Logbook

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To anyone reading my logbook:

I know that a logbook should be handwritten but I found that inconvenient and irksome, it was much easier for me to do it online where I was able to research and write on docs, instead of writing my information on paper then going through the hassle of typing it on my slides.
Ps. My logbook may contain more or less information compared to my slides, this is where I initially typed it out before putting it on the slides, so I may have made some changes before or after doing so.

Choosing a topic

December 27, 2024

Options:

- Canadian Climate; and How Global Warming Affects Us
- Microplastic Contamination
- Biodegradable Plastics
- Using Microorganisms and Plants to Purify Polluted water
- Climate Change and Its Effects On Humans and Environment
- How Global Warming Affects Biodiversity and Ecosystems
- Using Electrocoagulation to Remove Heavy Metals from Water
- Impact of Permafrost Thawing on Greenhouse Gas Emissions

December 29, 2024
Topic chosen: Biodegradable plastic

Abstract

Plastic pollution is a huge issue, and things like straws and cutlery only make it worse. Regular plastic takes forever to break down, so it ends up just piling up in oceans and landfills. Biodegradable plastics are starting to get more attention because they break down way faster, and could help cut down on the waste. In this project, I look at how biodegradable plastics work, especially when it comes to straws and cutlery, and if they can actually help fix the problem. A big question I explore is whether they could even be used in the food industry, where there's so much disposable plastic being used. While biodegradable plastics aren't perfect, they could still help reduce plastic waste and make things more sustainable in the future.

December 31, 2024

Hypothesis

If biodegradable plastics are used to replace regular plastics in single-use items like straws and cutlery, they will reduce the amount of plastic waste in the environment. This is because biodegradable plastics break down much faster than traditional plastics, which may help decrease the time they spend polluting our oceans and landfills.

What is Plastic?

So what is plastic exactly? Plastics are a wide variety of synthetic and semisynthetic materials that are based on polymers. There plasticity allows plastics to be able to be pressed, extruded or molded, enabling them to be fashioned in a wide variety of shapes, sizes, and colors. This adaptability, along with the fact that (depending on the kind) they are lightweight, durable, flexible, non-toxic, and cheap to produce, makes them such a commonly spread material. Globally, we produce 380 million tons of plastic annually, and reports indicate that 50% of these plastics are single use plastics, meaning that they will only be used for only a few minutes before being thrown in the trash. From 1950 to 2017 9.3 billion metric tons of plastic have been produced and its estimated that more than half of that was produced after 2004, and it is estimated that annual global plastic production will reach over 1.3 billion tons by 2060, applications include packaging (40%) and building/construction (20%).

Types of Plastic

All in all there are thousands of different types of plastic but they can be organized into 7 categories, each one is different from the other and has its own properties and uses. In 1988, the Society of the Plastics Industry introduced the Resin Identification Code (RIC) system which divided plastic resins into 7 different categories. The purpose was to “provide a consistent national system to facilitate recycling of post-consumer plastics.", since then RIC has been recognized as the worldwide standard plastic classification. The types of plastic are:

- **PET: Polyethylene terephthalate** or PET is the most widely used plastic, it's used food and drink packaging purposes, mostly because it can keep oxygen from getting in and spoiling the good. These are also the most widely recycled plastic.

- **HDPE: High-Density Polyethylene** or HDPE is a extremely stretchy and resistant plastic, it's mostly used for plastic bags, milk cartons, recycling bins, agricultural pipe, but also playground equipment, lids, and shampoo bottles etc. Since its made of longer, unbranching polymer chains, it’s more thicker and much stronger than PET, it is also extremely heat resistant, able to withstand up to 120 °C. HDPE is also one of the most easily recycled polymer.

- **PVC: Polyvinyl chloride** or PVC is the third most common synthetic plastic polymer, there are two primary types of it: rigid and flexible. PVC is widely used in the construction and building industries in its rigid form to make drinking and wastewater pipes as well as door and windows frames. It can be used for flooring, electrical cable insulation,

plumbing, and wiring when combined with other materials to make it softer and more flexible.

- **LDPE:** Low-density molecules, which differentiates LDPE from HDPE, gives this resin a thinner and more flexible structure. It is simple and cheap to produce because it has the most straightforward structure of all the plastics. Utilized in many kinds of containers, dispensing bottles, plastic bags, six-pack rings, and most famously, plastic wraps, it is rarely recycled by curbside programs though.

- **PP: Polypropylene** or PP is the second most common commodity, and its market is expected to continue expanding over the next years. Found in yogurt containers, vehicle parts, thermal vests, tupperware, and even disposable diapers, it is strong and resilient to extreme temperatures.

- **PS:** The sixth kind of plastic on the list is **polystyrene**, which comes in solid or foamed forms. It is widely used in everything from beverage cups, insulation, packaging materials, egg cartons, and disposable dinnerware since it is a relatively cheap resin per unit weight and simple to make. Better known by its brand name, Styrofoam, it is extremely flammable and dangerous because it may release toxins when heated, which frequently occurs because it is used in take-out containers that consumers often microwave to reheat the food. PS. It is one of the worst kinds of plastic for the environment.

