Science Fair Logbook

Using starches to make bioplastic

Oct 10, 2025

- Did some exploratory research on the project itself
- Started by looking into plastics and their environmental impact, which led me to bioplastics as a possible alternative
- Began exploring possible project topics related to sustainability and environmental impact
- Looked into the problem of traditional plastics and why they are harmful to the environment
- Discovered bioplastics as a potential alternative to conventional plastics
- Researched what bioplastics are and common ingredients used (starch, glycerin, water, etc.)

Oct 11, 2025

- Decided that comparing multiple bioplastic recipes would allow patterns to be observed
- Noted that changing ingredients or ratios can affect strength, flexibility, and breakdown rate
- Brainstormed different aspects that could be tested:
    - Durability (strength, flexibility, cracking)
    - Eco-friendliness (material source, renewability)
    - Cost-effectiveness (ingredient availability and price)
    - Biodegradability (how quickly materials break down)
- Considered that comparing multiple bioplastic recipes could lead to meaningful results

- Concluded the initial problem for the project:
- Which bioplastic recipe provides the greatest overall performance in terms of durability, eco-friendliness, cost-effectiveness, and biodegradability?

Oct 13, 2025

- Looked into common bioplastic ingredients and their roles:
    - **Starch**: main structural component, provides rigidity
    - **Glycerin**: plasticizer that increases flexibility
    - **Water**: helps gelatinize starch during heating
- Learned that changing glycerin amounts affects:
    - Higher glycerin → more flexible but weaker material
    - Lower glycerin → stiffer but more brittle material
- Noted that bioplastics can vary in:
    - Durability (tear resistance, flexibility, cracking)

    - Cost (availability and price of ingredients)
    - Biodegradability (rate and extent of breakdown)
- Considered different ways biodegradability might be observed:
    - Visual breakdown (cracks, discoloration, fragmentation)
    - Texture changes over time

<u>Abstract Background information</u>

- Brown algae bioplastics are made by mixing dried algae with water, glycerol, & cornstarch
- Farming green algae under controlled conditions to optimize biomass production
- Evaluate the biodegradation, tensile strength, and melting point of these bioplastics, hypothesizing that Saccharina Latissima (brown algae) are superior properties because of high growth rate, and substantial yield of polysaccharides (large carbohydrate polymers made of long chains of monosaccharides (simple sugars) linked by glycosidic bonds) and alginate
- Saccharina Latissima's potential as a sustainable alternative to traditional plastics, offering promising prospects for environmental conservation
- The increased global demand for plastic materials has led to severe plastic waste pollution, particularly to the marine environment
- This critical issue affects both sea life and human beings since microplastics can enter the food chain and cause several health impacts
- Plastic recycling, chemical treatments, incineration and landfill are not the best solutions for reducing plastic pollution

https://isef.net/project/eaev093t-algae-as-a-resource-for-bioplastic-production

<u>Oct 11, 2025</u>

- Two newly identified environmentally friendly approaches, plastic biodegradation and bioplastic production using algae, to solve the increased global plastic waste
- Algae, particularly microalgae, can degrade the plastic materials through the toxins systems or enzymes synthesized by microalgae itself while using the plastic polymers as carbon sources
- Algae-derived bioplastics have identical properties and characteristics as petroleum-based plastics, while remarkably being biodegradable in nature
- New insights into different methods of producing algae-based bioplastics (e.g., blending with other materials and genetic engineering)

https://www.sciencedirect.com/science/article/pii/S2666498420300570
https://isef.net/project/mats059-biodegradable-algae-plastic

Oct 12, 2025

Water tests

1. Original water
2. Week 1
3. Week 2
4. Week 3
5. Week 4
    a. Final and last week
        i. Could measure thickness?

Oct 13, 2025

Each test

- 4 bioplastics + 1 conventional plastic

Oct 14, 2025

- Global production of plastics had increased to around 359 million metric tons in 2018, from 245 million metric tons in 2008
- Expected to be at a triple rate because of the mass demand & consumption of oil
- Despite the mass production of plastics since 1950s, there's an effective method executed to tackle the disposal issues from plastic waste
- Recycling rate of plastics is rather low compared to the plastics made while most of them are being disposed in the landfills
- Landfills are one of the worst ways to dispose of plastic as they can contaminate both our water and air, and take up our land space to build, garden, and etc.
- The decomposition of plastics is the hardest among all the general commodities such as fruits, papers, leathers and aluminium
- This is because it may continue in the nature for centuries before decaying
- Even though bioplastic is better for the environment, we don't use it because it's more expensive
- What we can do is to make mass production of algae farming

Decided to not do seaweed/algae as there are only a few ways and resulted in making starch recipes

Oct 15, 2025

Ways to Compare Bioplastic to Traditional Plastic

1. Durability
2. Eco - friendly
3. Cost Effectiveness
4. Source Material
5. Biodegradability

Oct 16, 2025

- 5 plastics
    - 3 tests
- 15 trials for each time jump

<u>Oct 17, 2025</u>

- Decided to not test source material sustainability as it cannot be tested quantitatively

<u>Oct 18, 2025</u>

- Bioplastics made at home usually melt or deform when exposed to hot water
- Silicone molds are highly effective for creating specific shapes
- Agar (vegan gelatine)
- Carrageenan (mostly is used for food thickener)
- Alganite
- Many forms of bioplastics also boast impressive properties, like respectable levels of strength, flexibility, good barrier properties, and chemical resistance

<u>Oct 19, 2025</u>

- Plastic can be reduced to its basic constituents in a rapid manner with the help of biological agents
- Various microorganisms have great potential to convert certain plastic polymer biologically into simpler products via aerobic and anaerobic mechanism
- For example, a biological agent could utilize the organic polymer as a nutritional substrate for energy and growth, resulting in microbial biomass as the end product of complete biodegradation
- Recently, it was found that various microalgae promote biodegradation of polymers and the energy needed for degradation is reduced, since the synthesized enzymes with simple or multiple toxin systems involve a reduction in activation energy to weaken the chemical bonds in the polymer

<u>Oct 20, 2025</u>

- The Great Pacific Patch contains more than 3.5 million tons
- 90% of garbage is plastic
- Plastic is a major source of marine pollution
- Plastic as been found blocking airways of marine animals
- Abandoned fishing nets and soda packing get tangled in animals necks and bodies
- Plastics releases toxins and acts like a chemical sponge
- Plastics are broken down into microscopic pieces which lead their way up the food chain and eventually get eaten by humans
- In men plastic causes cancer, immune system damage, behavioral problems, and reduced fertility

<u>Oct 21, 2025</u>

Why we need to do this

- We know that the waste are not being recycled properly, and the waste can get to the ocean and take ages to degrade

- I have a strong feeling that I want to do something to build a sustainable way and circular economy

Oct 22, 2025

Recipe 1:
50mL Water
5mL Vinegar
5g Glycerol
6g Wheat Flour

Recipe 2:
50mL Water
5mL Vinegar
5g Glycerol
7.5g potato starch

Recipe 3:
50mL Water
5mL Vinegar
5g Glycerol
6g Tapioca starch

Recipe 4:
50mL Water
5mL Vinegar
5g Glycerol
7.5g sweet potato starch

Recipe 5:
50mL Beetroot juice
5mL Vinegar
5g Glycerol
7g potato starch
(Not using this recipe as it uses potato starch again and instead of water it is using beetroot juice)
https://www.wikihow.com/Make-Bioplastic
https://www.instructables.com/Make-Your-Own-Bioplastics/
Found ingredients and recipes here

Oct 23, 2025

- Wheat flour is being used for my experiment because it is low-cost, renewable, and has lots of material rich in components like starch, gluten, and fiber, which can be processed into biodegradable polymers
- Potato starch is used for bioplastics because it is a renewable,mass produced, and biodegradable raw material that can be converted into a plastic-like resin at a low cost
- Tapioca starch is commonly used for bioplastics as it is an abundant, renewable, and inexpensive natural polymer that is biodegradable
- It also provides a low-cost and environmentally friendly alternative to conventional plastics
- Sweet potato starch is used for bioplastics because they are a rich source of starch, a natural polymer that can be processed into a biodegradable material and with a high starch content

<u>Oct 24, 2025</u>

- Starch is used in bioplastic recipes primarily because it is an abundant, inexpensive, and it's a renewable natural polymer that provides the main molecular structure, or polymer matrix

<u>Oct 25, 2025</u>

Problem

- Which bioplastic recipe provides the greatest overall performance in terms of durability, eco-friendliness, cost-effectiveness, and biodegradability?

<u>Oct 26, 2025</u>

Hypothesis

- **If** four bioplastic recipes made with wheat flour, potato starch, tapioca starch, and sweet potato starch are compared, **then** the potato starch recipe will perform the best overall **because** potato starch forms stronger and more flexible films that are still biodegradable and affordable to produce.

