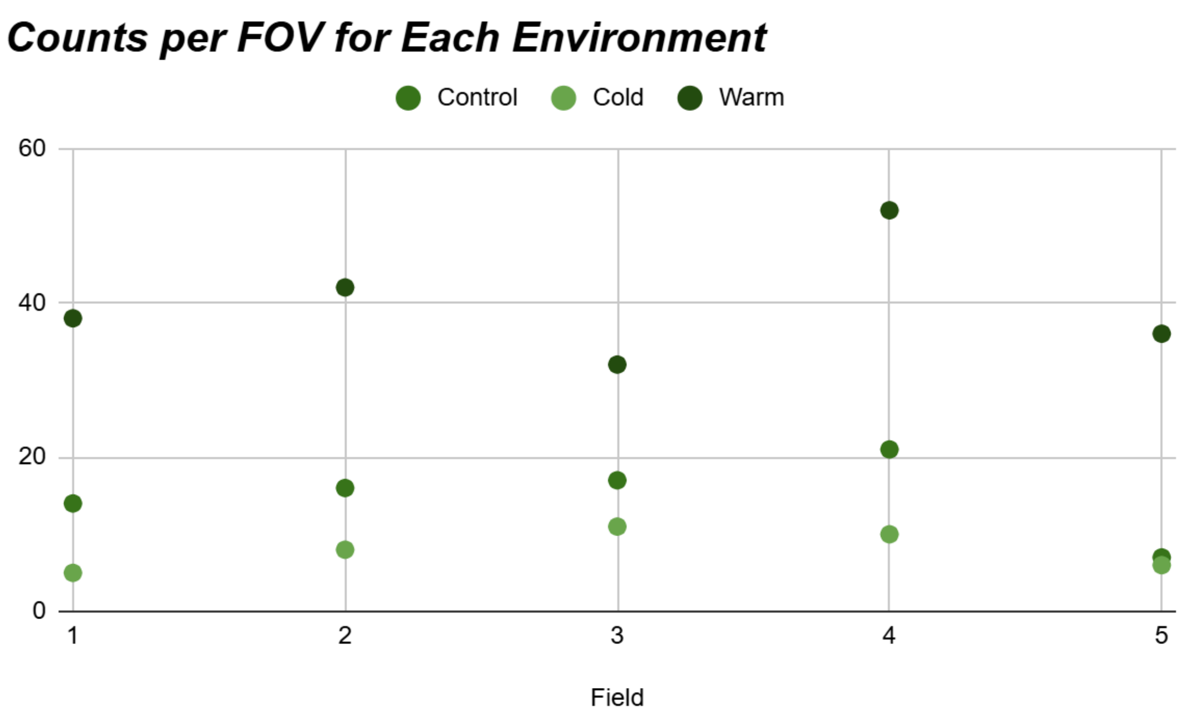
Field	Control	Cold	Warm
1	14	5	38

2	16	8	42
3	17	11	32
4	21	10	52
5	7	6	36



This chart/table shows the original data that was collected when we averaged the amount.

Further Explanations:

The results of our study align fairly well with existing data collected/known about the processes of plastic degradation. To elaborate, the exposure of UV rays can cause photodegradation (a process where materials breakdown due to the exposure of light), alongside the increase in temperatures, which accelerates chemical reactions. Combined, the moisture and thermal energy from this environment promotes a process similar to hydrolysis - a process where water is used to break bonds.

These factors combined weaken the plastic structure and lead to the formation and release of microplastic particles.

In contrast, cold conditions slow these chemical and physical processes, resulting in fewer particles being released into the water.

Tue, Dec, 23/2025

CONCLUSIONS FOR THE EXPERIMENT:

This experiment examined how different environmental conditions (control, warm, and cold), effect the release of microplastic particles from single-use plastic water bottles - which is a growing global health and environmental concern. By exposing identical bottles to three controlled environments—recommended storage conditions, cold temperatures, and warm, moist conditions with UV exposure—our experiment clearly concluded how UV rays and warmer conditions result in a higher amount of plastic particles released.

