UNIT II - FOOD PROCESSING

Lesson 4: Processing Dairy Products

Objective

The student will be able to summarize how dairy products are processed and packaged.

I. Study Questions

A. What techniques are used to process raw milk?

B. Why is raw milk pasteurized and homogenized?

C. How are major dairy products processed?

D. Why should milk and dairy products be packaged?

E. How is the dairy processing industry organized?

II. References

A. Martin, Phillip R. *Food Science and Technology* (Student Reference). University of Missouri-Columbia: Instructional Materials Laboratory, 1994. Unit II.

B. Activity Sheets

1. AS 4.1: Pasteurization in a Double Boiler (Instructor)
2. AS 4.1: Pasteurization in a Double Boiler (Student)
3. AS 4.2: Making Plain Yogurt (Instructor)
4. AS 4.2: Making Plain Yogurt (Student)

UNIT II - FOOD PROCESSING

Lesson 4: Processing Dairy Products

TEACHING PROCEDURES

A. Review

Lesson 3 examined the products of raw milk, the grades of raw milk, and the factors that affect milk taste and composition. Review the grades of raw milk and explain that Grades A and B milk undergo the processes discussed in this lesson.

B. Motivation

Have students work in pairs to process ice cream. Each pair will need:

½ c. milk
½ c. whipping cream
¼ c. sugar
Fruit and nuts (optional)
1 pt freezer bag
1 ½-gal. freezer bag
3 c. ice
½ c. salt

Have students measure the milk, whipping cream, sugar, and vanilla and place in pint freezer bag. Fruit and nuts may be added. Seal bag tightly while keeping as much air as possible in bag. Place sealed bag inside ½-gallon bag. Add ice and salt. Close tightly. Take turns shaking the bag until ice cream is set, about 10-15 minutes. Discuss why salt was added to the ice.

C. Assignment

D. Supervised Study

E. Discussion

1. Discuss what techniques are used to process raw milk. Between the time the milk leaves the cow and arrives at the grocer, nine processes take place.

What techniques are used to process raw milk?

a. Quality control tests
b. Separation

c. Standardization
d. Clarification
e. Pasteurization
f. Homogenization
g. Fortification
h. Cooling
i. Packaging

2. Discuss why raw milk is pasteurized and homogenized. Milk is pasteurized to prevent disease and homogenized for improved taste and appearance. Have students complete AS 4.1.

Why is raw milk pasteurized and homogenized?

a. Pasteurization is necessary to rid milk of any disease-producing microorganism and to reduce total bacterial numbers for improved shelf life. Also, pasteurization destroys lipase and other natural enzymes.
   1. Batch method
   2. HTST - high temperature short-time method
b. Homogenization subdivides fat globules and clumps to a small enough size to prevent their rising to the top and forming a cream layer. Homogenized milk has a richer taste and has a whiter appearance than unhomoginized milk.

3. Discuss how major dairy products are processed. Have students work in groups to complete AS 4.2.

How are major dairy products processed?

a. Whole milk - milk fat level standardized to at least 3.25 percent, pasteurized, homogenized, fortified with Vitamin D, and packaged
b. Low-fat milk - milk fat level standardized to ½ percent, 1 percent, 1.5 percent or 2 percent, pasteurized, homogenized, fortified with vitamins A and D, and packaged
c. Non-fat milk - milk fat level lowered below 0.5 percent, pasteurized, homogenized, fortified with vitamins A and D, and packaged
d. Chocolate milk - either whole, low fat, or non-fat milk is mixed with either chocolate syrup or cocoa powder and sugar
e. Cultured buttermilk - skim, low fat or whole milk heated to 185°F for 30 minutes, inoculated with lactic acid-producing bacteria and held at 72°F until acidity reaches about 0.85 percent or pH reaches about 4.5
f. Yogurt - fermented whole or skim milk by *Streptococcus thermophilus*, and *Lactobacillus bulgaricus*; pH is lowered to point where casein clabbers or coagulates