<u>Oct 27, 2025</u>

Explanation

- Durability
  - Potato starch mostly forms a fairly strong starch film when heated and mixed with glycerol, so it should resist tearing better than very flexible recipes
- Eco-friendliness and source material
  - Potatoes are a common, renewable food crop with low processing needs for making small lab batches
- Cost-effectiveness
  - Potato starch is inexpensive and easy to measure for experiments
- Biodegradability
  - Starch-based plastics typically break down in soil or compost, and potato starch is expected to biodegrade nicely in my tests

Oct 28, 2025

What to test for in the water test (not finalized)

- weight loss
- CO_2/oxygen consumption
- disintegration (breaking into <2mm pieces)
- surface erosion
- changes in chemical structure
- using methods like respirometry (CO_2 release)
- mass loss, spectroscopy (FTIR)
- microscopy (SEM)
- standardized OECD/ASTM tests
- pH level of water while biodegrading
- Turbidity
- TDS (total dissolved solids)

Oct 29, 2025

After researching some more I found out that the three best things to test in water biodegradation tests would be the following

- pH level of water while biodegrading
- Turbidity
- TDS (total dissolved solids)

These are the most important things to test because these parameters directly dictate the health, activity, and efficiency of the microorganisms (bacteria and fungi) responsible for breaking down pollutants

https://www.gaimc.com/Newsinfo/water-quality-parameters-guide-ph-tds-ec-do

Oct 30, 2025

What each test tests

- pH
    - measures how acidic or basic a liquid is on a scale of 0 to 14, indicating the concentration of hydrogen ions
- Turbidity
    - measures the amount of suspended particles (silt, clay, organic matter, algae) in the water
- TDS
    - represents the concentration of dissolved inorganic salts, metals, and small amounts of organic matter

Oct 31, 2025

- I will need 75 pH strips
- As I mentioned before 15 trials for each time jump
- There will also be 5 samples which consist of 4 bioplastics and one conventional plastic
- The bioplastics are:

    - Wheat flour
    - Potato starch
    - Tapioca starch
    - Sweet potato starch

<u>Nov 1, 2025</u>

I will keep the bioplastic in plastic or glass jars for 4 weeks and will test the pH level of the water, turbidity, and TDS

Why these tests

- pH
    - Helps know how much the plastic contaminated the water
- Turbidity
    - How cloudy the plastic makes the water when biodegrading
- TDS
    - Lets me know how much the plastic is biodegrading

For the final week I'll do the tests that I'm doing every week and also look at the texture, thickness, changes in color, and changes in size

<u>Nov 2, 2025</u>

Background research

Main questions

1. What are bioplastics, and how are they made?
2. How do bioplastics differ fuel based on properties?
3. What are the effects of commercial plastics?

<u>Nov 3, 2025</u>

How to test water biodegradability test

What I'll need (per sample):

Dry sample pieces (same size & thickness) 3 identical pieces per recipe

3 clear plastic or glass jars (one jar per replicate) with lids

Water and salt

Digital kitchen scale

Ruler, marker, notebook, camera/phone for photos

Tweezers or tongs, paper towels, small tray for drying

Labels/stickers

pH strips

Thermometer

Measuring cup

Stopwatch

Setup (Day 0)

1. Label jars with recipe name/number and replicate (e.g., 1-A, 1-B, 1-C)
2. Measure and record the dry mass of each sample (if you have a scale). Write this down. If no scale, record size and take a photo; you can still do visual comparisons.

3. Place one sample into each jar. Add the same amount of water to every jar (e.g., 200 mL). Close lids loosely so gas can escape (or cover with cloth).
4. Put jars somewhere with stable temperature, out of direct sunlight. Record the date and starting time.

Checking and recording (every 2–3 days; run for 2–4 weeks)

At each check (e.g., Day 3, Day 6, Day 9, Day 12, Day 15, etc.) do this:

1. Observe and take photos note changes in color, holes, softness, or if it flakes apart.
2. Smell test (brief): note if water smells different
3. If you weigh: remove the sample with tweezers, gently rinse off water, pat dry with paper towel, air-dry for 30 minutes on a tray, then weigh. Record the mass. Return the sample to fresh water if continuing.
4. Record water appearance: clear, cloudy, bits floating, color change. (This helps show breakdown.)
5. Note pH changes.
6. Keep everything labeled and take photos from the same angle each time.

How to calculate biodegradation (percent mass loss):

* Starting mass = M_0 (grams)
* Mass at check = M_1 (grams)
* Percent mass lost = $((M_0 - M_1) \div M_0) \times 100\%$

Record percent loss at each time point and plot a simple graph (days on x-axis, % mass loss on y-axis).

Saltwater (simulated ocean)

To mimic ocean conditions:

Add 35 g of table salt per 1 L of water (that's about the same saltiness as seawater). For 200 mL, use 7 g salt. Dissolve fully before adding samples.

Note: saltwater can speed up or slow down breakdown for different materials

<u>Nov 4,2025</u>

<u>Researching on background research question #1</u>

- Plastics are a versatile group of materials with countless short-lived and durable applications
- At a global level, no more than 9% of all plastics are recycled
- The major issue with plastics waste is the mismanagement of plastic items towards and at the end of their lifetime, which can be attributed to a lack of waste collection and recycling infrastructure in most developing and emerging countries and inadequate or inappropriate waste collection and sorting infrastructure even in the developed/industrialized countries, coupled with human behavioural aspects, and the leakage of micro- and nanoplastics particles that are hard-to-impossible to catch and retain with today's technologies

- Also, the demand for recycled plastics has increased strongly in some areas, with “green” products being more accepted by the customers, leading to comparatively higher prices and some shortages in supply

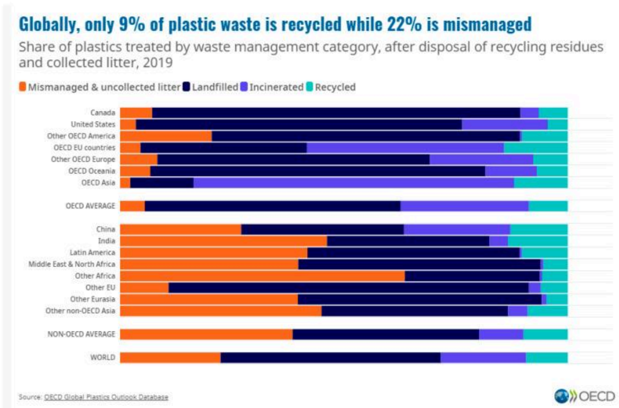


Image website
https://pmc.ncbi.nlm.nih.gov/articles/PMC10747977/

Image website
http://blog.teachersource.com/2020/08/14/diy-bioplastics/

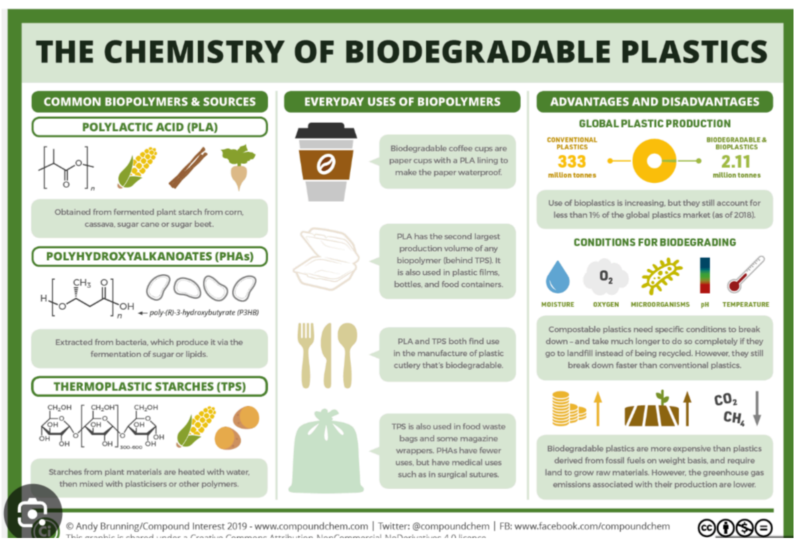


Image website
https://www.parekhplast.com/blog/bioplastics--classification-types-and-uses

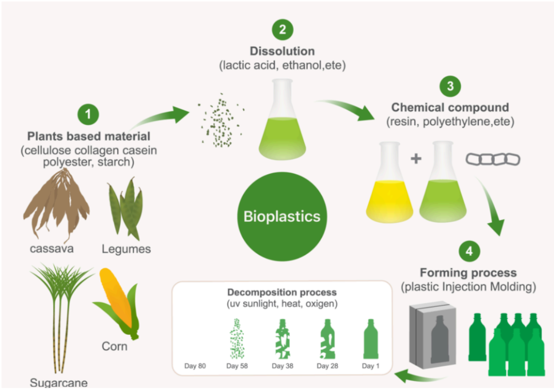
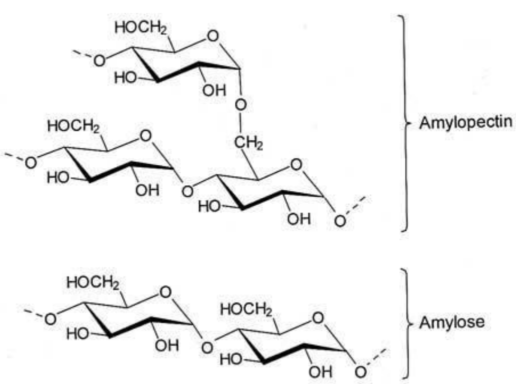
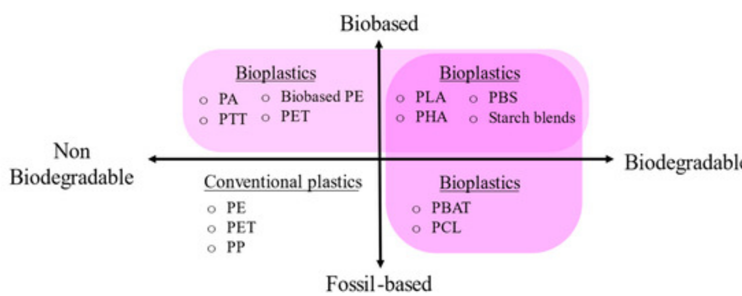


