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**Cheese-Making**

**Introduction:** Cheese is a food product made from milk. The many forms and tastes of cheeses result from the varieties of bacteria used, the type of milk used, and various other “secret” ingredients and procedures. Let’s experiment with making cheese.

**Background:** Milk is often considered to be one of nature’s most “complete” foods with its mixture of fats, proteins, and other nutrients. Milk is an emulsion, a mixture of two normally immiscible liquids, fat and water. The fat and water are held together by a natural emulsifying agent, called casein, the name for a group of proteins. If the protein (casein) is destroyed, the emulsion breaks down into its component parts and the insoluble calcium caseinate and fat precipitate out of the suspension. The “solid” portion that precipitates out of milk called the curd. The “liquid” portion of the, milk that remains after the curding process is called the whey.

 Fermentation is a process in which microorganisms, such as bacteria or yeast, grow in a food and produce acids or alcohol and carbon dioxide. When milk is allowed to ferment, lactic acid is produced. The lactic acid curdles the milk protein, forming a solid curd and clear liquid whey. The whey is drained from the curd and then the curd is allowed to age.

 The process of separating milk into curds and whey has been used for centuries. The process of forming curds has several advantages for preserving and using milk as a food source. Milk has a very short shelf life and spoils very easily. (Bacteria like it too!) Turning milk into curds does several things to help keep milk protein unspoiled. In solid form, the milk curds can be dried and treated in a variety of ways to prevent bacterial growth and spoilage. In addition, the curdling process concentrates the food value into small, solid material that is easier to store. Further treating the curds and turning it into cheese gives a whole new set of food textures and tastes. Different curing techniques, subtle variations in additives, varietal cultures of bacteria/fungi, and processing stages produce the differences in taste, texture, color, and aroma of cheeses. However, most cheeses begin using the same coagulation procedure used in this laboratory activity.

 The consistency and amount of curd produced from a batch of milk depends upon the availability and concentration of chymosin, the enzyme that converts liquid milk to curds and whey. Historically, the enzyme source used by cheese makers has been from extracts taken from the stomachs of calves while they are still nursing their mothers’ milk. The stomach extract, called rennet, provides a high concentration of enzymes has promoted the continual exploration for alternative sources of the enzymes for making cheese.

 With recent advances in DNA biotechnology, a new source of curdling enzymes has been developed. The first step was to identify the gene for the curdling enzyme, chymosin. Once the gene was isolated, recombinant DNA technology was used to splice the gene into a host bacteria plasmid. The “recombinant” plasmid was then introduced into the bacterium, which began producing the enzyme. The enzyme is then extracted, dried, and stored until needed. Chymosin was one of the first products produced by this method that was approved by the Food and Drug Administration.

**Materials**

 Bleach solution, 10% Plastic wrap

 Chymosin Enzyme solution, 3mL Ring stand with ring

 Powdered milk, 50g Scissors

 Beaker, 600mL (cooking pan) Stirring rod (or spoon)

 Cheesecloth String

 Hot plate (stove) Thermometer

**Safety Precautions**

 *Real cheese is made in controlled food preparation environments to assure quality and human safety. The cheese you produce should not be eaten. Be sure to wash thoroughly after handling the cheese materials and products. Be careful around sources of heat such as hot plates or stoves. Follow all other normal laboratory safety rules.*

**Procedure**

1. Mix 50 g of powdered milk in 500 mL of water and heat using a hot plate or stove until the milk is 37°C. Do not heat too quickly or the milk will scald. Stir continuously and remove from the heat when the milk reaches 37°C.
2. Add 3 mL of chymosin enzyme solution to the milk and stir thoroughly.
3. Cover the container with plastic wrap or other loose fitting cover. Let the mixture sit at room temperature until a firm curd has separated from the whey. The time it takes to curd will depend upon the room temperature and the fluctuation in the room temperature. Check the chymosin/milk mixture at 24-hour intervals until a firm curd is obtained. This will likely occur within 24 to 48 hours.
4. Cut a large square of cheesecloth and fold it two or three layers thick. Ask a partner to hold the cheesecloth over a 600-mL beaker like a loose net. Pour the curd/whey mixture slowly into the cheesecloth sack. Gather he edges together to form a small cheesecloth bag. Tie the top of the bag together with string, leaving enough string to hang the bag.
5. Hang the bag from a ring support (or from other devices as directed by your instructor) and allow the whey to drain from the bottom of the bag into the 600-mL beaker.
6. Transfer the hanging bag and collection beaker to a refrigerated area as directed by your instructor. Allow the whey to drain for 48 hours.
7. After aging for 48 hours, inspect your bag of cheese. How does the amount of whey compare to the original amount of milk? How much cheese is obtained from 500 mL of milk? Untie the bag and inspect your cheese. Observe its color, odor, texture, and other physical properties. You might experiment further with cheese-making and try answering questions of interest to you. What happens if cheese is aged longer? What effect will temperature have on aging? What effect would using different milk types have on the cheese? What about cream?

Data/Observation:

Question:

1. What is biotechnology?

2. How is this laboratory related to biotechnology?

3. What other food processes use biotechnology? Describe its chemistry/biology in detail.