Biotech Cheese Kit

Old and New Cheese Making

Biotechnology is a relatively new term that refers to the use of living organisms, or any component of a living organism, to make useful products. Humans have been practicing **biotechnology** in one form or another since the dawn of civilization. Over time, agricultural biotechnology has changed and evolved as people continue seeking methods to improve food production and preservation in order to provide greater access to more, high quality food at low cost.

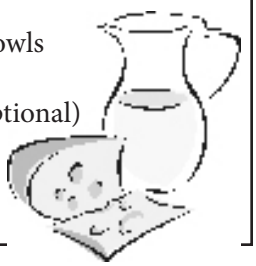
Cheese making provides an interesting example of biotechnology. According to legend, cheese was "discovered" thousands of years ago by a traveler who carried milk in a pouch made from a sheep stomach. During the journey, the sun's heat and the enzymes in the lining of the stomach pouch changed the milk into curds and whey.

Scientists later discovered that an enzyme produced in the stomach lining cells of very young ruminants (e.g., lambs, calves, and goat kids) would coagulate the protein in milk, forming cheese curds. This enzyme, called chymosin, is a protease because it reacts with a protein. There are certain species of plants and molds that also produce proteases capable of coagulating milk, but chymosin creates a stronger curd and produces the flavors we are accustomed to in many traditional cheeses.

In the past, a large number of young calves and lambs were slaughtered for meat and to use their stomachs as a supply of chymosin for cheese making. Today, many people are opposed to slaugtering young animals for food, so other techniques have been developed. Through **genetic engineering**, the animal gene that causes cells to produce chymosin can be removed and inserted into a bacteria or yeast cell. This causes the bacteria or yeast to produce

Materials

- Biotech Cheese Kit (includes biotech rennet, animal rennet, and cheesecloth)
- 2 Crock-Pots
- Thermometer
- Large spoon
- Large knife
- Colander(s)
- 6 quarts of reconstituted powdered milk
- 2 quarts buttermilk
- Salt
- 2 small bowls
- Crackers
- Herbs (optional)



the enzyme. Yeast replicates and grows rapidly, so it is often genetically modified to produce chymosin, which is then extracted and purified—no animals necessary. This creates an endless supply of human-made chymosin.

There are some people who are opposed to the practice of genetic engineering, and use of **genetically modified organisms (GMOs)** is not allowed in the production of organic foods. So, chymosin is still extracted from the stomachs of young ruminants to produce non-GMO rennet. **Rennet** is the generic term for any product that is used to coagulate milk.

Cheese making is really the removal of water from milk; milk is about 87% water. This is commonly done by adding rennet to warm, soured milk to coagulate the protein. (Rennet works best at 90°F and in an acidic environment.) Coagulation changes the chemical makeup of protein so it is no longer water-soluble, resulting in curdled milk with the consistency of jello. This curd is cut to release the whey (milk liquid). The curds may then be stirred and heated before they are removed from the whey to form cheese.

In this Biotech Cheese Making Kit, you will compare animal rennet, which was extracted from the stomach of calves and contains 97% chymosin, to biotech rennet, which was extracted from genetically modified yeast and contains 100% chymosin. Buttermilk is added to help with the flavor and increase acidity. Buttermilk is fermented by beneficial bacteria to create its unique, acidic flavor. In most cheese recipes, fermenting the milk is the first step, and it can take anywhere from 30 minutes to 24 hours. Using buttermilk reduces the amount of time needed to make cheese so that it can be done in the classroom. The result will be a mild-flavored cheese curd. Mixing the final curd with a little bit of cream or whole milk will give you cottage cheese, or you can simply cut the curd into bite-sized pieces, salt them, and eat them! Then ask your students if they can see or taste any difference between "old" (animal rennet) and "new" (biotech rennet) cheese.

Vocabulary

biotechnology: techniques that involve the use of living organisms, or any component of a living organism, to make useful products

chymosin: an enzyme that coagulates milk and is used in making cheese; produced in the stomach lining of young ruminants and by genetically modified microorganisms

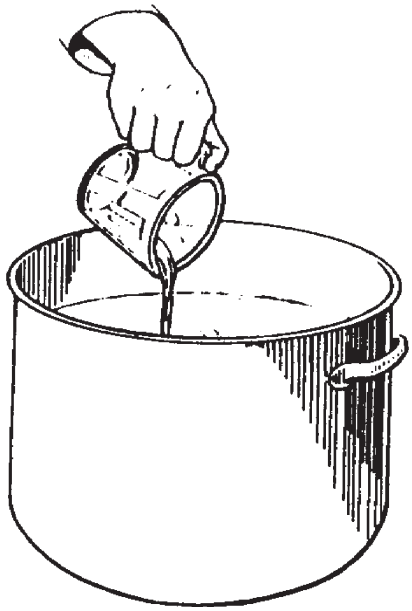
genetic engineering: the process of manually adding DNA to an organism with the goal of adding one or more new traits not already found in that organism