Image website
https://cse.umn.edu/college/k-12-outreach/make-it-and-break-it

- As the bioplastic paste cools, the water is expelled and the amylose molecules hydrogen bond to form a semi-crystalline structure again resulting in a brittle plastic film



  - More to the 2nd background question
  - In general, bioplastic can be understood simply as plastic that is not derived from fossil resources like oil and gas
  - They are also plastics that are biodegradable and don't just turn into microplastics
  - Although some bioplastics are not biodegradable most are better than conventional plastics



- Bioplastics are an environmentally friendly plastic that are made by processing renewable sources like cornstarch, sugarcane, and vegetable oil through steps that include fermentation, polymerization, and molding

https://www.mdpi.com/fermentation/fermentation-09-00655/article_deploy/html/images/fermentation-09-00655-g001-550.jpg (website for picture)
https://cse.umn.edu/college/k-12-outreach/make-it-and-break-it
https://www.azom.com/article.aspx?ArticleID=22110

Nov 5, 2025

Researching for background question #2

regular plastics properties

- Regular plastics are made from repeating units of carbon molecules that form long chains called polymers
- The single molecules that make up the polymers are obtained by refining petroleum oil

- Along with other additives, the polymers are heated and liquified then injected into molds where they solidify
- The plastic has different properties than the individual compounds that it was composed from. At the molecular level, unique chemical bounds not found in nature are formed, which lend themselves to increased durability, thermostability (the ability to resist permanent change at high temperatures), and water resistance
- In natural decomposition, microbes such as bacteria and fungi break the chemical bonds holding substances together
- The chemical bonds in organic compounds have specific shapes that entices microbes to bind and then begin decomposition. In petroleum-based plastics, the polymers are longer molecules than what would occur in nature, making it harder for microbes to recognize them and bind, leading to the inability of plastic to be broken down
- While several factors impact the timeline to degrade plastics, like the polymer it is made from and the environment it is discarded in, on average, single-use plastic bottles will take about 450 years to degrade, while a plastic bag can take anywhere from 10 to 1,000 years to degrade in a landfill
- Production and disposal release significant amounts of greenhouse gases
- Can contain and leach out toxic chemical
- Highly durable and resistant to degradation
- Uses finite, non-renewable resources

<u>Nov 6, 2025</u>

Bioplastic properties

- Utilizes resources that can be replenished naturally
- Can sometimes have limitations in mechanical properties such as brittleness or higher water vapor permeability
- Surprisingly, the structural similarity between bioplastic and petroleum-based plastics are very similar
- Often free from harmful chemicals like bisphenols (BPA), which are commonly found in conventional plastics
- They both contain polymers but are distinguished based on the source
- A common polymer used in bioplastics is polylactic acid (PLA) which is synthesized by fermenting plant starch from agricultural waste.
- Lactic acid molecules are bound together in this natural process, forming long chains that become polymers
- These polymers, unlike petroleum-based ones, have molecular bonds that can be broken apart by water, heat, and the sun
- Making them a more eco-friendly choice than regular plastic
- This difference in degradability comes from the bonds that makeup the structure of the polymers

- Generally have a lower carbon footprint and can be carbon-neutral due to the plants used to create them absorbing carbon dioxide

Nov 7, 2025

Things to consider

- Using fossil fuel to make plastics does not necessarily produce more CO2 than production of bioplastics
- Bioplastics also cost more money to produce
- They also have limited functionality like I said above with the mechanical challenges as they biodegrade when exposed to heat or the sun for a long period of time
- Bioplastics also need humidity and heat to decompose, and if there is no heat and it is really like in the winter the plastics will just sit there
- Bioplastic or biodegradable plastics are called BDP(s)

https://amino.bio/blogs/what-is/bioplastics-vs-regular-petroleum-based-plastics-how-do-they-compare?srsltid=AfmBOoryKLkuAxgQck7bQ7wYRxqQqXvbuD_5oDuYkSgwXRfN3mpB7Tjt

Nov 8, 2025

Researching for background question #3

Effects on the environment

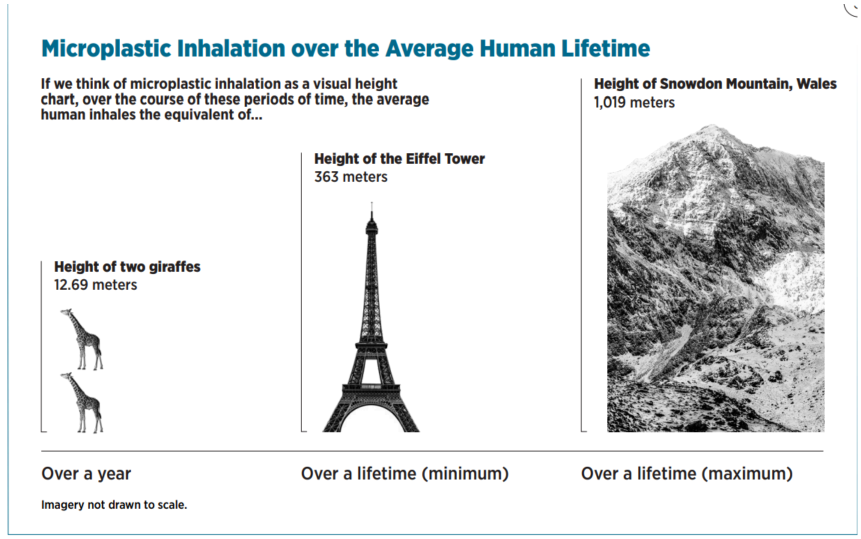
- Plastic pollution poses a threat to the marine environment
- It puts marine species at higher risk of ingesting plastic, suffocating, or becoming entangled in plastic pollution
- Research indicates that more than 1,500 species in marine and terrestrial environments are known to ingest plastics
- The Organization for Economic Cooperation and Development estimated that in 2019, plastic products were responsible for 3.4% of global greenhouse gas emissions throughout their life cycles, with 90% of these emissions coming from the production and conversion of fossil fuels into new plastic products
- OECD also reports that, unless human Plastic pollution includes improperly discarded plastic products that clogs up drainage systems, the seas and releases toxic chemicals to the environment, behavior changes, greenhouse gas emissions associated with the life cycle of plastic products are expected to double by 2060
- The World Economic Forum projects that without intervention, the global plastics industry will account for 20% of total oil consumption and up to 15% of global carbon emissions by 2050
- Plastic pollution also includes improperly discarded plastic products that clogs up drainage systems, the seas and releases toxic chemicals to the environment
- Every day, the equivalent of 2,000 garbage trucks full of plastic are dumped into the world's oceans, rivers, and lakes
- Plastic pollution is a global problem
- Every year 19-23 million tonnes of plastic waste leaks into aquatic ecosystems, polluting lakes, rivers and seas

- Plastic pollution can alter habitats and natural processes, reducing ecosystems' ability to adapt to climate change, directly affecting millions of people's livelihoods, food
- As we go higher up the food chain we realize that plastic is disrupting it all

https://www.epa.gov/plastics/impacts-plastic-pollution
https://www.unep.org/plastic-pollution
Nov 9, 2025
Effects on the human body

- Humans are exposed to a large variety of toxic chemicals and microplastics through inhalation, ingestion, and direct skin contact, all along the plastic lifecycle
- According to WWF, an average person could be ingesting approximately 5 grams of plastic every week
- While the health impacts of plastics is still a rather new research area, scientific results to-date do indicate plastic causes diseases, disability and premature death at very stage of its life cycle
- The toxic chemical additives and pollutants found in plastics threaten human health on a global scale
- Scientifically-proven health effects include causing cancer or changing hormone activity (known as endocrine disruption), which can lead to reproductive, growth, and cognitive impairment
- Many of the toxic chemical additives have several other known health impacts, persist in the environment, and bioaccumulate in exposed organisms
- Research also revealed that microplastics can harm our health, and act as vessels for pathogens to enter our system, increasing the spread of diseases
- Examples include pollution at extraction sites, workers exposure to chemicals, air pollution from waste incineration, and water and soil contamination
- Vulnerable groups, including children, women, workers in the informal waste sector and marginalized communities are particularly exposed, thus raising concerns of human rights and environmental injustice
- The adverse effects of plastic are particularly acute children in the womb and young ones, with increased risks of prematurity, stillbirth, birth defects of the reproductive organs, neurodevelopmental impairment, impaired lung growth, and childhood cancer (Minderoo-Monaco Commission on Plastics and Health, 2023).
- Plastics also contribute to the numerous health risks associated with warming temperatures and extreme weather events due to climate change
- The effects of plastic production on human health also have important monetary costs, recently estimated to more than $250 billion in 2015 globally and more than $920 billions in the USA alone for diseases and disability caused by the plastic-associated chemicals PBDE, BPA and DEHP

- There is no doubt that humans are exposed to plastics through daily life products, plastic-based medical supplies, as well as through the food chain and airborne plastic pollution
- Workers in the extraction, manufacture, transportation and waste sector and local communities where these activities are conducted are further exposed
- Through these various pathways, we are exposed to microplastics and the chemical additives they contain
- Recent studies have found microplastics in human blood, lungs, and placenta
- As 99% of plastics are created from chemicals of fossil origin, oil-associated toxicological short and long term health hazards from respiratory symptoms to adverse neurological effects, including stress and generalized anxiety disorder are part of the plastic value-chain



Source: Data from an investigation by the University of Portsmouth and Good Morning Britain.