- **Other:** Plastics fall under this category if they don't fall under any of the others. Polycarbonates (PC), which are used to create solid, durable products, are the most well-known plastics in this category. In addition to being used in phones, polycarbonates are frequently used for eye protection in the production of lenses for sunglasses, sports, and safety goggles.
  The usage of these has been controversial recently since they leak bisphenol A, a substance listed as potentially dangerous to the environment, when heated to high temperatures. Additionally, because BPA does not break down in landfills, it will remain on the earth and eventually find its way into waterways, leading to water contamination. Also, category number seven is barely recycled.

Plastic Fabrication

Fossil fuels are taken out from deep down and transported to factories, where they are converted into smaller molecules called monomers, which is the first step in the production of plastic. The small building elements of plastic are called monomers, and they combine chemically to form long chains known as polymers. The strength, flexibility, and usefulness of plastic are attributed to these polymers.

Manufacturers add color pigments, stabilizers, or plasticizers to plastic to increase its variety; this is why some plastics are hard, while others, like plastic bags, are soft and stretchy. When the mixture is ready, it is heated, formed, and chilled to create items like packaging, bottles, and containers.

However, as I mentioned, plastic has a significant impact on the environment despite its affordability and convenience.

Defects to Normal Plastics

Why would we change to biodegradable plastics when we have perfectly functional plastics at our disposal? Why not just use these plastics and once we're done, why not just throw the waste in a giant landfill? Why waste time and energy into making biodegradable plastics?

Well in truth the carbon footprint of regular plastics is just not worth it.

Normal plastics can take anywhere from **20 to 500 years to decompose**, and even then they do not completely go back to the earth but just get smaller and smaller, leading to massive waste accumulation in landfills and the natural environment.

There are many cons to normal plastics some of which include:

- **Non-biodegradable:** Plastics do not completely decompose for hundreds of years and pollute earth's surface
- **Marine Pollution:** Plastics often ends up in the ocean, endangering the marine life that lives in it and disrupting the ecosystems that rely on the ocean, along with this marine pollution also poses a threat to human health and well-being
- **Production:** The production of these plastics produces tons of greenhouse gasses, in fact it's estimated that only the extraction of the fossil fuels used for these plastics and the transportation to get these fossil fuels to plastic factories emits a whopping **1.5 to 12.5 million metric tons of greenhouse gasses.**
- **Fossil fuel dependency:** Normal plastics are primarily produced by petroleum based products, which is a non-renewable resource, extracting it is energy intensive and like I said before, produces tons of greenhouse gasses which contribute to global warming.

- **Difficult to recycle:** Most types of plastics are difficult to recycle, or the recycling process is completely inefficient. Plastic quality often degrades too limiting its reuse potential.
- **Toxicity:** Normal Plastics often release toxic chemicals into the environment, such as Bisphenol A (BPA) and phthalates. These chemicals can get into the water supply, into the soil (disrupting plant life), and food, all of it causing major harm to humans, animals, and plants.
- **Microplastics:** As plastics break down, they fragment into tiny particles called microplastics, which have been found in water, food, and even the air. Microplastics can be tremendously harmful to all living organisms.
- **Harm to Wildlife:** Animals often mistake plastic for food, they can suffocate on it or get entangled in it, this can lead to extreme injuries or even death.

In total, plastic causes 4-8% of the total greenhouse gas emissions contributing to global warming, so if we could just limit our plastic production and usage we could cutdown on 4-8% of total gas emissions causing global warming, it may not sound much but its a major step forward. Along with this Plastics make up a significant portion of municipal solid waste (MSW) in landfills. In the United States, for example, plastics account for roughly **12-20%** of the total weight of landfill waste. However, plastic occupies a much higher proportion of landfill **volume** than weight because plastics are lightweight and take up more space compared to other materials like metals, glass, or organic waste. According to estimates, **8.3 billion metric tons** of plastic have been produced globally since plastic production began, with a large portion of it ending up in landfills or the environment.

January 3, 2024

Purpose

The purpose of this project is to find a reliable and sustainable substitute for normal plastics, one that is biodegradable, eco-friendly, and one that's production and disposing is not harmful to the environment. Specifically in the food industry, where we need toxic free, food grade alternatives.

Question

Can **biodegradable plastics** replace regular plastics, both in everyday use and in items like **straws and cutlery**, helping to reduce **environmental damage** while still keeping products **Food grade safe and functional**?

January 4, 2025

Reuse, Repurpose, Recycle

We've all heard about how we should reuse and recycle plastic, but in reality it's not as easy as it sounds. Even though these ideas are supposed to help reduce plastic waste, they're not solving the problem as well as we want them too.

Reusing plastic is practical for certain things, like using a container to store food or reusing a bottle for water. But not all plastics are durable enough to be reused multiple times. Over time, they crack, break, or wear out. For example, single-use plastics, like straws or thin bags, aren't designed to be reused at all. That means reusing plastic can only go so far before it ends up as trash.