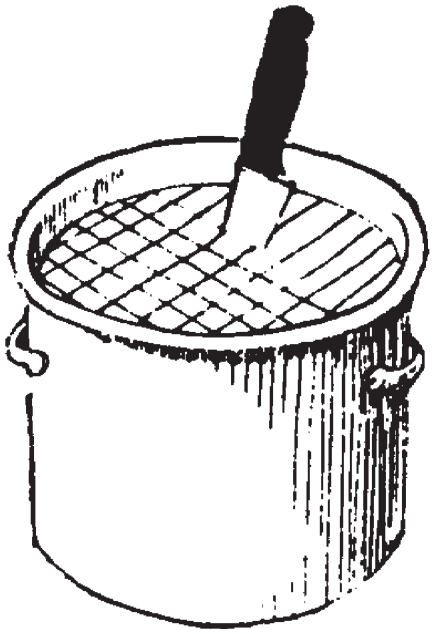
genetically modified organism (GMO): any organism developed through a process in which a copy of a desired gene or section of genetic material from one organism is placed in another organism

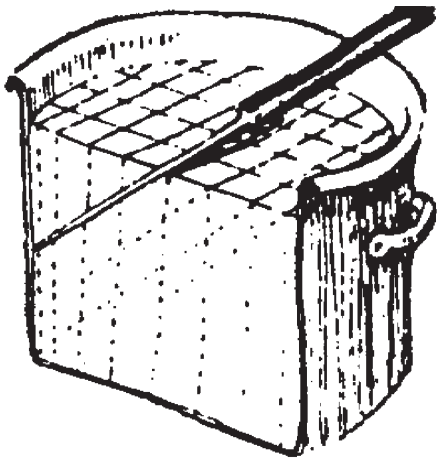
rennet: any product, compound, or ingredient that is added to milk to produce a slow coagulation

Making Biotech- and Animal-Rennet Cheese in a Crock-Pot
Follow the steps below to make both biotech- and animal-rennet cheese simultaneously in two separate Crock-Pots.

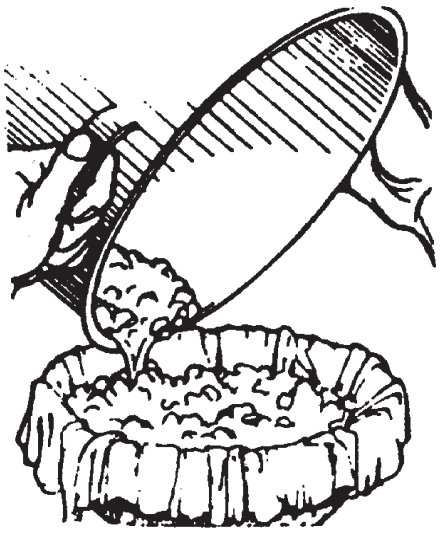
1. Determine how much liquid each Crock-Pot will hold. Use Crock-Pots that will hold at least 1 gallon with an inch of "headroom."
2. Add 1 quart of room-temperature buttermilk to each Crock-Pot and turn the pots on high. (Buttermilk is added to help with the flavor and increase acidity so the milk will coagulate faster.) Add 3 quarts of warm (90-95°F/95-40°C) powdered milk to the Crock-Pot for a total of 1 gallon of liquid.
3. Stir the mixture. When the milk temperature reaches 90°F (35°C) turn the Crock-Pot off.
4. Dilute the rennets before adding them to the milk: mix 10 drops of biotech rennet into 1/4-cup cool, non-chlorinated water, and dissolve 1/4 tablet of animal rennet into a separate 1/4-cup non-chlorinated water.
5. Stir the biotech and animal rennets into separate Crock-Pots of warm milk. Stir thoroughly, but for no longer than one minute.
6. Bring temperature back up to 90°F if it has decreased, and turn off the Crock-Pots.
7. Put the lids on both Crock-Pots. Let the animal-rennet mixture sit for 45-55 minutes and the biotech-rennet mixture for 20-25 minutes or until the milk forms a solid curd that shows a "clean break." To test for a clean break, insert a knife into the curd at an angle. If the curd breaks cleanly around the knife, it is ready. If the mixture is not thick enough to cut, let it incubate longer. Check temperature and warm to 90°F if necessary.
8. Using a large knife, cut the curd by cutting 1-inch slices across the curd and then cutting again at a 90 degree angle to the first cuts. Now follow the same lines and cut the curd diagonally, at an angle 45 degrees to the counter. You are trying to make small blocks.
9. Turn the Crock-Pot on high and bring the temperature up to 102-105°F while stirring slowly. The curds and whey will separate. To ensure even heating and to prevent the curd from matting together, continuously stir the curd slowly and GENTLY while heating. As you find larger pieces, cut them to uniform size.
10. Turn off the heat and stir this mixture for about 5 minutes after the temperature is reached. Do not let the temperature go over 105°F.







11. Line a colander with fine cheesecloth, and put the colander over a sink or container to catch whey.
12. Pour or scoop the curds into the colander, and allow any remaining whey to drain for approximately 5 minutes. Rinse the curds with cool water. This removes some of the whey and leaves a cheese that is not sour.
13. Wrap the cheesecloth around the curds, and press out the whey. You can weight it down with a milk jug filled with water if desired.
14. When the whey stops draining, put the cheese in a bowl, cut or break up the cheese with a fork, and add 1/2-teaspoon salt. Add a small amount of cream (1/4 cup) or whole milk for a creamier consistency more like cottage cheese. You can also flavor the curds with different herbs. Serve the cheese on crackers.



Results

As a result of participating in this activity, students should gain an understanding of biotechnology and the benefits and concerns surrounding GMOs.