- To date, it has been estimated that more than 16,000 chemicals are used to make plastic, of which at least 4200 are chemicals of concern
- This number shows a both a growth in the number of used chemicals and an improvement in their identification, as it departures from the 13,000 chemicals found by UNEP and BRS in 2023
- A growing body of evidence points to the health risks posed are not only caused by plastic additives, as humans are also directly exposed to plastic materials in the form of microplastics and nano-plastics (Project TENDR, 2024)
- Exposure to plastics and chemicals can happen through ingestion through food and waste, chemicals leaching and accumulation in air and dust
- These act as endocrine-disrupting chemicals (EDCs), which are linked to infertility, obesity, diabetes, prostate or breast cancer, thyroid problems and increased risk of cardiovascular disease and stroke, among others
- Other health conditions linked to additives include reproductive, growth, and cognitive impairment and neurodevelopment disorders
- The technical report Chemicals in Plastics released by UNEP and the Basel, Rotterdam and Stockholm Conventions Secretariat in May 2023, highlights how women and children are particularly susceptible to these toxic chemicals

- Exposures can have severe or long-lasting adverse effects on several key periods of a woman’s life and may impact the next generations
- Eating plastic isn't just from drinking out of a plastic cup its also can be indirect as eat marine animals and they eat plastic

https://www.genevaenvironmentnetwork.org/resources/updates/plastics-and-health/#scroll-nav__8

Nov 10, 2025

What is BPA

It is an industrial chemical that is a building block for making plastics and resins.

It is a colorless solid and is soluble in most organic solvents but not in water.

Polycarbonate plastics: These are hard, clear plastics used in some food and drink containers, water bottles, and shatterproof windows.

BPA full form is bisphenol A

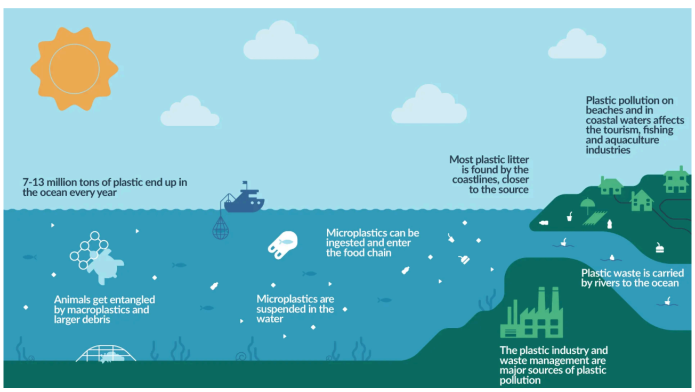


Image website

Plastic Pollution | CMEMS

Image website

Unwanted influence of plastic waste on the nature [1].

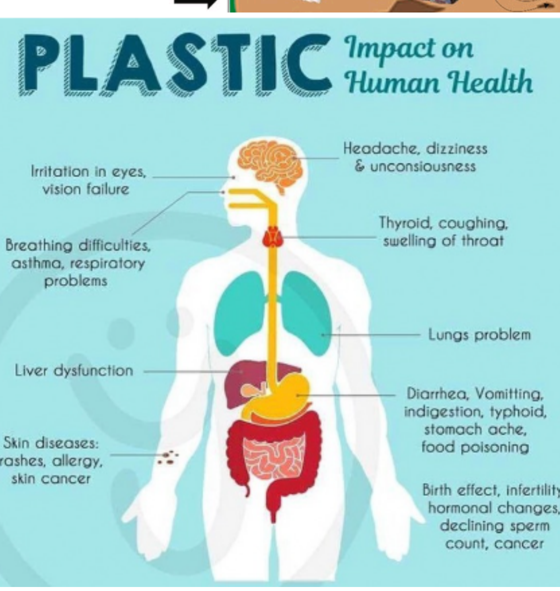


Image website

How Plastic Pollution Negatively Impacts Human Health: What You Need to Know

Completed all background research slides

Nov 11, 2025

- Created some iterations in the final problem question:

The original research question focused broadly on determining which bioplastic recipe provides the greatest overall performance in terms of durability, eco-friendliness, cost-effectiveness, and biodegradability. After further planning, it became clear that evaluating all of these factors equally would make the investigation too broad and reduce the reliability of the results.

Durability and eco-friendliness are difficult to measure quantitatively within the scope of this experiment and would rely heavily on subjective observation. To improve the clarity and scientific strength of the project, the research focus was refined to concentrate primarily on biodegradability as the main measurable variable.

Rather than assessing biodegradability through a single test, the investigation was redesigned to include multiple biodegradation testing methods. These methods are used to directly compare results across four different bioplastic recipes. Durability and eco-friendliness are still considered, but are recorded through qualitative observations such as physical integrity, flexibility, and visible degradation over time.

Previous Problem:Which bioplastic recipe provides the greatest overall performance in terms of durability, eco-friendliness, cost-effectiveness, and biodegradability

New Problem: Which bioplastic formulation demonstrates the most effective biodegradability, and how do these results compare across four different bioplastic recipes?

Nov 12, 2025

Started researching on biodegradable plastics as I need one controlled plastic the experiment but it also needs to have a chance to biodegrade

- Bioplastic carrier bags are made from plant-based materials like cornstarch, sugarcane, or potatoes
- Are mostly PLA and sometimes PHA
- PHA are a family of biopolymers produced by microorganisms, offering thermoplastic properties for bag manufacturing
- While PLA is made from fermented plant starches (like corn), performs similarly to traditional/conventional plastics and is a common choice for compostable bags

Started looking at why water and cornstarch make a non-netonion fluid and why other starches don't make a non-netonion fluid

- Water and cornstarch create oobleck because cornstarch particles are uniquely shaped

(long, thin) and don't dissolve,
- Forms a suspension that acts like a solid under quick pressure (locking together) but flows like a liquid slowly (particles slide apart), a behavior other starches don't replicate as effectively due to differences in particle size, shape, or chemical properties

<u>Nov 13, 2025</u>

How does salinity affect pH

I need to understand how salinity affects pH to make sure my bioplastics are breaking down because of their material, not because the water became more acidic.

When salinity increases:

- Pure salt (NaCl) does not directly change pH because it is neutral
- Higher salinity water often contains other dissolved ions (like bicarbonates and carbonates)
- These ions help buffer the water, meaning they resist big pH changes

How ingredients in bioplastics can affect pH

I need to know this to understand how ingredients in bioplastics can affect pH to go lower depending on if the ingredients release acids

Starches (potato, tapioca, sweet potato)

- These bioplastics are made mostly from natural starches

When starch-based plastics start to biodegrade:

- They break into simple sugars and organic compounds
- Microorganisms can use these compounds and release mild acids
- This can cause the water's pH to decrease slightly (become more acidic) over time

This means starch-based bioplastics can affect pH more noticeably

Glycerol/glycerin

- Glycerin is often added to make bioplastics flexible

Glycerin is mostly pH neutral:

- It dissolves easily in water
- It can help microbes grow, which may indirectly lower pH
- Its effect on pH is usually small but supportive of biodegradation

PLA (polylactic acid)

PLA is made from plant sugars but is chemically more stable

- It does not break down easily in salt water

Because it degrades very slowly:

- It releases very few acidic compounds
- The pH of the water stays mostly unchanged

This is why PLA often shows less pH change

How decomposition affects pH

Decomposition usually lowers pH, meaning the environment becomes more acidic.

What happens during decomposition:

- As a material (like a bioplastic) decomposes, it breaks into smaller molecules
- Microorganisms use these molecules as food

While feeding, microbes release acidic by-products such as:

- Organic acids
- Carbon dioxide (which forms carbonic acid in water)

Effect on pH

- These acids cause the pH of the water to slowly decrease
- Faster decomposition leads to greater pH drop
- Slower decomposition turns out to little or no pH change

<u>Nov 14, 2025</u>

Originally I was using table salt but after some more research I decided on coarse sea salt, as sea salt is less processed, contains vital trace minerals, and lacks the harmful additives found in refined table salt

<u>Nov 15, 2025</u>

How salinity affects turbidity

I need to understand how salinity affects turbidity so I don't misinterpret cloudiness changes and can accurately compare biodegradation between bioplastics

When salinity increases:

- Dissolved salts cause small particles to clump together (this is called flocculation).