Recycling plastic is where things get even more complicated. First, not all types of plastic can be recycled. Plastic items are often made of different types of resin, which need to be separated before recycling. This requires a lot of sorting, which is time-consuming and expensive. On top of that, even if a piece of plastic is recyclable, it doesn't mean it will actually get recycled. A lot of plastic is thrown in the wrong bin, contaminated with food or dirt, or just ends up in landfills anyway because recycling systems can't handle it all.

Even when plastic does get recycled, the process isn't perfect. Melting plastic down takes a lot of energy, and the heat can degrade the material, making it weaker. This is why recycled plastic often can't be turned back into the same product. For example, a recycled plastic bottle might be turned into something like a park bench or clothing fibers, but it can't easily go back to being a bottle. Plus, plastic can only be recycled a few times before it becomes completely unusable.

In the end, recycling might sound like a great idea, but it's really just delaying the problem instead of solving it. A huge amount of plastic still ends up in landfills or the ocean, even with all the recycling programs out there. It's clear that recycling alone isn't enough to fix the mess

we’ve made with plastic.

Repurposing, like turning plastic bottles into planters or making art out of old plastics, is another option. But let’s be honest, not everyone has the time, skills, or creativity to turn trash into treasure. Most people just throw things away because it’s easier.

The truth is, while reusing, repurposing, and recycling are helpful in small ways, they’re not enough to deal with the scale of the plastic problem.

January 6, 2024

Landfills and Ocean Pollution

Plastic waste is a major issue for our oceans and landfills. Although most people believe that plastic is something that just gets thrown away, the truth is that it doesn't truly "go away." It must find a home, and that home is frequently the ocean or landfills, where it may remain for hundreds of years.

Plastic makes up a significant amount of the garbage that currently fills landfills. Even worse, unlike other materials, plastic does not decompose in landfills. Rather than breaking down, it simply remains in place and gradually fragments into tiny fragments known as microplastics. These microscopic plastic fragments have the potential to contaminate the area surrounding the landfill by releasing harmful chemicals into the groundwater and soil.

Ocean pollution is an equally serious issue. Millions of tons of plastic waste end up in the ocean each year. A large portion of it originates from landfills, where plastic debris is either dumped or carried away by the wind, eventually finding its way to rivers and the ocean. Marine life, such as turtles that confuse plastic bags for jellyfish, can be strangled or suffocated by plastics in the water. Even the tiniest organisms, such as plankton, can confuse plastic fragments for food, and some species become entangled in plastic debris. The worst part is that plastic simply breaks down into ever-tinier fragments, which travel farther and do more damage. It never completely vanishes.

January 7, 2024

Toxins and Microplastics

Plastic isn’t just a problem because it doesn’t decompose; it also carries a bunch of harmful chemicals that can make us and the environment sick. As plastic breaks down, it releases toxins, which are chemicals that can damage our health. One of the worst parts of plastic pollution is how it turns into microplastics, tiny bits of plastic that are so small you can’t even see them with the naked eye. And these microplastics are everywhere.

Plastics often contain harmful chemicals like Bisphenol A (BPA) and phthalates. These chemicals can leach out of plastic into water, food, and the environment. When these chemicals

get into the soil or water, they can disrupt plant life, poison wildlife, and even end up in the food we eat, BPA, for example, has been linked which can mess with human development and health.

Microplastics are even more dangerous, as plastic breaks apart in the ocean or in landfills, it turns into smaller and smaller pieces. These microplastics end up floating about in the air, the water, and even in our food. Marine animals often mistake microplastics for food, and when they eat it, the plastic gets into their system. Humans can end up eating seafood that's contaminated with microplastics, and studies have found that microplastics are even showing up in our drinking water.

The worst part is that we don't fully know how harmful microplastics are to humans yet. But we do know they have the potential to cause health problems, especially since they carry toxic chemicals and can accumulate in our bodies over time.

In short, plastic doesn't just sit around being wasteful—it actively pollutes everything it touches. The toxins in plastic and the spread of microplastics are causing damage to the environment and putting our health at risk. Until we figure out how to reduce plastic production and clean up the mess, these hidden dangers will continue to affect us all.

January 8, 2024

A Deception in a Renowned Solution

Paper cups and straws are advertised as a better option for the environment compared to normal plastics, however, people do not realize that these products are not completely paper. Most of them are coated with a thin layer of plastic, like polyethylene, which prevents leaks but comes with its own set of problems.
When hot liquids are poured into the cups, the plastic layer can start to melt, this causes tiny plastic particles to break off and mix into your drink, even though you can't see them, these microplastics can still end up in your body with every sip.
Additionally, heat can cause the plastic to release harmful chemicals, such as BPA and phthalates, into the liquid, over time these substances may pose health risks.
What appears to be a harmless and environmentally friendly option is actually another form of plastic pollution, hidden behind false advertisement.
These products are marketed as eco-friendly, but the truth is they're just another contributor to the global plastic waste crisis. And worse, they directly harm our bodies, the last thing we need is microplastics and chemicals like BPA and phthalates can be detrimental to our bodies, it honestly seems like a good substitute for poison.