The results strongly supported our hypotheses that warmer environments increase microplastic contamination in bottled water. This is because the samples that were exposed to heat, moisture, and UV radiation consistently showed the highest average particle counts (20–30 particles per field of view), as well as the greatest diversity in particle shapes, including fibers, rods, and irregular fragments. Compared to the cold environment, which released the lowest amount of particles (3–5 per field), suggesting that low temperatures significantly slow plastic degradation. The control environment produced intermediate results, confirming that even properly stored plastic bottles can release microplastics over time, although at a reduced rate.

Too add on, both of our original hypotheses were proven correct. As we predicted, microplastic particles were observed in all water bottle samples, confirming that no single-use plastic water bottle is completely "*safe*" of microplastic contamination. This supports the both of our hypotheses that polyethylene terephthalate (PET) naturally degrades over time, even under recommended storage conditions. Furthermore, bottles exposed to UV radiation and warm, humid environments released significantly higher concentrations of microplastics, once again proving our hypotheses correct. These findings align with established scientific research on plastic photodegradation, hydrolysis, and thermal degradation. UV radiation weakens polymer bonds, heat accelerates chemical reactions, and moisture promotes structural breakdown, collectively increasing the fragmentation of plastics into micro- and nano plastics.

While light microscopy allowed for the visualization and comparison of particle quantity and morphology, it could not definitively identify chemical composition. As such, some observed particles may not have been plastic. In the future, studies might want to use advanced techniques/technologies to identify nano plastics, such as FTIR or Raman to enhance visibility, results, and limit and uncertainty.

The future applications of this experiment are highly significant. This is because bottled water is increasingly becoming a major source of microplastic exposure for humans. Our experiment/project highlights this issue.

In conclusion, our experiment goes to show that environmental factors—especially heat and UV exposure—play a critical role in accelerating microplastic release from plastic water bottles. Addressing microplastic pollution will require a combination of scientific innovation, informed consumer choices, stronger regulations, and the development of sustainable materials. By increasing awareness and advancing biodegradable plastic technologies, meaningful progress can be made toward protecting human health and preserving ecosystems.

CONCLUSIONS FOR BIOPLASTICS

This experiment showed how changing natural and renewable resources can be used to create a strong Bioplastic that can replace petroleum-based plastics. From the four trials of the biodegradable plastics, improvements were made by changing the ratios, composition of materials and the method to create Bioplastic.

The results showed the improvements and changes made from each trial made the final product stronger, firm, and flexible. Trial 1 was the weakest Bioplastic from all the plastics, it had low tensile strength (90.87g), low flexibility and poor water resistance. Trial 2 was a major improvement, without the use of algae powder, an addition of polymers and plasticizers, and more heating. I created a plastic that had more tensile strength (216.69g), flexibility (no damage after 100-180degree bends). Trial 3 slightly increased the strength, while the flexibility detracted and the water resistance was increased, indicating adding algae powder did not improve molecular structure and reduced flexibility. Trial 4 was the most successful. Removing the algae powder, adding concentration of polymers, plasticizer and heating, the final Bioplastic withstood 321.54g of mass, 100-180degree bends and had the best water resistance.

Our hypotheses were partially supported. We predicted that bioplastics created from a combination of algae and starch-based polymers could exhibit enhanced UV resistance, faster biodegradation, and minimal microplastic formation in water. The experimental results suggest that using naturally derived polymers instead of petroleum-based materials allows the bioplastic to maintain moderate flexibility and strength while reducing environmental harm, particularly to marine ecosystems. These findings highlight a promising pathway for developing environmentally friendly bioplastics that degrade safely in aquatic environments, an improvement that many current bioplastics have yet to fully achieve.

