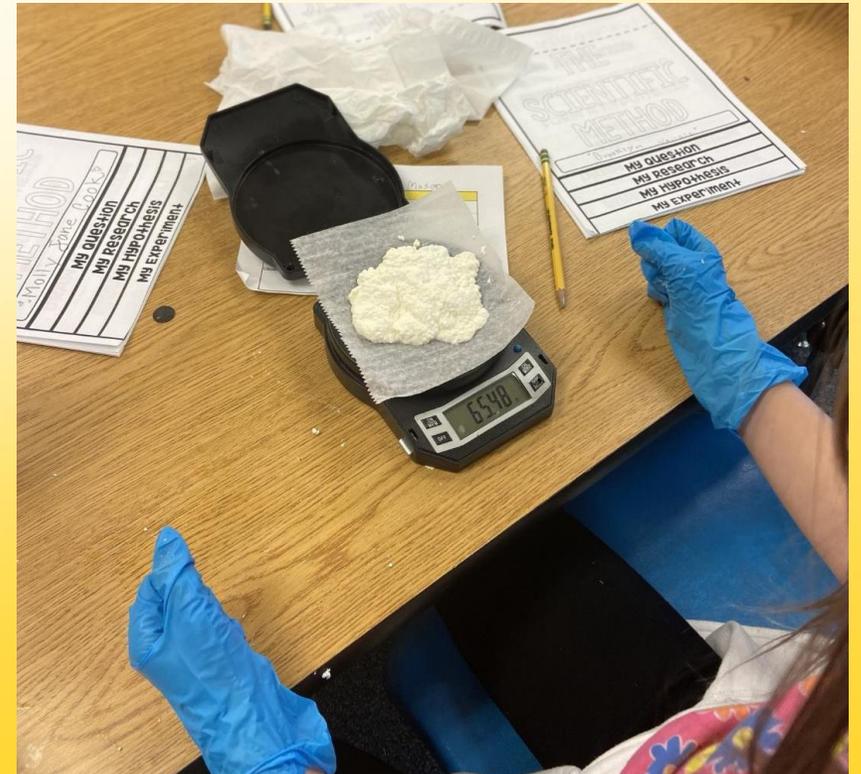


Making Casein Plastic From Milk



Background

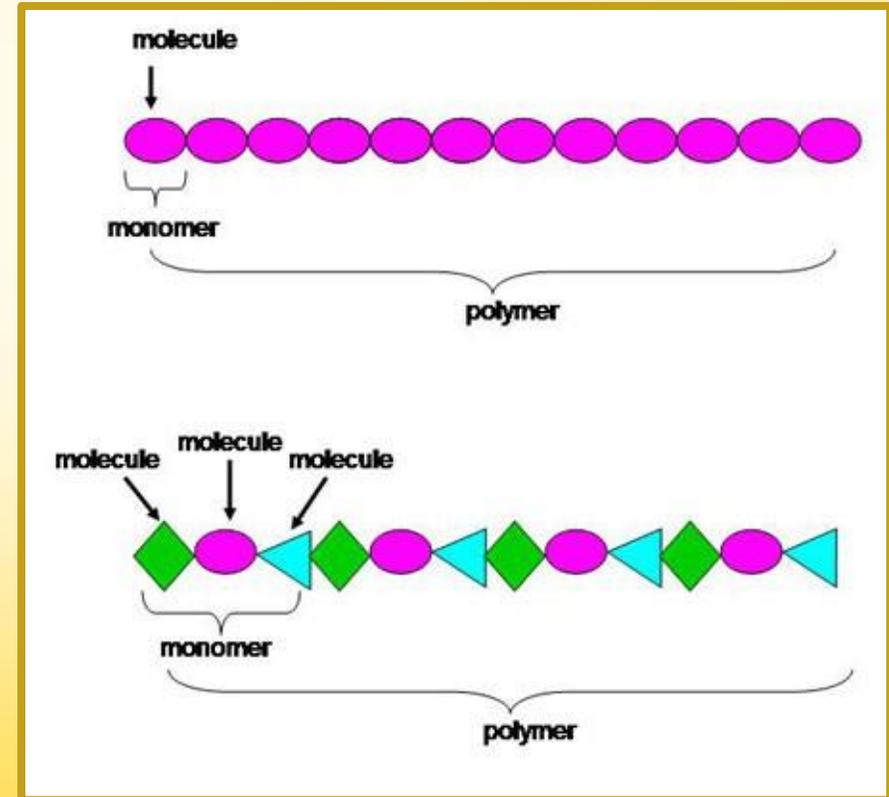
- Milk Contains a protein called casein which is the same protein used to make cheese.
- The casein protein can be separated from milk by heating the milk and adding an acid (in our case vinegar).
- The result is curds or plastic, known as **casein plastic** and was used to manufacture buttons, decorative buckles, beads, and other jewelry, as well as fountain pens and hand-held mirrors and fancy comb-and-brush sets.