A Future Without a Solution

There is a serious problem with plastic pollution, and to be honest, it doesn't seem like things will improve anytime soon. Tons of plastic that we continue to discard simply accumulate. It simply remains in place rather than decomposing. Even though plastics are becoming smaller, they are still around. They simply transform into microplastics, which are now present everywhere—in our food, in the water, and even in the air.

Not only are landfills already overflowing, but they are also filled with plastic that will remain in place for hundreds of years. In addition, the ocean is essentially turning into a soup of plastic. Marine life is becoming entangled in plastic, or worse, consuming it, believing iIt's food. Additionally, even though we may not be aware of it, this plastic is entering our food supply. Fish and even the salt we use to season our food are exhibiting signs of it.

The future will be chaotic if we can't figure out a solution. Plastic will continue to accumulate in landfills, the ocean, and other places. We cannot ignore the issue, but we will only continue to exacerbate it in the absence of a practical solution. Who knows what kind of harm the plastic we use now will cause in the centuries to come?

January 9, 2024

Introduction to Biodegradable Plastics

Biodegradable plastics are a type of plastic that can break down naturally over time, unlike regular plastics that take hundreds of years to decompose. These plastics are made from renewable resources like plants, corn, or vegetable oils, making them more eco-friendly. Since they decompose faster, biodegradable plastics help reduce pollution and waste, especially in landfills and oceans.

Biodegradable plastics come in different forms, like polylactic acid (PLA), polyhydroxyalkanoates (PHA), and starch-based plastics. Each of these types has its own benefits and challenges. For example, PLA is commonly used for food packaging, while PHA is biodegradable in the ocean.

Biodegradable plastics are a great step forward, but there are quite a few challenges with implementing them; they are costly, some need to decompose in factories and can’t decompose in nature by themselves, they require the natural resources that make them biodegradable (which often requires water, soil, and other resources), and there production may cause just as much greenhouse gases as normal plastics

Introduction to Bioplastics

Unlike petroleum, a non-renewable fossil fuel, bioplastics are made from natural, renewable resources like plants. They offer a more environmentally friendly alternative to conventional plastics, which can be hazardous to the environment and take hundreds of years to break down. Bioplastics can reduce waste and pollution because they break down naturally over time. Furthermore, some bioplastics can be safely broken down in composting facilities because they are compostable.

Made from corn starch, sugarcane, or even algae, bioplastics can be utilized in a variety of products, including straws, cutlery, and packaging.Despite their potential to lessen plastic pollution, bioplastics have drawbacks, such as increased costs and the requirement for suitable Unlike petroleum, a non-renewable fossil fuel, bioplastics are made from natural, renewable resources like plants. They offer a more environmentally friendly alternative to conventional plastics, which can be hazardous to the environment and take hundreds of years to break down. Bioplastics can reduce waste and pollution because they break down naturally over time. Furthermore, some bioplastics can be safely broken down in composting facilities because they are compostable.

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Biodegradable Plastics VS. Bioplastics

Though they may sound alike biodegradable plastics and bioplastics are **not** the same in fact some bioplastics aren't even even biodegradable, here some key differences:

Features	Bioplastics	Biodegradable
Made of	Renewable Resources	Renewable Resources or petroleum-based
Decomposing	May or may not be decomposable	Definitely decomposable
Examples	PLA, PHA, Bio-PE	PLA, PHA, starch-based plastics
Environmental impact	Reduces fossil fuel use	Reduces plastic waste if properly

		managed
Usage	Packaging, medical products, textiles	Food containers, cutlery, bags

January 10, 2025

Creation of Biodegradable Plastics

Renewable resources like corn, sugarcane, or potatoes are used to make biodegradable plastics. These plants supply the sugars and starches that are used to make the plastic.

Using techniques like fermentation, the starches or sugars are first broken down into smaller components. Lactic acid and other molecules known as monomers are created as a result. The primary structure of the plastic is made up of long chains called polymers, which are formed by chemically joining the monomers.

For instance, corn starch is fermented to produce lactic acid, which is subsequently converted into plastic to create polylactic acid (PLA). Another kind, known as polyhydroxyalkanoates (PHA), is created by feeding specific bacteria plant oils or sugars, which naturally result in the production of plastic as a byproduct.

Following its formation, the plastic is transformed into pellets or sheets that can be used to make products like packaging, utensils, or bags. Additional materials might be mixed in to improve strength or flexibility, depending on how the plastic will be used.