g. Acidophilus milk - fermented whole milk that has *Lactobacillus acidophilus* bacteria added to digest lactose
h. Cream - separated centrifugally from fluid milk, then processed into various fat-content creams
i. Sour cream - following pasteurization, cream is cultured with lactic acid-forming bacteria
j. Butter - cream is churned to break the oil-in-water emulsion and to form a water-in-oil emulsion; washed with cold water and worked to reduce water content to 15 percent
k. Canned milk - 60 percent of water in the milk removed; carrageenan gum added to give a smooth texture; homogenized, canned, sterilized at 240°F for 15 minutes, sweetened condensed milk is canned milk with sugar added
l. Nonfat dried milk - dehydrated milk that can be stored for long periods
m. Ice cream - milk is heated to 110°F, sugar, emulsifier, stabilizer, and flavorings are added; it is pasteurized, homogenized, aged slightly, frozen to 22°F, and whipped with air; semi-solid ice cream is packaged then hardened to about -20°F
n. Natural cheese - pasteurized milk with the enzyme rennin added; the lactose in the milk is converted to lactic acid by bacterial cultures which reduce the pH from 6.7 to 4.6; at this point the soft curd develops which is then cut to release the whey; it is heated, pressed to 40 percent water, salted, shaped, ripened to alter texture, odor, and flavor; cottage cheese and cream cheese are not ripened
o. Processed cheese - different types of natural cheese are mixed and ground together and then melted to a uniform product with the aid of emulsifiers

4. Discuss why milk and dairy products should be packaged. Milk can be bought in glass, clear plastic, opaque plastic, cardboard, etc. How it can be packaged is not as important as why it should be packaged.

Why should milk and dairy products be packaged?

a. Increases shelf-life and freshness - decreases mold and bacterial contamination
b. Fluid milk contains light sensitive riboflavin (Vitamin B_2), thiamine, Vitamin A and Vitamin C - Opaque packaging reduces the breakdown of these
c. Dried milk must be packaged in a material impermeable to oxygen

5. Discuss how the dairy processing industry is organized. Cooperatives play an important role.

How is the dairy processing industry organized?

a. Individual producers belonging to cooperatives
b. Cooperative processes wholesale milk, cheese, ice cream, etc.
c. International Dairy Foods Association conducts research, educational, promotional, regulatory, legislative, and training activities.

F. Other activities

1. Complete Cottage Cheese Lab as instructed in the University of Missouri Extension Guide #G09550. It is included as Appendix B.

2. Invite a dairy cooperative representative to discuss the coop's role.

3. Teacher demonstration: Fill five test tubes of raw milk and 5 test tubes of pasteurized milk ¾ full and refrigerate at 45°F. Watch for changes, coagulation, gas bubbles, and digestion (clearing of fluid). Check pH with litmus paper for about two weeks.

4. Show the video from United Dairy Industry Association on milk commercials.

G. Conclusion

Before milk arrives at the grocery store, it is tested, standardized, clarified, pasteurized, homogenized, fortified, cooled, and packaged. Pasteurization is critical in maintaining milk quality and safety by killing spoilage and disease-producing microorganisms. Homogenization improves milk's texture and flavor. Proper packaging is needed to maintain freshness and increase shelf life.

H. Competency

1. Summarize how dairy products are processed and packaged.

2. Related Core Competencies and Key Skills:

9D-6: Identify the control, the dependent, and the independent variables in an experiment.
9E-5: Identify the basic and acidic ranges and the neutral point on the pH scale.

I. Answers to Evaluation

1. a
2. c

3. d
4. c
5. Homogenization provides a consistent texture and flavor. It prevents cream from rising.
6. Acidophilus milk is produced for lactose-intolerant people.
7. Instructor's discretion
8. Ice cream - 10 percent milk fat; sherbet - 1 to 2 percent milk fat
9. Packaging enhances freshness and shelf-life, is necessary for dried milk to hold nitrogen gas, and prevents riboflavin breakdown.

J. Answers to Activity Sheets

AS 4.1

1. most likely, tube A
2. most likely, tube B
3. most likely, tube G
4. whether spoilage was by acid-producing bacteria (pink)
5. to prevent cross contamination
6. 145°F is the critical temperature and it must be maintained for 30 minutes for pasteurization to take place (or 161°F for 15 seconds).

AS 4.2

1. Gelatin is a thickening agent.
2. D
3. E

UNIT II - FOOD PROCESSING
Lesson 4: Processing of Dairy Products

Name _____
Date _____

EVALUATION

Circle the letter that corresponds to the best answer.

