MAKING YOGURT

LAB BAC 1

INTRODUCTION

Yogurt is made by the fermentation of **lactose** (milk sugar) by bacterial enzymes. This process is anaerobic, meaning that it occurs in the absence of oxygen. Lactose is a compound sugar, made up of the two simple sugars glucose and galactose. During the making of yogurt, the lactose is broken down by the lactase enzyme (provided by bacteria) into these two components, as shown in Figure 1. Further processing of glucose and galactose results in the end products of lactic acid and acetaldehyde. The production of **lactic acid** and **acetaldehyde** lowers the pH of the milk, causing it to have a sour, tart taste. The lower pH also affects the **casein** (milk protein), causing it to coagulate and precipitate, forming the solid curd that makes up yogurt. The leftover watery liquid is the whey. The two bacteria most commonly used to make yogurt are *Lactobacillus bulgaricus* and *Streptococcus thermophilus*.

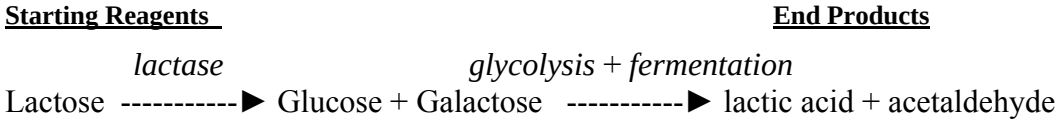

Figure 1. Enzymatic reaction in yogurt production.

Lactobacillus bulgaricus and *Streptococcus thermophilus* are not the only bacteria that can convert lactose into lactic acid. Fresh milk begins acquiring microbes from the very moment it leaves the cow. Milking equipment, people processing the milk, even bacteria in the air can all contaminate milk. To prevent the milk from going bad, all milk sold at the grocery store is pasteurized. Pasteurization is the process in which milk is heated for a certain length of time to kill *most* of the microorganisms that might be present. The U.S. Public Health Service guidelines say that heating milk at 62.8°C (145°F) for 30 minutes or 71.7°C (161°F) for 15 seconds meets pasteurization standards. These standards are based on the amount of heat necessary to kill most of the bacteria that are commonly found in milk. Of course, once you open a container of milk, it can contain or acquire a mix of bacterial species that can ferment milk in an undesirable fashion, as indicated in Table 1. Therefore, before you start making yogurt, it is necessary to heat the milk so that the only bacteria it contains are the ones we will add! Adding specific bacteria is called using a "starter culture". Table 1 should be referred to when observing your finished yogurt. In general, a "sniff" test is a good idea!

Table 1. Examples of Common Microorganisms in Milk

Type of Microorganism	Sources	End Products
Streptococci (acid producer)	Dairy utensils, plants	Lactic acid, acetic acid, ethanol, and carbon dioxide (not tasty)
Coliforms (acid producer)	Manure, polluted water, soil, and plants	Lactic acid, other
Proteolytic (acts on protein)	Soil, water, utensils	Degrades casein; may be proceeded by coagulation of milk (smells & tastes bad)
Lipolytic (acts on milk fat)	Soil, water, utensils	Hydrolyzes milk fat to glycerol and fatty acids (rancid odor and taste)

Students can perform this experiment in groups of 2-4, depending on the classroom space and equipment availability. Approximately half the class will make yogurt with just liquid milk (Control group). The other half will add 50 g of powdered milk to the liquid milk (Experimental group). The Control and Experimental groups will have to compare their yogurt results when filling out the Observations Sheet.

PURPOSE

The purpose of this experiment is to produce yogurt by adding specific bacteria to prepared milk. The product will be observed and comparisons will be made between an experimental group, a control group, and commercial yogurt.

EQUIPMENT/MATERIALS

500 mL glass beaker
thermometer
hot plate
stir stick
12 oz paper/plastic cups
clean plastic spoons
milk (% fat does not matter)
plastic wrap
elastic bands
32°C incubator
ice buckets (optional)
powdered milk
plain yogurt with active cultures

SAFETY

- Always wear an apron and goggles in the lab.
- Use care handling the beaker of hot milk.
- Do not eat the yogurt.

PROCEDURE

1. Obtain 8 oz. (1 cup) of milk from the instructor. Place the milk in a clean glass beaker. Experimental groups should also obtain 50 g of powdered milk and mix this into the beaker with their milk. Place a thermometer into the beaker.
2. Use a hot plate to heat the milk slowly until it reaches 95°C (do not allow milk to boil), stirring often to prevent the milk from burning onto the bottom of the beaker. Pay special attention as you near the target temperature.
3. Take the milk off the hot plate and set it aside to cool. Cover it with plastic wrap to prevent contamination from the air. Do NOT remove the thermometer! You can cool the beaker more quickly by running cold water down the sides of the beaker. Be careful not to get water in the beaker. Once the temperature gets below 60°C, you may place the beaker in an ice bath.
4. Cool the milk to 32°C. Pour the cooled milk into a clean paper/plastic cup.
5. Add one heaping spoonful of "store bought" yogurt to the 8 oz. milk. This will provide your "starter culture" of bacteria. Stir the milk and yogurt thoroughly.
6. Cover the cup tightly with plastic wrap, and label the cup with your name. Note whether your group was Control or Experimental. Place the cup into a 32°C incubator.
7. After placing the yogurt culture into the incubator, write down the ingredients that are in the "store bought" yogurt. This information will assist you in the Data/Observations Section.
8. Ferment the yogurt for 24 hrs at 32°C. If you cannot examine your results the next day, place it in a refrigerator until the next class period.

NOTE: Do not eat the yogurt! It was made in laboratory glassware that may have had chemicals in it previously.

REFERENCES:

Eneger, Eldon D. and Frederick C. Ross. *Laboratory Manual:Concepts in Biology.* "The Chemistry and Ecology of Yogurt Production". Wm. C. Brown Publishers. 8th Edition. ©1997. pp. 95-97.

Pelczar, Michael J., E.C.S. Chan, and Krieg, Noel R. *Microbiology Concepts and Applications.* "Part XI: Industrial Microbiology". McGraw Hill, Inc. ©1993. pp. 847-874.

OBSERVATION SHEET

Name _____
Name _____
Period _____ Class _____
Date _____

MAKING YOGURT

OBSERVATIONS

1. Describe the color and the consistency of your yogurt. Does it have an odor? Note whether your yogurt was part of the Control or Experimental group.

2. How does your yogurt compare to the other group (either Experimental or Control)?

3. Compare your "home-made" yogurt to the "store-bought" variety. What effect do some of the other ingredients have on the "store-bought" yogurt?

QUESTIONS

1. What are the 2 most common bacteria used in yogurt making?

2. During the fermentation process, what happens to the lactose (milk sugar)? What are the end products of fermentation?

3. Why does yogurt taste sour?

4. What causes the milk to thicken and form "curds"?

5. Why must you heat the milk before making yogurt? What do you think would happen if you added the "starter culture" before the milk was cooled to 32°C?

6. When incubating the yogurt overnight, why do you need to have a tight cover on the container?

7. EXTRA CREDIT: Many cows are given antibiotics as part of their regular diet. It has been determined that these antibiotics can be detected in the milk of these cows. How do you think this might affect the yogurt making process?