Intrinsic Factors

Intrinsic factors are the factors that affect a plastics biodegradable internally, there are two categories we can sort this in; physical properties and chemical composition:

- **Physical properties:** These are a plastics physical traits, they affect how accessible it is to microorganisms, a plastics physical traits are;
    - **Shape:** The structure of the material can influence how microorganisms can attach to and interact with it. Example: film, pellet, fiber.
    - **Surface area:** The amount of surface area exposed to microorganisms significantly speeds up the degradation process because the microorganisms have more area to work with on the surface.
    - **Thickness:** Thicker materials are harder to break down because it takes more time for microorganisms to break them down and degrade them from the inside.
- **Chemical composition:** This is the chemical makeup of the plastic, though all biodegradable plastics are obviously biodegradable some resist more to degradation than others, here is a list of biodegradable plastics from least to most resistant:

    - **n-alkanes**: These are straight-chain hydrocarbons. They're pretty simple, so microorganisms can break them down easily.
    - **Branched alkanes**: These have branches on their chains, which makes it a bit harder for microorganisms to break them apart.
    - **Low molecular weight aromatics**: These are small, ring-shaped molecules. They're more complicated than alkanes but still easier to break down compared to others.
    - **Cyclic alkanes**: These are hydrocarbons with ring shapes. Microorganisms have a tougher time breaking these down.
    - **High molecular weight aromatics and polar polymers**: These are big, complex molecules or ones with charged parts. They're the hardest for microorganisms to degrade

Extrinsic Factors

Extrinsic Factors are the factors that are not of the plastic itself but of the environment, these get divided into two groups; abiotic (non-living) and biotic (living):

- **Abiotic Factors:**
    - **Temperature:** Warmer temperatures usually speed up the degradation process since they help the microorganisms grow and work faster.
    - **Concentration of water/salt:** The amount of water/salt matters because it can make it harder/easier for the microorganisms to work and survive depending on how much.
    - **Photo-degradation:** This happens when sunlight (UV rays) breaks down the material, making it easier for microorganisms to biodegrade it.
    - **Hydrolysis:** This is when water reacts with the material and breaks it into smaller pieces, which microorganisms can then degrade more easily.
- **Biotic Factors:**
    - **Presence of proper microorganisms:** Biodegradation can only happen if the right types of microorganisms, like certain bacteria or fungi, are around to break down the material, without them, the material won't decompose properly.

January 12, 2024

The Drawback to Some Biodegradable Plastics

Biodegradable plastics are designed to decompose and return to nature. The fact that many biodegradable plastics cannot simply break down on their own, however, may surprise some people. To properly decompose, they require specific circumstances.

Industrial composting facilities are required to treat a large number of biodegradable plastics. To aid in the plastic's breakdown, these locations regulate the temperature, moisture content, and other elements. Biodegradable plastics may persist in the same way as conventional plastics in the absence of these circumstances. For instance, polylactic acid (PLA) requires extremely high heat to decompose, so it typically doesn't break down in a landfill or a backyard compost pile.

This indicates that although these plastics are designed to be environmentally friendly, proper disposal methods are necessary to work. If they end up in regular trash or the environment, they

might not break down as planned and could still add to pollution, but the upside is that they will still take less time to decompose compared to normal plastics

Types of Biodegradable Bioplastics

Polylactic Acid (PLA)

What It Is: PLA is made from plant-based materials, like corn starch or sugarcane. It is one of the most common biodegradable plastics.

Uses: PLA is often used for things like food containers, disposable cutlery, and drink cups.

How It Breaks Down: PLA breaks down in industrial composting facilities, where it can turn into water, carbon dioxide, and organic matter. However, it may not break down as well in natural environments like landfills or oceans.

Limitations: PLA is not heat-resistant, so it can't be used for hot foods or drinks.
Cost: $2.80 per kilogram
Decomposition (optimal conditions): 1-3 months

Polyhydroxyalkanoates (PHA)

What It Is: PHA is a biodegradable plastic produced by bacteria using plant sugars and oils. It's one of the most environmentally friendly bioplastics because it decomposes easily in both industrial composting and natural environments, including the ocean.

Uses: PHA can be used for packaging, medical products, and agricultural films.

How It Breaks Down: PHA breaks down easily in nature, even in marine environments, making it ideal for items like biodegradable plastic bags.

Limitations: PHA is more expensive to make compared to other bioplastics, which makes it less common.

Cost: $3.00-$5.00 per kilogram
Decomposition (optimal conditions): 1-3 months

January 13, 2024

Starch-Based Plastics

What It Is: These plastics are made from natural starch, often derived from corn or potatoes. They are biodegradable and compostable.

Uses: Starch-based plastics are commonly used for food packaging, disposable containers, and agricultural films.

How It Breaks Down: These plastics break down in composting environments, turning into natural materials like carbon dioxide and water.

Limitations: Starch-based plastics aren't as strong as other bioplastics and can get damaged when exposed to moisture.

Cost: $2.50 per kilogram

Decomposition (optimal conditions): 3-6 months

Polybutylene Succinate (PBS)

What It Is: PBS is a biodegradable plastic made from renewable plant sources. It is similar to regular plastic but breaks down more easily.

Uses: PBS is used in products like packaging, disposable cutlery, and agricultural films.

How It Breaks Down: PBS is compostable and breaks down in industrial composting environments.

Limitations: PBS is not as widely used as other biodegradable plastics, and it's more expensive to produce.

Cost: $4.50 per kilogram

Decomposition (optimal conditions): 6-12 months

Polycaprolactone (PCL)

What It Is: PCL is a biodegradable plastic made from petrochemical sources, but it can still break down by microorganisms in the environment.