1. Pasteurizing milk using the HTST method requires that milk is heated to ____ for ____.

   a. 161°F, 15 seconds
   b. 145°F, 30 minutes
   c. 130°F, 45 minutes
   d. 30°F, 145 seconds

2. Whole milk is a minimum of ____ milk fat.

   a. 1.0 percent
   b. 2.0 percent
   c. 3.25 percent
   d. 12.65 percent

3. Whole milk is fortified with ____ vitamin(s).

   a. C
   b. A & C
   c. A & D
   d. D

4. Low-fat milk and skim milk are fortified with ____ vitamin(s).

   a. C
   b. A & C
   c. A & D
   d. D

Complete the following short answer questions.

5. Why is milk homogenized?

6. Why is acidophilus milk produced?

7. Write an essay on the cheese-making process. Use each of the following terms appropriately: rennin, lactic acid, lactose, pH, cutting the curd, whey, salted, and shaped.

8. What is the difference between ice cream and sherbet?

9. Give two reasons why packaging dairy products is important.

UNIT II - FOOD PROCESSING AS 4.1
Instructor

Lesson 4: Processing Dairy Products

Pasteurization in a Double Boiler

Prepare litmus solution to be used in AS 4.1, Pasteurization in a Double Boiler.

Reagent: litmus, available from Signa Chemical Company, St. Louis, MO., 800-325-3010 (catalog number L7382, about $1/gram)

Procedure:

1. Add 5 g. litmus to 50 ml distilled water. Heat in a boiling water bath for 30 minutes or until dissolved. Make more or less solution depending on the class size. You will need 0.5 ml for each test tube of milk used.

2. Cover and cool overnight.

3. Filter through filter-paper (Whatman No. 12. A coffee filter will work fine.)

4. This solution is stable for at least one year if kept in a cool, dark place.

5. The day before use, pipette 0.5 ml of litmus solution into each test tube to be used the next day. Place the test tubes in a boiling water bath for 30 minutes. Remove from heat and allow to cool overnight. (If you have access to an autoclave, you can sterilize the solution at 121°C [250°F, 15 psi] for 20 minutes.)

Additional notes about pasteurization in a double boiler:

Step 2: Cultured yogurt, cottage cheese or sour cream could be substituted for the buttermilk, although best results will be obtained using fresh buttermilk. Be certain that the ingredients statement includes the words 'active starter culture' or similar.

Step 3: Maintaining the temperature may require adjustment of the heat source. Be certain that water touches the bottom of the upper pan in the double boiler at all times.

Step 7: If two sets of samples can be obtained, store one set at 7°C (45°F) and another at 25°C (72°F). Compare results between the two temperatures.

UNIT II - FOOD PROCESSING AS 4.1
Student

Lesson 4: Processing Dairy Products Name

Pasteurization in a Double Boiler

Objective: Students will determine the critical temperature needed to pasteurize milk.

Activity Length: 2 periods, 10 minutes for 10 periods thereafter

Materials and Equipment:

raw milk, or pasteurized milk with cultured buttermilk
double boiler
heat source
7 sterile pipets (5-10ml)
7 sterile test tubes containing litmus solution with screw caps
test tube rack
thermometers
ice bath
refrigerator
sterile stirring rod
sterile eye dropper
timer or watch

Procedure:

1. Place water in bottom pan of double boiler and bring to a boil.

2. Place raw milk or pasteurized milk containing 1 percent cultured buttermilk in top pan (minimum of 100 ml of milk).

3. Heat milk, stirring every 1-2 minutes with a stirring rod until the temperature reaches 63°C (145°F). Continue to stir and maintain 63°C (145°F).

4. Remove 5 ml of hot milk with a sterile pipet and place the milk into the test tubes containing the sterilized litmus solution. Screw on the cap, and mix the milk and litmus solution together well.

5. Immediately following the transfer of milk to the test tube, place the test tube in an ice/water bath and cool to about 7°C (45°F).

6. While maintaining 63°C (145°F) with the remaining milk in the double boiler, at 5-minute intervals remove 5 ml of milk and place it in sterile test tubes marked B, C, D, E, F, and G. Be sure to use a different, sterile pipet for each sample. Complete Step 5 after filling each test tube.