When particles clump:

- They become heavier
- They sink faster

This can make the water less turbid (clearer) over time

As bioplastics break down:

- They release small particles and organic matter
- This can increase turbidity at first

In salt water:

- Some of those particles clump and settle
- Turbidity may increase then decrease over time

How ingredients in bioplastics can affect turbidity

Starches

When they start to degrade:

- Starch swells, dissolves, or breaks into tiny particles
- Some starch becomes suspended in the water
- This causes higher turbidity (cloudier water), especially early in the experiment
- More starch means more cloudiness

Glycerin

- Glycerin makes bioplastics flexible and dissolves easily in water

It can:

- Increase microbial growth
- Help release small particles from the plastic
- This can slightly increase turbidity over time

PLA (polylactic acid)

- PLA is more chemically stable
- It does not break down much in salt water

Very few particles are released:

- Turbidity stays low and mostly unchanged

Particle size matters

- Smaller particles stay suspended longer which means higher turbidity
- Larger particles sink faster which means lower turbidity
- Starch-based bioplastics tend to release small particles, increasing turbidity more than PLA

What happens during decomposition

- As a material (like a bioplastic) decomposes, it breaks into smaller pieces.
- Tiny particles and dissolved organic matter are released into the water.

- Microorganisms grow and multiply as they feed on this material.

Effect on turbidity

- Early stages:
  - More particles and microbes → higher turbidity (cloudier water)
- Later stages (especially in salt water):
  - Particles can clump together and settle
  - Turbidity may decrease, even though decomposition is still happening

How does salinity affect TDS

Effect of salinity

- Salinity is mostly dissolved salt (like sodium and chloride ions).
- When salinity increases:
  - More salt dissolves in the water
  - The TDS value increases
- When salinity decreases:
  - Less dissolved material
  - Lower TDS
- The more salt leads to a higher TDS

How do the ingredients within the plastic affect TDS

Starches (potato, tapioca, sweet potato)

- These bioplastics are made mostly of natural starch
- When placed in water:
  - Starch absorbs water and partially dissolves
  - As the plastic degrades, small starch molecules and sugars enter the water
- These dissolved substances increase TDS

More starch breakdown = higher TDS

Plasticizers (like glycerin)

- Glycerin is added to make bioplastics flexible
- It is water-soluble, so:
  - Some glycerin dissolves into the water
  - This adds to the total dissolved solids
- It can also support microbial activity, which releases more dissolved compounds

PLA (polylactic acid)

- PLA is chemically stable in salt water

- It does not dissolve easily
- Very little material enters the water, so:
    - TDS changes are small or minimal

Why different recipes give different TDS values

- Ingredients that dissolve easily leads to higher TDS
- Ingredients that are stable leads to lower TDS
- That's why starch-based bioplastics usually show larger TDS increases than PLA

How decomposition affects TDS

Decomposition increases TDS over time

What happens during decomposition

1. As a material (like a bioplastic) decomposes, it breaks into smaller molecules
2. These molecules dissolve into the water
3. Microorganisms also release dissolved by-products while breaking down the material

Effect on TDS

- More dissolved substances in the water leads to higher TDS
- Faster decomposition causes a larger increase in TDS

- Slower decomposition causes little or no change in TDS

<u>Nov 16, 2025</u>

What makes the bonding materials different from these starches (potato, tapioca, and sweet potato) differing from corn starches?

More amylose = stronger bonding
More amylopectin = weaker, more flexible bonding

Granule size and shape

- Potato starch has large granules
- Corn starch has smaller, tighter granules
- Tapioca starch granules swell easily

Larger or easily swollen granules:

- Let water in more easily
- Break hydrogen bonds faster
- Biodegrade more quickly

Hydrogen bonding ability

- Starch chains bond using hydrogen bonds
- Different starch structures
  - Form more or fewer hydrogen bonds
  - Hold together differently when heated and dried

This changes:

- Plastic strength
- Water absorption
- Decomposition speed

Interaction with glycerin

- Some starches bind glycerin more easily
- This weakens internal bonding and increases flexibility
- Starches like tapioca and sweet potato are more affected than corn starch

<u>Nov 18, 2025</u>

Why I used the ingredients I used

- Water
  - Water is the essential medium to disperse the starch particles, preventing them from clumping and creating a uniform mixture
  - When heated, water causes the starch granules to swell and burst (gelatinize), which releases the starch molecules (amylose and amylopectin) and allows them to form a continuous network, crucial for film formation
  - Water helps the plasticizers (like glycerin) integrate into the starch matrix, making the final product more flexible and less brittle
  - As the mixture cools and dries, the water evaporates, leaving behind the solidified, interconnected starch-plasticizer network that forms the bioplastic film
- Vinegar
  - Starch is a polymer made of long, tangled chains, some branched (amylopectin) and some straight (amylose) and vinegar breaks it down
  - The acetic acid in vinegar chemically modifies the starch, cutting off the branches from the amylopectin molecules
  - This process converts the branched structure into more straight-chain amylose, which can then align better
  - This molecular restructuring leads to a smoother, stronger, and more flexible bioplastic film, preventing it from being too rigid and crumbly
- Glycerin
  - Starch molecules naturally form rigid structures; glycerin inserts itself between these chains, reducing intermolecular forces and allowing the plastic to bend and stretch

    - Without glycerin (or a similar plasticizer like sorbitol), starch bioplastics would be hard, crack easily, and be useless for most applications
    - It gives the bioplastic thermoplastic properties, allowing it to be shaped through techniques like extrusion or film casting
    - Glycerin's hydroxyl (-OH) groups attract and bind water, contributing to the film's moisture content and affecting its mechanical properties

Nov 19, 2025

Salinity test strips and how they work

- Salinity test strips work by using a chemical reaction on a pad that changes color in proportion to the salt (sodium chloride) concentration in water; you dip the strip, wait a specified time
- Then compare the resulting color to a chart on the bottle for a quick, inexpensive estimate of salt levels
- Chemical Reaction:
    - The strip has a special test pad containing silver nitrate or similar chemicals that react with chloride ions (from salt) in the water

Why would they help in my experiment

- Biofilm Development:
    - Microbes colonize plastic surfaces to form a "plastisphere"
    - Changes in salinity affect the composition and activity of these microbes, which directly impacts how fast the plastic breaks down
- Abiotic Influence
    - While biodegradation is primarily driven by microorganisms, salts themselves can cause physical and chemical alterations to materials
- Using salinity test strips for my project is advantageous because it allows me to monitor how the degradation process alters the chemical composition of the water, specifically by tracking the release of ions or changes in salinity caused by microorganisms
- These strips are cost-effective, easy to use, and provide rapid results (around 30 seconds), making them ideal for monitoring multiple aquarium setups over time

https://www.sciencedirect.com/science/article/abs/pii/S0304389423004077#:~:text=Significant%20differences%20existed%20between%20the,marine%20life%20and%20human%20health

Instead of measuring TDS I have decided to test for salinity by salinity strips. I could not measure the amount of TDS as the meter went off the charts and resulted on me using salinity strips to measure salinity.

Nov 30,2025

- Started working on variable slides

Manipulated Variables

The different starches/flours used each recipe:-

- Wheat flour

- Potato starch
- Tapioca starch
- sweet potato starch

Responding Variables

- Bioplastic made by each flour or starch and its performance, such as durability, eco-friendliness, cost-effectiveness, source material sustainability, and biodegradability

Controlled Variables

- Amount of bioplastic made
- Amount of each ingredient
- Cooking temperature (62 c)
- Type of moulds
- Thickness of the bioplastic sheet
- Size of samples
- Equipment used
- Mixing/stirring speed and time
- Amount of repetition
- Storage conditions
- Handling conditions
- Solidification conditions
- Testing location
- Testing time
- Heating time
- Solidification time (72 hours)

<u>Dec.3,2025</u>

Added more controlled variables to slideshow

Note:

For experiment do not fully flood the jar with water. If it is too wet, oxygen cannot penetrate, which limits the growth of decomposer microorganisms

<u>Dec 19,2025</u>

materials list

- 600mL water
- 60mL vinegar
- 60g glycerol
- 18g wheat flour
- 22.5g potato starch
- 18g tapioca starch
- 22.5g sweet potato starch
- Silicone mould
    - 2 in x 3 in
    - 2.5mL thick

- Stirring stick
- Measuring cup
- Beaker
- Gloves
- Pot
- Spatula
- 12 clear plastic or glass jars (one jar per replicate) with lids
- Digital kitchen scale
- Ruler
- Marker
- Camera/phone for photos
- Tweezers or tongs
- Paper towels
- Small tray for drying
- Labels/stickers
- pH strips
- TDS meter
- Turbidimeters
- Table salt

<u>Dec. 20, 2025</u>

- Made all bioplastic samples and let them dry for 48 hrs

<u>Dec 21,2025</u>

Procedure plan

1. Gather/buy materials
2. Choose a flat clean surface to work on
3. Put on PPE (Personal Protection Equipment)
4. Take out six moulds
5. Label each one corresponding to one of the four bioplastic recipes: "Wheat Flour," "Potato Starch," "Tapioca Starch," and "Sweet Potato Starch "
6. Label each with the corresponding numbers
   1. Wheat flour
   2. Potato starch
   3. Tapioca starch
   4. Sweet potato starch
7. Measure 50mL Water
8. Measure 5mL Vinegar
9. Measure 5g Glycerol
10. Measure 6g Wheat Flour
11. Add all ingredients into a small pot
12. Stir the mixture until smooth and lump-free