Uses: PCL is used in medical applications, such as drug delivery and tissue engineering, as well as in biodegradable packaging.

How It Breaks Down: PCL breaks down slowly in both composting and natural environments.

Limitations: PCL is more expensive than other biodegradable plastics and isn't used as widely.

Cost: $7.00 per kilogram

Decomposition (optimal conditions): 1-2 years

Cellulose-Based Plastics

What It Is: These plastics are made from wood pulp or cotton fibers. They are a natural and biodegradable material.

Uses: Cellulose-based plastics are used in packaging, coatings, and medical devices.

How It Breaks Down: Cellulose-based plastics break down in the environment and return to organic matter.

Limitations: The process of making cellulose plastics can be more complicated, and they may not be as durable as other types of plastics.

Cost: $4.00 per kilogram

Decomposition (optimal conditions): 6 months to 1 year

Mater-Bi

What It Is: Mater-Bi is a type of compostable plastic made from renewable sources like starches, vegetable oils, and other biodegradable materials.

Uses: It is commonly used in food packaging, bags, and agricultural films.

How It Breaks Down: Mater-Bi decomposes in industrial composting facilities, where it turns into organic materials like carbon dioxide, water, and biomass.

Limitations: Mater-Bi needs specific conditions to break down and isn't suitable for all environments.

Cost: $5.00 per kilogram

Decomposition (optimal conditions): 3-6 months

Algae-Based Plastics

What It Is: Algae-based plastics are made from algae, which is a fast-growing, renewable resource. These plastics are biodegradable and eco-friendly.

Uses: Algae-based plastics can be used for packaging, food containers, and biodegradable straws.

How It Breaks Down: Algae-based plastics break down naturally in the environment, including in oceans, helping to reduce ocean pollution.

Limitations: The production process is still in development and can be expensive.

Cost: $6.00 per kilogram

Decomposition (optimal conditions): 6 months to 1 year

Protein-Based Bioplastics

What It Is: Protein-based plastics are made from proteins like casein (milk proteins) or soy. They are biodegradable and can be used in many products.

Uses: Protein-based plastics are used for packaging, coatings, and medical applications.

How It Breaks Down: These plastics break down into natural materials like amino acids when exposed to microorganisms.

Limitations: Protein-based plastics are not as durable as other bioplastics and require more research for larger-scale production.

Cost: $5.50 per kilogram

Decomposition (optimal conditions): 3-6 months

Polyhydroxybutyrate (PHB)

What It Is: PHB is a bioplastic produced by bacteria from plant sugars and renewable resources. It is biodegradable and similar to traditional plastics in many ways.

Uses: PHB is used for packaging, medical products, and agricultural applications.

How It Breaks Down: PHB breaks down naturally in the environment when exposed to microorganisms.

Limitations: The production cost is high, which makes PHB less common and harder to produce.

Cost: $8.00 per kilogram

Decomposition (optimal conditions): 6 months to 1 year

January 15, 2025

Types of Non-Biodegradable Bioplastics

Polytrimethylene Terephthalate (PTT)

What It Is: PTT is a bio-based plastic made from renewable resources like corn or sugarcane. It is used in various applications and is biodegradable.

Uses: PTT is used in textiles, clothing, and some types of packaging.

How It Breaks Down: PTT is biodegradable and breaks down through natural microbial activity in composting environments.

Limitations: PTT is still being developed and is not as widely available or used as other bioplastics like PLA or PHA.

Cost: $4.00 per kilogram

Decomposition (optimal conditions): 1-2 years

Polyethylene Furanoate (PEF)

What It Is: PEF is a plant-based alternative to polyethylene made from renewable resources like plant sugars.

Uses: PEF is mainly used for food packaging, beverage containers, and bottles.

How It Breaks Down: PEF is biodegradable and breaks down naturally in composting environments.

Limitations: PEF is still being developed and is not yet as widely available or cost-effective as other bioplastics.

Cost: $6.00 per kilogram

Decomposition (optimal conditions): 1-2 years

Bio-Based Polycarbonate (Bio-PC)

What It Is: Bio-based polycarbonate (Bio-PC) is a form of plastic made from renewable plant-based sources like sugar.

Uses: Bio-PC is used for products like electronics, eyewear lenses, and bottles.

How It Breaks Down: Bio-PC is not biodegradable but is made from renewable resources, which makes it more environmentally friendly than traditional polycarbonate.

Limitations: Bio-PC is not biodegradable, and recycling options for Bio-PC are limited.

Cost: $9.00 per kilogram

Decomposition (optimal conditions): Not biodegradable

Bio-Based Polyethylene (Bio-PE)

What It Is: Plastic made from renewable sources like sugarcane, but chemically the same as regular polyethylene.

Uses: Packaging, plastic bottles, and bags.

Breakdown: **Not biodegradable**

Limitations: Non-biodegradable

Cost: $3.00 per kilogram

Decomposition (optimal conditions): Not biodegradable

Bio-Based Polypropylene (Bio-PP)

What It Is: Plastic made from plant-based materials like sugarcane or corn, identical to regular polypropylene.