7. Store all tubes at 7°C (45°F) and observe daily for evidence of spoilage: coagulation, gas bubbles, solubilization (digestion of protein).

8. Record and analyze data for the effects of heating and time of heating before the milk begins to spoil.

9. Complete the chart describing the physical evidence of spoilage and color changes due to pH alterations.

	TUBE A	B	C	D	E	F	G
DAY 1							
2							
3							
4							
5							
6							
7							
8							
9							
10							

Key Questions:

1. Which tube(s) showed signs of spoilage first?

2. Which tube(s) showed signs of spoilage second?

3. Did you have a tube that never showed signs of spoilage? If so, which one(s)?

4. What did the litmus solution tell you? (Some bacteria reduce--opposite of oxidize--litmus causing it to become colorless. If this happens, color will appear at the top of the tube where milk is exposed to O_2.)

5. Why did you use a different sterile pipet for each sample?

6. What can you conclude about the necessity of temperature and length of heating time for pasteurization to take place?

Adapted from: "Making Yogurt at Home," University Extension Guide #GH1183.

UNIT II - FOOD PROCESSING AS 4.2
Instructor

Lesson 4: Processing Dairy Products

Making Plain Yogurt

Objective: The student will be able to identify the ingredients needed to produce yogurt and explain why each is needed.

Activity Length: 2 periods (4 hours incubation time)

Background Information:

With the exception of a commercial yogurt maker with an electrically heated base, most of the equipment needed to prepare yogurt can be found in any kitchen. Make sure you have all the necessary equipment **before** you begin preparing yogurt. This recipe makes 4 to 5 cups. Yogurt can be stored in the refrigerator for about 10 days. This recipe can be doubled or tripled with no loss of quality, but make sure you can use that amount in 10 days or less. Adjust pan and container size accordingly.

Materials and Equipment: (1 set per group of students)

Double boiler that holds at least 5 cups
Candy thermometer with a range of 100°F to 300°F
Container for yogurt that holds at least 5 cups (glass, crockery, food-grade plastic or stainless steel), or use individual custard cups or jelly jars--then the yogurt can be eaten directly from the container in which it was made.
Other useful equipment: large spoon, large bowl, and aluminum foil or plastic wrap to cover yogurt containers if they don't have lids
Incubator to maintain a constant temperature of 108°F to 112°F when incubating yogurt. (The most foolproof method for incubating yogurt is in a commercial yogurt-maker with an electrically heated base. If you don't want to purchase a yogurt-maker, experiment with the other methods of incubation described in *Table 1* until you find one that fits your needs.)

1 quart milk (whole, low-fat, skim or reconstituted nonfat dry milk) **A safety precaution: If you use home-produced milk, either from a cow or goat, it must be pasteurized before preparing yogurt or any other milk product.**
Nonfat dry milk powder - use _ cup powder when using whole or low-fat milk, use _ cup powder when using skim or reconstituted nonfat dry milk
¼ cup commercial, unflavored, cultured yogurt*
2 to 4 tablespoons sugar or honey (optional)

½ package (1 teaspoon) unflavored gelatin (for thick, firm yogurt only)

*__Special hint:__ To make yogurt in the classroom or at home, an active (living) yogurt culture is needed as a "starter." Commercial, unflavored cultured yogurt, from the supermarket is usually used. Yogurt starter cultures can also be purchased at health food stores, but are quite expensive compared to commercial cultured yogurt. Once you start making yogurt, save some of your homemade yogurt to "start" your next batch. For best results, however, purchase commercial cultured yogurt to replenish a homemade culture every four to five batches.

Procedure:

1. Thoroughly wash equipment for making yogurt and container(s) with hot, soapy water. Rinse everything thoroughly and air dry. A dishwasher can also be used.

2. Pour boiling water into the yogurt container(s) and leave until ready to use.

3. Prepare the incubator following manufacturer's instructions (*see Table 1)*. Instruct students on how the incubator should be operated.

For Thin Yogurt:

4. Place cold, pasteurized milk in top of a double boiler and stir in nonfat dry milk powder. Add sugar or honey if a sweeter, less tart yogurt, is desired.