These decorative belt buckles were all manufactured from casein plastic in the 1930s and '40s. (Photograph courtesy of [Galessa's Plastics Photostream](#), 2007)

Research

- There are many forms of plastic material that look and feel different.
- The differences are from the molecules that are repeated over and over again in a chain.
- The chain of molecules that repeats is called a polymer.
- All plastics are polymers.
- Polymers can be one type of molecule that repeats or a chain of different molecules that repeats. (see picture to the right)
- Milk contains many molecules of a protein called **casein**. When you heat milk and add an **acid** (in our case vinegar), the casein molecules unfold and reorganize into a long chain.
- Each casein molecule is a monomer and the polymer you make is made up of many of those casein monomers hooked together in a repeating pattern like the picture (all pink) example.
- The polymer can be scooped up and molded, which is why it is a plastic.



The top image shows a polymer where the monomers are just one type of molecule. The bottom image shows a polymer where the monomers are made up of three different molecules. In both polymers, the monomers link in a repeating pattern.

Question

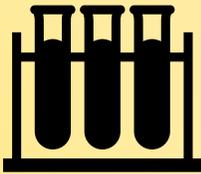
- What is the best amount of vinegar to yield the most casein from 250ml of milk?



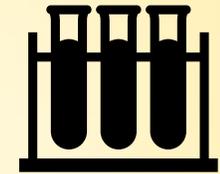
Hypothesis

- I think more ml of vinegar will yield the most casein from 250ml of milk.





Variables and Control



Independent Variables

- Amount of vinegar used per 250ml of milk.

Dependent Variables

- Amount of casein yielded in grams.

Control

- Amount of milk used
- Same size glass jar
- Temperature of milk (greater than 120 degrees Fahrenheit)
- Strainer used
- Gram scale used

Materials

- Whole milk 1.5 gallons
- Vinegar 1 gallon
- Glass measuring cups
- Thermometer
- Potholders
- Spoons for stirring
- Cheese cloth
- Wax paper
- Masking tape
- Pen or permanent marker
- Microwave
- Graduated cylinders
- Scale to measure grams
- Data collection sheet
- pencil
- Gloves
- Mask
- An adult to help
- Rubber bands
- Clear plastic drinking cups

