



Minor Challenge Set #2

STEM Field: Chemical Engineering

Level: Junior

Challenge Name: Casein Plastic from Milk

Project cost: 0-20 USD

Materials required:

- Whole milk
- White vinegar
- 2-cup glass measuring cup
- A teaspoon
- Spoon for stirring
- Microwave
- Pot holder
- Paper towels
- Fine mesh strainer

Safety:

- Adult supervision is advised when handling the heated milk

Duration:

- The hands-on time for this challenge is about 30 minutes to 1 hour.
- Your plastic will take several days to dry.
- The time guideline is an estimation only, and students and mentors can complete the tasks around their schedules.

Introduction:

Polymers are long chains of molecules (or monomers) that are bonded together. When these longer chains are mixed together they become tangled. If the molecules are unable to become detangled a solid will form. This is what plastics are!

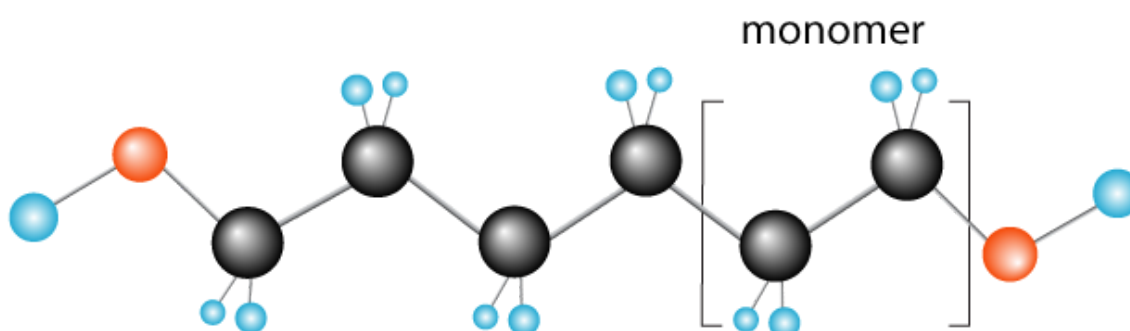


Figure 1: An illustration of how a polymer is made up of many repeating monomer units.

There are many examples of polymers in our world, some are natural and some are made by humans. In this experiment you will extract polymers from milk! How? When you mix the vinegar and milk together the milk will separate into two substances. The first is a liquid called “whey”, the second is a solid called a “curd”. The curd is the fat and casein which form polymers.

When we allow these polymer chains to dry out we get a plastic called casein plastic. In the early 1900’s, casein plastic was used to make items like buttons or plastic jewellery.

Instructions:

1. Stack 5 sheets of paper towel on top of each other.
2. Measure out 1 cup of milk.
3. Microwave the cup of milk for 1 minute. The milk should be hot but not yet boiling. Ask an adult to help with this.
4. This can be a bit smelly: Add 4 teaspoons of vinegar to the milk and stir it gently. This should result in solid white pieces floating in the milk. If this isn't the case try adding more vinegar.
5. Using a spoon, scoop out as much of the floating white solids as possible and place it on the paper towel stack from step 1.
6. Pour what is left of the milk through a fine mesh strainer and add the solids collected to the pile on the paper towel.
7. Gently pat the solids dry. Use more paper towels as needed to soak up as much liquid as possible.
8. Gather as much of the fairly dry solids as possible and knead them into a smooth ball.
9. Now you have your raw plastic! You can mould it into a fun shape. One option is to roll it flat and cut out a shape with a cookie cutter. Another is to mould it with your fingers.
10. Set your plastic on a sheet of wax paper and leave it to dry. It may take a few days for it to become hard.

Note: It is possible for the shape to warp or even crack as it dries. Please don't expect the shapes to look exactly the same once hardened.

Extension

1. What happens if you add dye to the milk?
2. Can you speed up the drying process by using your oven at a low temperature? How does this affect the change in the moulded plastic's shape?

Reflection Questions:

- Are there any improvements you would make to this challenge?
- What real world application/s can you apply this challenge to?
- What other plastics are made out of natural materials?
- What are some benefits of plastics? And what are some disadvantages of plastics? Do these disadvantages change if the plastic is made out of renewable materials?

Submission Guidelines:

- Submit photos of your experiment setup. Include a short summary that addresses the reflection questions.

Note: Remember, if you want to upload pictures of your Minor Challenge that also include you, please check if it is OK with your mentor first.

- The submission form is on the Minor Challenges page:
<https://sciencechallenge.org.au/index.php/minor-challenges/>
Fill out the details and make sure you upload your submission.

Learn More! Resources:

- To learn more about how a casein plastic check out the link below:
<https://www.scientificamerican.com/article/bring-science-home-milk-plastic/>

Bibliography:

- Figure 1: Amy.dobos (2019) *Polymers: From DNA to Rubber Ducks, Curious*. Available at: <https://www.science.org.au/curious/everything-else/polymers> (Accessed: April 5, 2023).
- *Casein plastic from milk* (2021) *Home Science Tools Resource Center*. Available at: <https://learning-center.homesciencetools.com/article/casein-plastic-project/> (Accessed: April 5, 2023).