Uses: Packaging, textiles, automotive parts.

Breakdown: **Not biodegradable**

Limitations: Can contribute to plastic waste if not recycled.

Cost: $3.50 per kilogram

Decomposition (optimal conditions): Not biodegradable

Analysis

Normal plastics pollute our lands and oceans, and do not decompose for centuries, even then they do not fully decompose but get smaller and smaller, turning into microplastics that litter the oceans, and what we consume. This is the reason biodegradable plastics are such a big thing, they give us a potential solution by breaking down so much faster and reducing long-term waste buildup.

Some biodegradable plastics, like **PLA (Polylactic Acid)**, can decompose in less than six months under the right conditions. Compared to the normal plastics that use, that last for longer than you and I will, this is a major improvement.

If waste is taken care of more quickly there is less build up in landfills and oceans, which already betters the situation by so much.

One of the biggest advantages of biodegradable plastics is the fact that they come from renewable sources like corn, sugarcane, and algae. On the other hand regular plastics are made from fossil-fuels, non renewable resources that take millions of years to form and release massive amounts of greenhouse gasses into our atmosphere, when extracted. Using renewable sources instead of non-renewable ones greatly cuts down on emissions and reduces our dependence on oil.

15-03-25

Biodegradable plastics also cause less harm to the environment by means of wildlife. Many animals often mistake plastic for food, and end up choking or getting poisoned by them. Since biodegradable plastics break down much faster they’re less likely to cause long-term harm. Though this isn't the perfect solution for this problem because a lot of biodegradable plastics still need specific conditions to decompose properly, like high heat and moisture in industrial

composting facilities. If they end up in regular trash or in the environment they may take way longer than expected to decompose.

For example, **PLA (Polylactic Acid)** sounds like a great alternative but it has some huge downsides, for one they need industrial composting to decompose properly, this means that if they are thrown in the regular trash or thrown in the environment, they will not decompose, for say six months, as they're advertised. That is why better waste management systems are needed to be implemented if we are to go through with the intent of replacing traditional plastics.

So, when it comes to picking the best biodegradable plastic for straws and cutlery, there are a few key things to consider:

Environmental impact (How well does it break down?)

Food safety (Is it safe to use with food and drinks?)

Durability (Will it hold up when eating or drinking?)

Here's how the main options compare:

PHA (Polyhydroxyalkanoates) is probably the best overall. It's heat-resistant, food-safe, and naturally biodegradable—even in the ocean. The downside? It's expensive, which makes it harder to produce on a large scale.

PLA is a good choice for cold drinks and food, but it softens with heat and won't break down unless it's sent to an industrial composting facility.

Starch-based plastics are cheap and compostable, but they aren't very strong. That makes them fine for cutlery, but not great for straws, which need more durability.

So the best option would be, if not for the cost, **PHA (Polyhydroxyalkanoates)**. It's the most durable and breaks down naturally, on land and in water, but because of its high price, PLA and Starch-based plastics are more commonly used, even though they have more limitations in comparison to PHA. If production costs drop in the future, PHA could replace plastics completely.

Until then, switching to any biodegradable plastic would better the scene significantly, as long as we dispose of them properly.

16-03-25

Starch-based plastics are another biodegradable option for products like cutlery. These are made from modified starch, often mixed with other biodegradable materials to improve strength and durability. Starch-based plastics can work well for single-use items like cutlery because they're cheap and can break down quickly in composting systems. However, they are generally not as strong or flexible as PLA or PHA, so they might not be the best choice for straws,

especially if they need to hold up against bending or breaking while drinking.

Which is the best? If we're talking about balancing environmental impact, food safety, and functionality, **PHA** seems to be the top contender for both straws and cutlery. It's more heat-resistant, breaks down more easily in natural environments, and is still food-grade safe. However, PLA can be a good option for cold drinks and foods, as long as you keep in mind that it's not as durable with heat. Starch-based plastics are best for cutlery that's used with cold foods but might not hold up well for straws.

18-02-25

Conclusion

Biodegradable plastics are one of the best ways to cope with plastic pollution, for instance, these plastics decompose much faster and are less harmful to the environment than the conventional plastics that take hundreds of years to do that and leave behind dangerous microplastics. They are more sustainable since they are derived from renewable resources like plants rather than fossil fuels, they help to reduce greenhouse gas emissions.

However, they are not perfect, they may not degrade as they should if they ever find themselves in the environment or standard trash since they require specific conditions like composting facilities to do so. Even with that being said they still show a marked improvement. Biodegradable plastics can be used to make the earth better, save marine creatures, and decrease the output of garbage to the landfills. There is a possibility that biodegradable plastics will play a significant part in the solution to plastic pollution as their recycling abilities and proper disposal methods enhance.

And to answer my question **PHA** is likely the best biodegradable plastic for straws and cutlery if you're looking for a material that combines environmental benefits, food safety, and durability. It's a little more expensive but could be a game-changer in reducing plastic waste.

