



Credit for this lab goes to Ms. Fazio, NY Learns

Purpose:

The purpose of this experiment is to demonstrate the effect of pH and temperature on the structure of proteins. This lab will also introduce the concept of denaturing proteins.

Background:

Most people think of milk as a liquid. Yes, it is a liquid, but milk is really a mixture of fat and protein molecules in a watery solution.

As we discussed in class, proteins are large organic molecules that are built as chain (or polymer) of amino acids. The behavior and function of the protein is caused by the specific amino acids that are linked together in the chain. These amino acids react with each other and cause the protein chain to twist and fold up into large 3-D shape, forming a globular protein.

The "R" groups (or side groups) of each amino acid can either be hydrophobic (water-fearing) or hydrophilic (water-loving). When a section of the protein is made of hydrophobic amino acids, it will cause that part of the protein to try to stay away from water. When a section of the protein is made of hydrophilic amino acids, it will cause that part of the protein to try to stay in water.

The protein molecules in milk, called caseins, are very hydrophobic. They try to get away from the watery liquid of the milk, so they fold in on themselves a lot to hide from the water. This folding makes the milk protein molecules into globules in the milk. You can't see them because even though they are large molecules, they are still too small to see with the human eye.

Because pH (the acidity of a liquid) and high temperature both disrupt chemical bonds, they can affect how a molecule forms or how it behaves. This is especially true for proteins, since how they are shaped directly controls how they function. When a protein loses its 3-D shape and unravels back into a long chain, it is called "denaturing".

SAY CHEESE!!!

In this experiment we are investigating the effect of pH on protein structure.

Vinegar is a mild acid. It has a lower pH than water. An acid affects how the milk protein molecules hold together. When you add a mild acid to milk, the hydrogen atoms (H⁺) floating in the acid try to bond with parts of the amino acids in the milk protein globules. They break some of the internal bonds that hold the milk protein in a 3-D shape and force the protein to unravel back into a long chain.

All these long protein chains in the milk start to twist around each other trying to get away from the watery part of the milk, like lots of loose string getting all tangled up. All the proteins clump up and coagulate. You see this as milk curds, or cheese curds like in cottage cheese. We will now investigate this by making our own cheese. You see cooking is all about chemistry too!



Materials:

- 400-500 ml of whole milk
- 500 ml beaker
- 25-30 ml of vinegar (or lemon juice)
- hot plate
- stirring rod
- pH paper (Hydrion paper)
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Preliminary: Use the Hydrion paper to test and record the pH of milk & vinegar

Procedure:

1. milk in the beaker and warm on hot plate to approximately 37°C. 37°C is roughly body temperature, so the milk should be just warm to the touch.
2. Add vinegar (or lemon juice) while stirring. Coagulation, or curdling, occurs quickly.
3. Drain excess liquid. This is the whey.
You may let the curds sit in the filter (or cheese cloth) until well-drained, for a drier cheese.
4. Make observations.

Smell your cheese! You may want to add to salt for extra flavor.

Hint: If the mixture does not coagulate quickly, add more vinegar or lemon juice. Heating the mixture further may help as well.

Observations:

Questions (answer in complete sentences on separate paper):

1. What is the “building block” of a protein?
2. How are there so many proteins when there are only 20 “building blocks” to work with?
3. How can proteins become “denatured”?
4. What effect does pH and temperature have on proteins?
5. How does the addition of hydrogen atoms (H+) affect the milk protein molecules?
6. What happens in coagulation?
7. How did your cheese smell?