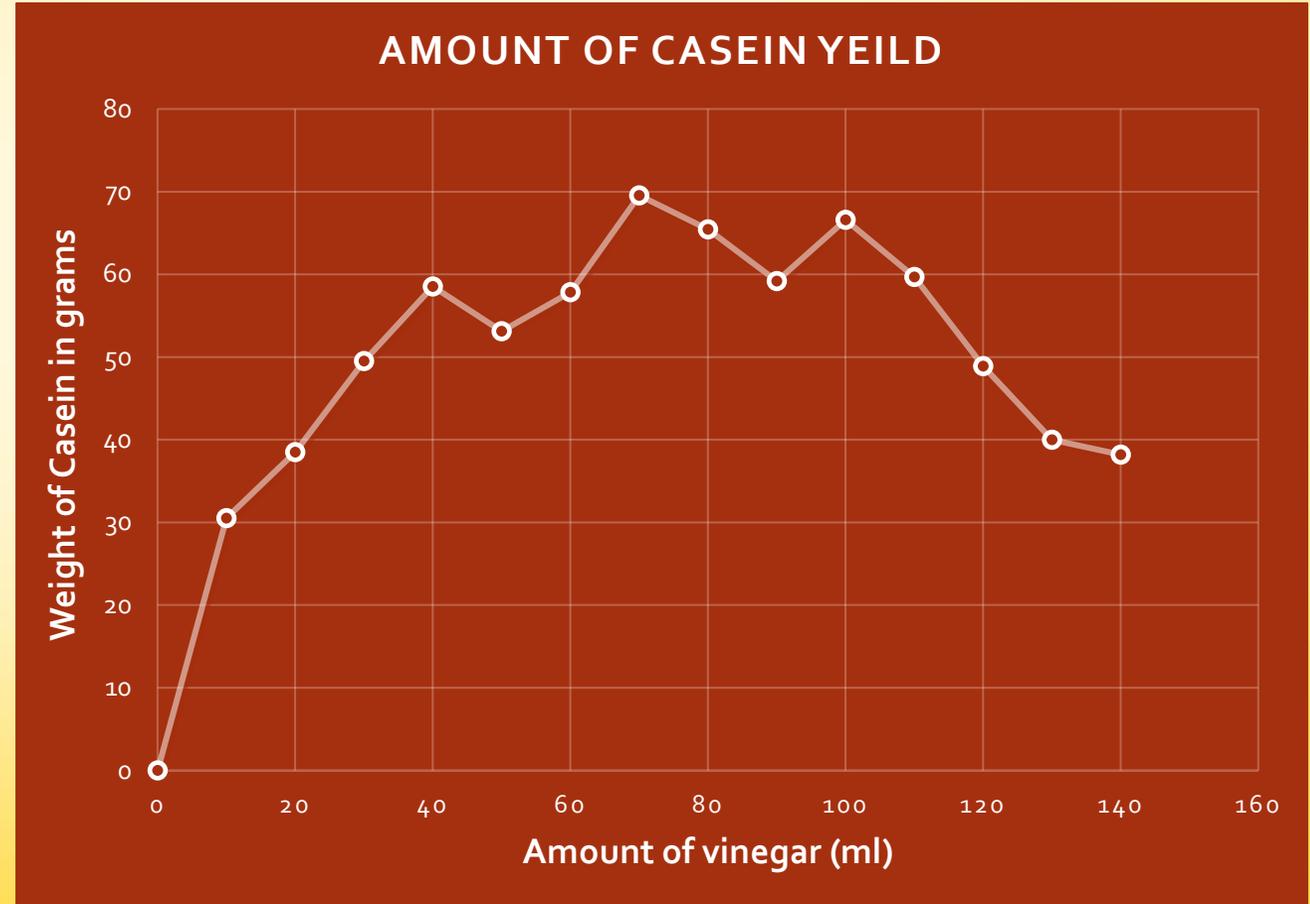
Procedure



1. Collect all materials from the list
2. Measure and pour 250ml of milk into glass cup and heat to 120°F or hotter using the thermometer
3. Add your vinegar amount to the heated milk and stir for 30 seconds then wait 3 minutes.
4. Document any observations while waiting. (are there curds forming, describe the liquid)
5. Drape cheesecloth over a clear plastic cup and secure with a rubber band
6. Pour the milk/vinegar mixture SLOWLY into the cheesecloth to strain.
7. Use the spoon to move around to get the liquid out.
8. Using your spoon scoop out the casein collected from the cheesecloth onto a piece of wax paper
9. Weigh the amount of casein you collected and document
10. Mold the casein into a shape and set aside to dry
11. Repeat steps 3-7 for each different amount of vinegar
12. Review your findings

Data

Vinegar to Grams	
Amount of vinegar (ml)	Weight (Grams)
0	0
10	30.5
20	38.5
30	49.53
40	58.53
50	53.11
60	57.85
70	69.56
80	65.46
90	59.169
100	66.58
110	59.7
120	48.9
130	40
140	38.2



Analysis

- 70ml of vinegar had the highest yield of casein
- As the amount of vinegar increased to 70ml so did the amount of casein in grams. After 70ml of vinegar the amount of casein started to decrease.
- The graph of the data the class collected follows an upside-down U-shape.
- Some teams spilled some of their milk and vinegar mixture leading to some differences in data. This can be seen in the 50ml, 60ml, 90ml groups.
- Some casein was observed to have more of a sticky texture which led to more of it remaining in the cheesecloth.
- When no vinegar was added the milk did not yield any casein as observed in our control.

Conclusion

- The most casein was a yield of 69.56 grams with the amount of vinegar at 70ml per 250ml of milk.
- Our hypothesis of using more ml of vinegar to yield the most casein from 250ml of milk was not supported.
- Any vinegar past 70ml decreased in the amount of casein.



Future Ideas



- We would like to see if changing the acid used instead of vinegar would change the amount of casein. Ideas to use are lemon juice, soda, orange juice, and pineapple juice.
- Would different types of milk, such as almond milk, soy milk, goat milk, skim milk, 1%, 2% also produce casein?
- Would the temperature that the milk is heated to past 120°F yield more or less casein?

References

Buddies, S. (2020, November 20). *Turn Milk into Plastic! | Science Project*. Science Buddies. https://www.sciencebuddies.org/science-fair-projects/project-ideas/Chem_p101/chemistry/turn-milk-into-plastic

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