20-03-25

Real-Life Application

Canada has been working on reducing plastic waste, and one of the big steps was banning certain single-use plastics. The government started rolling out this ban in 2022, targeting things like plastic bags, straws, stir sticks, and cutlery. The idea was to cut down on the amount of plastic ending up in landfills and oceans, but switching to alternatives hasn't been easy. Businesses have had to find replacements, and consumers have had to adjust to new materials, some of which are more expensive.

One option to replace single-use plastic is PLA (polylactic acid) plastic, which is biodegradable under the right conditions. Right now, only a small percentage of our plastic cutlery is

biodegradable. Most of what we still use is made from regular plastic, which doesn't break down naturally. If we fully switched to PLA, we could make a big difference in reducing plastic waste. However, there are challenges.

One of the biggest issues is cost. PLA is more expensive to produce than regular plastic because it's made from natural sources like cornstarch. This means businesses have to pay more, which can lead to higher prices for consumers. On top of that, even though PLA is biodegradable, it doesn't break down easily in normal conditions. It needs industrial composting facilities, and not every city has those. If PLA ends up in regular landfills, it doesn't break down much faster than normal plastic.

Another issue is supply. Right now, most PLA is imported, and if we want to rely on it more, we would need to invest in producing it locally. That would take time and money. However, if Canada did invest in local PLA production and made composting facilities more common, we could reduce a huge amount of plastic waste.

If more businesses started using PLA instead of regular plastic, and if cities improved composting systems, we could increase the percentage of biodegradable cutlery used in Canada. This would help reduce plastic pollution, especially in places where single-use plastics are a big problem. It's not a perfect solution, but with the right changes, it could make a huge difference in improving our plastic waste situation.

Canada's Plastic Ban and the Challenge of Switching to Biodegradable Alternatives

One of Canada's most significant efforts to reduce plastic waste was the prohibition of specific single-use plastics. In an effort to lessen the quantity of plastic that ends up in landfills and the ocean, this initiative began in 2022 and focused on items like plastic bags, straws, stir sticks, and cutlery. However, it hasn't been easy to replace these plastics in practice. People have had to adapt to new materials, some of which are more expensive and not always as convenient, and businesses have had difficulty finding suitable substitutes.

Polylactic acid, or PLA, plastic is one of the primary substitutes. Made from natural materials like cornstarch or sugarcane, PLA is biodegradable in the right circumstances. However, only a small portion of Canada's plastic cutlery is currently biodegradable. The majority of what's still being used is regular plastic, which sticks around for hundreds of years because it doesn't break down naturally. If Canada fully switched to PLA, we could drastically cut down on plastic waste. But the problem is—it's not that simple.

The Biggest Challenge? Cost.

ecause PLA is made from plant-based materials, its production costs are significantly higher than those of conventional plastic. PLA currently costs around $2.80 per kilogram, whereas conventional plastic costs about $1.50 per kilogram. Even though it might not seem like much, it quickly adds up when companies purchase large quantities of plastic goods. Businesses will raise prices for consumers to offset the cost if they must pay more for biodegradable substitutes.

The fact that PLA doesn't decompose randomly is another issue. In order to properly decompose, it must be sent to industrial composting facilities, where it is heated to high temperatures. The problem? Not all Canadian cities have these amenities. If PLA cups or cutlery wind up in a landfill instead of a composting facility, they won't break down much faster than regular plastic. So even though PLA sounds like a great eco-friendly option, if Canada doesn't improve its composting systems, switching to PLA won't fix the problem.

Supply Problems—We Don't Make Enough PLA in Canada

We import the majority of the PLA we use from other nations. Therefore, we would need to start producing more biodegradable plastics here if we wanted to use them more. However, that costs money and time. To produce PLA on a large scale, the government and private businesses would have to invest in new factories, which is not inexpensive.

Composting facilities would need to be extended throughout Canada at the same time. Currently, food waste—rather than biodegradable plastics—is the primary focus of the majority of industrial composting facilities. There could be a significant impact if the government encouraged businesses to switch to PLA and pushed for more composting facilities.

What Would a Full Switch to PLA Look Like?

If Canada fully committed to using PLA instead of regular plastic:

- Businesses would have to pay more for materials, which could lead to higher prices for consumers.
- Industrial composting facilities would need to expand so PLA can actually break down properly.
- Local PLA production would need to grow, so we don't rely on importing it from other countries.
- More awareness would be needed so people know how to properly dispose of biodegradable plastics.

Would It Actually Reduce Plastic Waste?

Yes, if done correctly. We could reduce the quantity of plastic waste that ends up in landfills if companies made the complete transition to PLA and if Canada made improvements to its composting systems. Although it wouldn't be a perfect solution, it would be a significant step in Canada's efforts to reduce plastic pollution.

Although Canada is currently making strides, biodegradable plastics won't completely replace conventional ones for some time. Investing in improved waste management systems and lowering the cost and increasing the availability of biodegradable plastics are crucial. Alternatives to single-use plastic will remain difficult to find until then.

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