Wed, Dec, 23/2025

APPLICATION

This experiment has very important applications to our world. Especially in today society where plastic production is increasing, and people are using plastic more than ever. Since bottled water is a major source of human exposure to microplastic, our experiment shows how common everyday storage conditions (such as how people tend to keep plastic water bottles in their cars in the summer) can increase contamination. It showcases that leaving plastic water bottles in warm places, such as cars or direct sunlight, can significantly increase the amount of microplastics released into the water. This information can help consumers make safer choices, such as avoiding heat and UV exposure or choosing reusable alternatives. The findings also support the development of safer packaging materials, including bioplastics like algae-based plastics, which may reduce long-term environmental and health risks. Additionally, our project was done in the intent to raise awareness about microplastics and how millions all across the globe are unknowingly consuming microplastic particles daily - just by drinking water! Overall, this experiment provides useful evidence that can inform public awareness, consumer habits, and future material design.

Plastic pollution is a major global problem due to the wide-spread of petroleum-based plastics that are strong and persist in the environment. These plastics are useful, but also cause environmental harm and the accumulation of microplastic in ecosystems, food, and human beings. This project investigates a bioplastic created from algae powder, agar powder, cornstarch and vegetable glycerin, and evaluates its strength, flexibility and water resistance. The project can help teach polymer chemistry, the connection of molecular structure to material properties and how plastizers affect polymer behaviour. The final plastic, can be easily industrially produced with modification to form an even stronger Bioplastic and be used as single use packaging for dry foods, snacks (chips bag) and produce products. The plastic can also have agricultural uses; seed coatings or plant started films. Overall, this bioplastic can be used for lightweight packaging, agricultural films, and it offers an alternative to petroleum plastics while reducing microplastic pollution.

EXPERIMENTAL SOURCES OF ERROR:

- **Microscope Limitations**
  - Using light microscopy at 400x magnification allows you to see small particles, but it cannot confirm chemical composition. Some of the observed particles might be air bubbles, dust, or other debris, not microplastics.
- **Sampling Errors**
  - When taking water samples from the bottles, it's possible that the sample wasn't perfectly mixed, so some fields of view could have more or fewer particles than average.
  - Dropping water on the microscope slide could introduce contamination from the slide, pipette, or environment.
- **Environmental Contamination**
  - Microplastics are everywhere in the air, so dust or fibers in the room could accidentally get into the samples.
  - Handling bottles or slides without gloves or clean equipment could add extra particles.
- **Uneven Exposure Conditions**
  - The warm, humid, and UV-exposed bottles might have had slightly different amounts of sunlight or heat depending on their placement.
  - The cold environment (freezer) might have temperature fluctuations that slightly slowed or accelerated microplastic release.
- **Variability in Bottles**
  - Even though all bottles were the same brand, slight differences in manufacturing or plastic thickness could affect how many particles were released.
- **Human Observation Error**
  - Counting particles under the microscope by eye can be subjective, especially when particles overlap or are very small.
- **Time Frame**
  - The experiment ran for 2–3 weeks. If the experiment were longer, more particles might have formed, meaning the results are only a snapshot in time.

SOURCES OF ERROR FOR CREATING THE BIODEGRADABLE PLASTIC:

- **Uneven Thickness of Plastic**
  Some sheets of bioplastic were thicker in certain areas and thinner in others. This could have affected the strength test results, since thinner sections would tear more easily.
- **Inconsistent Heating**
  The mixture was heated on a stove without measuring the exact temperature. If the temperature changed or the mixture was heated for slightly different times, polymer bonding may not have been consistent between trials.
- **Measurement Inaccuracies**
  Ingredients such as cornstarch, agar, and glycerin were measured using spoons, which may not be perfectly precise. Small differences in amounts could change the final properties of the plastic.
- **Drying Conditions**
  The plastic was air-dried at room temperature. Humidity and air circulation may have varied, affecting how evenly or completely the plastic dried.
- **Manual Testing Method**
  The strength test relied on adding coins manually, and the flexibility test involved bending by hand. Differences in speed, force, or angle could have influenced when the plastic broke.
- **Water Test Was Observational**
  The water resistance test was mostly qualitative (based on observation and touch). No measurements of mass loss or exact degradation rate were taken, which reduces accuracy.
- **Material Sticking to Foil**
  Some plastic stuck to the aluminum foil and tore during removal, which may have weakened the samples before test

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