Food Uses of Denatured Proteins

Proteins are made of long connected chains of amino acids. Different types of amino acids have different properties. Some are acidic, some are basic, some are hydrophobic etc. In the aqueous environment of the cell, the interactions between these different amino acids with water causes the protein chain to fold up into specific shapes. A protein's shape is very important, as it determines the behavior and function of the protein. Different processes can cause proteins to unfold such as heat, change in pH, and changes in salinity. When you unfold a protein molecule (called denaturation), its charged components can re-associate with other charged molecules (precipitation or coagulation). Cheeses and soybean tofu are examples of coagulated protein food products.

Activity 1 (Class Demonstration)

Protein structure demonstration using pipe-cleaners.

Activity 2 (Groups)

Precipitation of casein from milk with an acid (vinegar)

Milk protein consists of 80% casein and 20% whey proteins. Milk, in its natural state, is negatively charged. The negative charge allows the dispersion of casein in the milk. When an acid is added to milk, the hydrogen proton concentration neutralizes the negatively charged casein pockets. When milk is acidified to pH 4.7, the casein precipitates.

Materials

- ½ cup warm milk
- 2 teaspoons vinegar

• Stir stick

• 2 plastic cups

• Cheesecloth

• Rubber band

Directions

1. Add ½ cup warm milk to a plastic cup.

2. Add 2 teaspoons of vinegar to the warm milk and stir for 2 minutes, then allow the milk to sit for 5 minutes. The casein will precipitate into heavy white curds.

3. Cut out a piece (2-3 layers) of cheesecloth large enough to cover the top and 2 inches down the sides of a new cup. Using a rubber band, fasten the cheesecloth over the top of the cup. Pour the curdled milk into the cup, collecting the curds (casein) in the cheesecloth and allowing the vinegar and whey to drain off into the bottom of the cup.

4. Gather up the cheesecloth and twist to dry.

5. Have the children record their observations about the cheese. How is the cheese different than the milk it started as? What do the proteins look like now? What did the vinegar do?

Activity 3 (Groups)

Coagulation of protein from soymilk using a salt (magnesium sulfate)

Approximately 90% of soybean proteins are classified as globulins (tightly folded globule proteins), based on their solubility in salts. Tofu is made by coagulating the proteins in soymilk with magnesium sulfate. A bonding occurs between the positively charged magnesium ions and negatively charged anionic groups of the protein molecules, and the proteins coagulate.

Materials

• ½ cup hot soymilk

• 1/4 teaspoons Epsom salt

• Stir stick

• 2 plastic cups

• Cheesecloth

• Rubber band

Directions

1. Add ½ cup hot soymilk to a plastic cup.

2. Add ¼ teaspoon of Epsom salt to the hot soymilk and stir.

3. Wait until the curds are floating in an almost clear liquid.

4. Cut out a piece (2-3 layers) of cheesecloth large enough to cover the top and 2 inches down the sides of a new cup. Using a rubber band, fasten the cheesecloth over the top of the cup. Pour the curdled soy into the cup, collecting the curds in the cheesecloth and allowing the clear liquid to drain off into the bottom of the cup.

5. Gather up the cheesecloth and twist to dry.

6. Have the children record their observations about the cheese. How is the cheese different than the soymilk it started as? What do the proteins look like now? What did the salts do?