13. Place the small pot on the stove
14. Heat on low to medium heat
15. Stir continuously
16. Observe the mixture changing from cloudy to clear and thick
17. Remove from heat once it becomes gel-like
18. Pour the hot bioplastic mixture into it’s designated silicone mould
19. Spread evenly to the desired thickness using a spoon or ruler
20. Measure and record the thickness of the sample
21. Clean and sanitize the materials used
22. Repeat steps 7-9
23. Measure 7.5g potato starch
24. Repeat steps 11-21
25. Repeat steps 7-9
26. Measure 6g Tapioca starch
27. Repeat steps 11-21
28. Repeat steps 7-9
29. Measure 7.5g sweet potato starch
30. Repeat steps 11-21
31. Leave all four bioplastics to dry for 24-48hrs
32. Measure and record the thickness of each sample
33. Label each sample (Sample A, Sample B, Sample C) for the appropriate bioplastic material
34. Place two supports 8 cm apart
35. Lay one bioplastic strip across the supports so it is suspended in the middle
36. Gently place the smallest weight on the plastic
37. Observe and record if the bioplastic bends, stretches, or breaks
38. Add the next heavier weight
39. Repeat until the bioplastic breaks or permanently deforms
40. Record the maximum weight held before breaking
41. Measure how much the bioplastic bent
42. Repeat steps 32-42 for each bioplastic sample
43. Measure and record the initial size, thickness, and quality of the original clean water
44. Label containers as:
    Container 1: wheat
    Container 2: potato
    Container 3: tapioca
    Container 4: sweet potato
45. Fill each container with 250 mL of water
46. Place the corresponding bioplastic piece into its container
47. Place containers at room temperature

48. Do not disturb containers except during observations
49. On each observation, carefully remove the sample
50. Observe and record:
    a) Changes in size
    b) Softness or brittleness
    c) Cracks or holes
    d) Color changes
51. Take sample out of container
52. Measure and record size and mass
53. Return the sample to the container
54. Compare final measurements to initial measurements
55. Calculate percent change
56. Record conclusions about biodegradability
57. Repeat steps 47-56 for each bioplastic sample
58. Dispose of water safely

<u>Dec 22, 2025</u>

Revamped materials list

<u>New materials list</u>

- 3600mL water
- 60mL vinegar
- 60g glycerol
- 22.5g potato starch
- 18g tapioca starch
- 22.5g sweet potato starch
- Silicone sheet
- Stirring stick
- Measuring cup
- Beaker
- Gloves
- Pot
- Spatula
- 12 clear plastic or glass jars with lids
- Digital kitchen scale
- Ruler
- Marker
- Phone for photos
- Paper towels
- Small tray for drying
- Labels/stickers
- pH strips

- TDS meter
- Turbidimeters
- PLA plastic
- 12 plain white sheets of paper
- Wooden spoon
- Scissors

<u>Dec 23, 2025</u>

Revamped procedure plan

<u>New procedure plan</u>

1. Gather/buy materials
2. Choose a flat clean surface to work on
3. Put on PPE (Personal Protection Equipment)
4. Take out silicone sheet
5. Label each portion corresponding to one of the four bioplastic recipes:
6. “Potato Starch,” “Tapioca Starch,” and “Sweet Potato Starch ”
7. Label each with the corresponding letters
    a. Potato starch
    b. Tapioca starch
    c. Sweet potato starch
8. Measure 50mL Water
9. Measure 5mL Vinegar
10. Measure 5g Glycerol
11. Measure 7.5g potato starch
12. Add all ingredients into a small pot
13. Stir the mixture until smooth and lump-free
14. Place the small pot on the stove
15. Heat on low to medium heat
16. Stir continuously
17. Observe the mixture changing from cloudy to clear and thick
18. Remove from heat once it becomes gel-like
19. Pour the hot bioplastic mixture into it’s designated silicone mould
20. Spread evenly to the desired thickness using a spoon or ruler
21. Measure and record the thickness of the sample
22. Clean and sanitize the materials used
23. Repeat steps 8-10
24. Measure 6g Tapioca starch
25. Repeat steps 12-22
26. Repeat steps 8-10
27. Measure 7.5g sweet potato starch
28. Repeat steps 12-22

29. Leave all three bioplastics to dry for 48hrs
30. Cut all plastics into 4x4 squares
31. Measure 3 liters of water using a measuring cup
32. Measure 105g of coarse sea salt
33. Add the salt to the water and stir until fully dissolved (stir for about 2-3 minutes)
34. Get out the TDS meter and measure how many TDS there is
35. Record in the logbook
36. Take out a pH strip and dip it into the water and record the number the in the logbook
37. Measure 250mL of the salt water and pour it into a jar
38. Repeat this for 11 more jars
39. Label three containers with the name of one the bioplastic types(PLA-1, PLA-2, PLA-3)
40. Repeat this for the other bioplastics
41. Dry each bioplastic sample completely
42. Measure and record the initial mass (g) of each sample
43. Place one bioplastic sample into each container, making sure it is fully submerged
44. Close the containers loosely and store them at room temperature, away from direct sunlight
45. Repeat steps 37-40 for all bioplastic samples
46. Observe and record changes in:
    a. pH of water
    b. TDS
47. Open the lid and gently dip a pH strip in the jar
48. Wait for results and record in logbook
49. Dip the TDS meter and subtract the amount of TDS that you recorded in your logbook at steps 33-34
50. Repeat steps 46-50 for all twelve jars
51. Repeat steps 45-50 once a week for four weeks
52. On week four/last week take out a bioplastic sample and observe and record changes in:
    a. Texture
    b. Thickness
    c. Color changes
    d. Changes in size
53. Organize into graphs with the data and results in logbook

<u>Dec 24, 2025</u>

Revamped hypothesis and variables

<u>New hypothesis</u>

If four different bioplastic formulations (potato, tapioca, sweet potato, and PLA) are placed in salt water, **then** the potato-based bioplastic will demonstrate the most effective biodegradability, shown by the greatest mass loss and visible breakdown over time, **because** potato starch absorbs water easily and breaks down faster in salty aquatic environments than the other bioplastics

New variables

Manipulated Variables

The different starches/flours used each recipe:-

- Potato starch
- Tapioca starch
- Sweet potato starch
- PLA plastic

Responding Variables

Which bioplastic formulation demonstrates the greatest biodegradation over a four-week period?

Controlled Variables

- Amount of bioplastic made
- Amount of each ingredient
- Cooking temperature
- Thickness of the bioplastic sheet
- Size of samples
- Equipment used
- Mixing/stirring speed and time
- Amount of repetition
- Storage conditions
- Handling conditions
- Solidification conditions
- Testing location
- Testing time
- Heating time
- Solidification time (72 hours)

Dec. 25, 2025

- Finished making all the bioplastics and bought the PLA plastic as a controlled variable

Dec. 28, 2025

- Researched on how to properly clean a tds meter
- How to clean a tds meter
    - Rinse the probe with distilled or deionized water for basic cleaning, use a syringe to dislodge debris, or soak in isopropyl alcohol for tougher grime (rinsing thoroughly afterward)
- I decided to use the distilled water method as it seemed more appropriate for my project

Dec. 29, 2025

- Did the water part of my experiment for week 1

Results

Tables for Graphs 2025-2026

Dec. 30, 2025

- Started to work on my slides for procedure, variables, and materials

- Finished my slides for procedure, variables, and materials except for pictures

Dec. 31, 2025

- Finished all slides except observation, analysis, and conclusion

Jan. 1, 2026

- Added pictures to most of my slides

Jan. 2, 2026

- Made tables for all of my observations (on lab report format)
- Added them to my slides to finish them

Jan. 3, 2026

- Decided to change the background for all of my slides as I thought they didn't go with my topic
    - The slides were more plastic and plant based
    - Changed them to water and plastic based

Jan. 4, 2026

- Got paper for my trifold as I needed to start working it this weekend

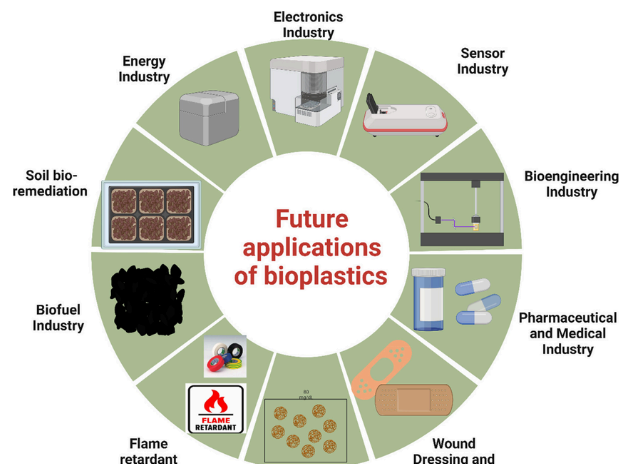
Jan. 5, 2026

- Did the water part of my experiment for week 2
- Added some pictures to slides after the testing
- Completed the tables for week 2

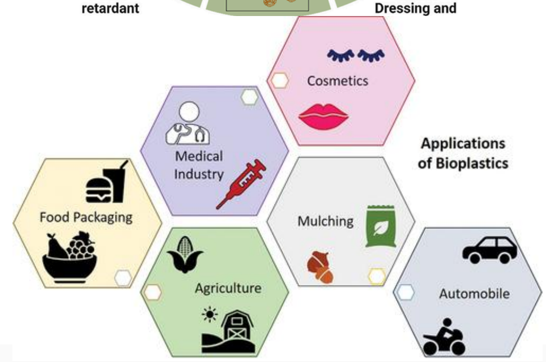
Jan. 6, 2026

- Started to look at some pictures for my application

https://www.researchgate.net/figure/Possible-future-a Applications-of-bio-plastics-in-different-industries_fig3 _377155434 - website image



https://www.tandfonline.com/doi/full/10.1080/257408 81.2024.2307369 - website image



Website image -https://link.springer.com/article/1

0.1186/s40643-025-00908-2

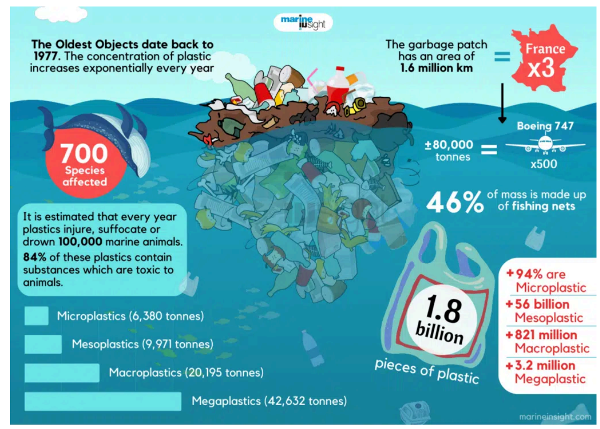
Jan. 7, 2026

- Another picture for my application

Website image-https://europlas.com.vn/en-US/blog-1/some-of-the-well-known-bioplastic-products-you-should-know

<u>Jan. 8, 2026</u>

Website image-
https://www.marineinsight.com/environment/what-is-the-pacific-ocean-garbage-patch/



<u>Jan. 9, 2026</u>

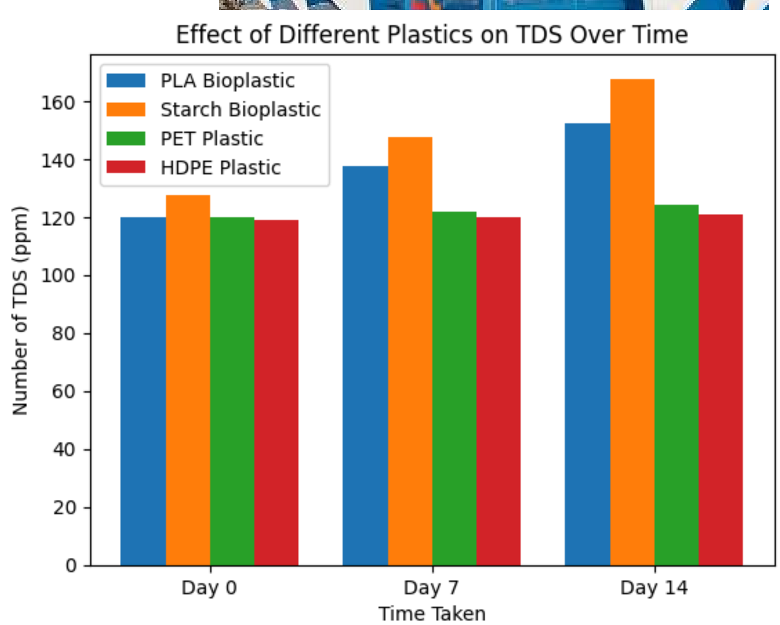
Website image - https://www.ptonline.com/blog/post/dutch-eu-building-features-xxl-3d-printed-bioplastic

Wanted a picture for application that wasn't an infographic

- Made out of bioplastic (was 3D printed) →

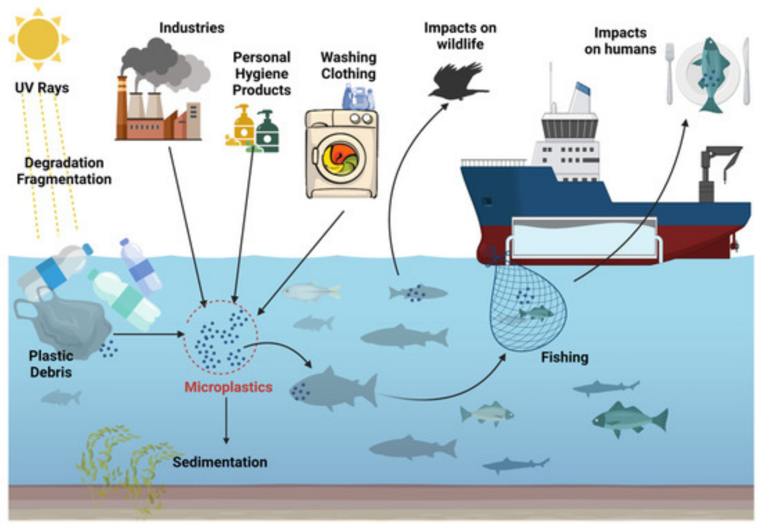
<u>Jan. 10, 2026</u>

- Reference on how i wanted to do my graphs →



Jan. 11, 2026

Website image - https://www.mdpi.com/2072-6643/15/3/617



Jan 12, 2026

- Started to work on my script

  Science Fair 2025-2026 Script

Jan 13 + 14 + 15, 2026

- Edited my script

Jan 16, 2026

- Cut out and started to practice my script

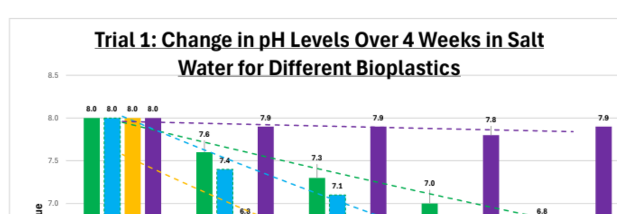
Jan 17 + 18, 2026

- Kept on practicing my script

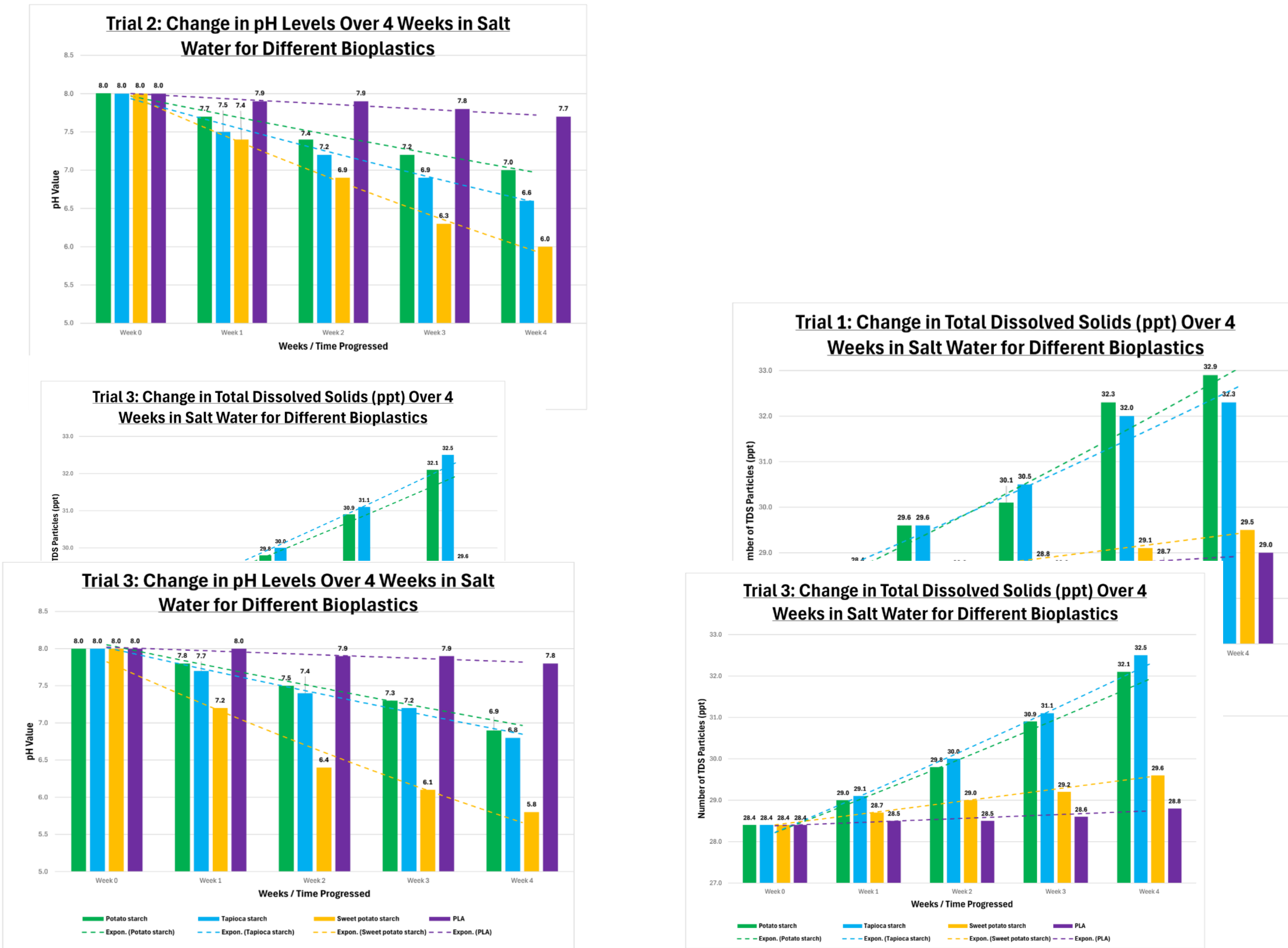
Jan 19, 2026

- Started to work on my trifold
  - Got paper for my trifold

Jan 20, 2026



- Made graphs for my analysis on excel:



<u>Jan 21 + 22, 2026</u>

- Made all analysis graphs into jot notes:

Total Dissolved Solids Results

- All materials began at a starting value of 28.4 at Week 0, establishing a consistent baseline for comparison
- Across all three trials, TDS increased steadily over time for every bioplastic, indicating consistent interaction with salt water

Trial 1:

- Potato starch increased steadily from 29.6 to 32.9 in Week 4

- This makes potato starch in Trial 1 a relative outlier compared to the other trials, suggesting faster breakdown or greater leaching in this run
- Tapioca starch increased from 29.6 to 32.3, showing strong and consistent increases like potato starch
- Sweet potato starch increased more gradually from 28.5 to 29.5
- Polylactic acid showed less change, rising only from 28.6 to 29

Trial 2:

- Potato starch increased from 29 to 32.1 similar to other trials
- Tapioca starch increased from 29.1 to 32.8 slightly higher than both Trial 1 and Trial 3, making it a mild relative outlier within the tapioca data
- Sweet potato starch increased from 28.6 to 29.4
- Polylactic acid remained stable from 28.5 to 28.9

Trial 3:

- Potato starch increased from 29 to 32.1
- Tapioca starch increased to 32.5, aligning with previous trials
- Sweet potato starch increased gradually from 28.7 to 29.6
- Polylactic acid was the primary outlier, remaining at 23 from Week 1 through Week 3 and increasing slightly to 23.1 in Week 4, far below its values in Trials 1 and 2 and below all other materials in Trial 3
- Overall, potato and tapioca starch consistently produced the largest increases in total dissolved solids, sweet potato starch produced moderate increases, and polylactic acid produced the smallest increases

Acidity (pH) Results

- All materials began at a starting level of 8.0 at Week 0 to simulate seawater conditions

Trial 1:

- Sweet potato starch showed the steepest drop, falling from 8.0 to 5.7, which is significantly lower than in Trials 2 and 3, making it a clear outlier
- Tapioca starch also showed a strong decrease to 6.0, lower than its final values in the other trials, suggesting a relatively higher acidifying effect in this trial
- Potato starch decreased more moderately to 6.8, slightly lower than Trials 2 and 3, but not extreme
- PLA remained nearly constant around 7.8–7.9, showing minimal pH impact and no outliers

Trial 2:

- Potato starch decreased from 7.7 to 7.0
- Sweet potato starch ended at 6.0, higher than Trial 1 but still lower than the other bioplastics, indicating consistent acidification rather than an outlier
- Tapioca starch and potato starch followed smooth, moderate declines, with values aligning closely with Trial 3
- PLA decreased slightly from 7.9 to 7.7, which is marginally lower than Trials 1 and 3 but still within a narrow range, not a strong outlier

Trial 3:

- Potato starch decreased from 7.8 to 6.9
- Tapioca starch decreased from 7.7 to 6.8
- Sweet potato starch ended at 6.0, higher than Trial 1 but still lower than the other bioplastics, indicating consistent acidification rather than an outlier
- Polylactic acid remained near neutral between 7.8 and 8.0
- Sweet potato starch was the primary outlier across all three trials due to its consistently lower acidity values compared to the other material

<u>Jan 23, 2026</u>

- Turned science fair background questions from paragraphs to background research
- Background Research Question 1:
    - Bioplastics are made from renewable natural materials like corn, sugarcane, or potatoes instead of fossil fuels
    - Plant materials are harvested and broken down to release sugars or starches
    - These sugars or starches are converted into chemicals through bacterial fermentation
    - Fermentation produces substances like lactic acid, an organic acid used to make bioplastics
    - Lactic acid molecules are linked together to form polymers such as PLA o PHA
    - These polymers can be melted and shaped into products like regular plastic
    - Many bioplastics are biodegradable and break down naturally
    - This reduces the formation of microplastics and nanoplastics
    - They help conserve non-renewable resources
    - Bioplastics support a more environmentally friendly future
    - They are not yet widely adopted around the world
- Background Research Question 2:

    - Conventional plastics are made from petroleum-based polymers with synthetic bonds not found in nature
    - These polymers resist microbial breakdown, taking hundreds of years to decompose
    - Their production releases greenhouse gases and relies on non-renewable resources
    - Bioplastics are made from renewable plant materials
    - Polymers like PLA are produced by fermenting plant starch into lactic acid
    - Their molecular bonds are more biodegradable and environmentally friendly
    - Carbon impact is lower because plants absorb CO_2 during growth
    - Bioplastics can have limits such as lower strength, higher cost, and heat sensitivity
    - Despite this, they offer a more sustainable alternative to conventional plastics
- Background Research Question 3:
    - Plastic pollution is a major global threat to the environment
    - Over 1,500 species are known to consume plastic
    - Around 19–23 million tonnes of plastic enter aquatic ecosystems each year
    - Plastic pollution disrupts habitats and reduces ecosystems' ability to adapt to climate change
    - It threatens food security and overall ecosystem stability
    - They accounted for 3.4% of global greenhouse gas emissions in 2019
    - Plastic-related emissions are expected to double by 2060
    - Humans are exposed to plastics through ingestion, inhalation, and skin contact
    - The average person may ingest about 5 grams of plastic per week
    - Plastic chemicals are linked to cancer, hormone disruption, and reproductive and cognitive issues
    - Microplastics have been found in human blood, lungs, and placentas
    - Vulnerable groups like children and pregnant women are at higher risk
    - Plastic pollution harms ecosystems, wildlife, climate, human health, and economic stability
- TDS Analysis Trial 1:
    - X axis: Weeks/Time Progressed
    - Y axis: Number of TDS Particles (ppm)
    - Legend: Types of 4 bioplastics

<u>Jan 24, 2026</u>

- Printed out all print outs for trifold

<u>Jan 25, 2026</u>

- Glued on every print out to my trifold

Jan 26, 2026

- Practiced answering potential judge questions
- Did a presentation run through
- Ensured all materials were packed and ready for the science fair presentation
- Tweaked my script to fit my trifold not slideshow

Jan 28, 2026

- Gave class presentation
- Ran a complete presentation run-through one last time
- Focused on speaking clearly and confidently while referencing my board
- Finalized my preparation and mentally reviewed key points
- Did a final review of my trifold and materials to check for any errors
- Reviewed my research to ensure I had strong responses for follow-up questions

Jan 30, 2026

- Gave presentations to judges for CYSF

Feb 3, 2026

- Received the news that I got in to CYSF
- Got feedback for my project:
    - To add data to more weeks
    - Contacted specific experts
        - Bioplastic degradability environments

Feb 4, 2026

- Started to put information into the CYSF platform
    - Put variables, materials, and procedure in

Feb 5, 2026

- Talked to Ms. Davis (CYSF organizer) and how to extend/make my project better
- Needed to talk to an expert and extend my weeks for pH and TDS

Experts For CYSF 2025-2026

- Did my observations for week 5
    - Recorded quantitative observations and qualitative observations

Feb 6, 2026

- Put in hypothesis and research (background) in the CYSF platform

<u>Feb 8, 2026</u>

- Starting to notice the lack of biodegradation within PLA
  - This isn't what I previously expected; although PLA takes the longest to biodegrade, I expected some biodegradation to occur

<u>Feb 11, 2026</u>

- Completed final checks on all bioplastic and PLA samples before starting Week 5 testing.
- Inspected all jars for contamination, leaks, or evaporation.
- Noted early surface softening on potato starch and tapioca starch samples.

<u>Feb 12, 2026</u>

- Organized all Week 5 and final results into one master data table.
- Checked all percent mass loss calculations for errors.
- Noted that potato starch and tapioca starch had the highest overall mass loss, while PLA had the lowest.

<u>Feb 18, 2026</u>

Created final graphs for:

- pH change over time
- TDS/salinity change over time

Reviewed trends and flagged any small outliers.

<u>Feb 19, 2026</u>

- Worked on uploading and formatting all my information within the CYSF platform
- Wrote short analysis notes explaining the trends shown in each graph
- Compared biodegradation behaviour of starch-based bioplastics to PLA

<u>Feb 21, 2026</u>

- Drafted my final conclusion and linked the results back to my hypothesis and background research on starch structure and water absorption
- Filmed my final video and made last minute edits to the platform

<u>Feb 22, 2026</u>

- Had teachers do a final read through of my project and implemented changes based on feedback