5. Heat milk to 200°F, stirring gently, and hold for ten minutes. **Do not boil**.

6. Place top of double boiler in cold water to cool milk rapidly to 112°F to 115°F. Watch the temperature carefully as it falls rapidly once it reaches 125°F. Remove pan from cold water.

7. Remove one cup of the warm milk and blend it with the yogurt, starter culture. Add

Table 1
Incubators

- **Method A:** Prewarm oven to 200°F and turn off. Use an oven thermometer to monitor temperature -- do not let it drop below 100°F. Turn oven on for short periods during incubation to maintain temperature of 108°F to 112°F.
- **Method B:** Line an ice chest (picnic cooler) with aluminum foil. Place four, one-quart jars filled with hot water (about 140°F) inside the ice chest with the yogurt container(s) and cover ice chest with a tight-fitting lid. Allow space between jars and container(s) of yogurt.
- **Method C:** Nestle several cardboard boxes inside each other, placing crushed newspapers between each box. Continue as directed in Method B for ice chest.
- **Method D:** A simple way to incubate a small amount of yogurt is to pour the mixture into a wide-mouth thermos and cover with a tight lid. When the yogurt is ready, loosen the thermos lid before storing in the refrigerator so the yogurt can cool rapidly.
- **Method E:** Set filled container(s) of yogurt on a towel-covered heating pad, set on medium heat, in a sheltered corner on a kitchen counter. Cover the jars with several towels.

this to the rest of the warm milk. Temperature should now be 110°F to 112°F.

8. Pour water out of the yogurt container.

9. Pour the yogurt immediately into the clean hot container(s), cover and place in prepared incubator. Close incubator.

10. Incubate about 4 hours. Yogurt should be set. The longer the incubation time, the more tart or acidic the flavor.
11. Refrigerate immediately. Rapid cooling stops the development of acid. Yogurt will keep for about ten days if held at 40°F or lower (normal refrigerator temperature).

For Thick, Firm Yogurt: (Follow steps 1 through 3 above.)

4. Place cold, pasteurized milk in the top of the double boiler and stir in nonfat dry milk powder. Stir in sugar or honey if sweeter, less tart yogurt is desired. Sprinkle gelatin over the milk. Let stand for 5 minutes to soften gelatin.
5. Heat milk to 200°F and hold for 20 to 30 minutes, stirring gently to dissolve gelatin. Continue from Step 6 under *Thin Yogurt*.

Adapted from: *Making Yogurt at Home*, University of Missouri Extension Guide #GH1183.

UNIT II - FOOD PROCESSING AS 4.2
Student

Lesson 4: Processing Dairy Products Name

Making Plain Yogurt

Objective: The student will be able to identify the ingredients needed to produce yogurt and explain why each is needed.

Activity Length: 2 periods (4 hours incubation time)

Materials and Equipment:

Double boiler
Candy thermometer
Container for yogurt that holds at least 5 cups (glass, crockery, food-grade plastic or stainless steel), or use individual custard cups or jelly jars with lids if possible.
Large spoon
Large bowl
Aluminum foil or plastic wrap to cover yogurt containers (if they don't have lids).
Incubator
1 quart milk (whole, low-fat, skim or reconstituted nonfat dry milk)
Nonfat dry milk power - Use _ cup powder when using whole or low-fat milk, use _ cup powder when using skim or reconstituted nonfat dry milk.
¼ cup commercial, unflavored, cultured yogurt*
2 to 4 tablespoons sugar or honey (optional)
½ package (1 teaspoon) unflavored gelatin (for thick, firm yogurt only)

Procedure:

1. Thoroughly wash equipment for making yogurt and container(s) with **hot**, soapy water. Rinse everything thoroughly and air dry. A dishwasher can also be used.

2. Pour boiling water into the yogurt container(s) and leave until ready to use.

3. Prepare the incubator following your instructor's directions.

For Thin Yogurt:

4. Place cold, pasteurized milk in top of a double boiler and stir in nonfat dry milk powder. Add sugar or honey if a sweeter, less tart yogurt is desired.

5. Heat milk to 200°F, stirring gently, and hold for ten minutes. **Do not boil**.

6. Place top of double boiler in cold water to cool milk rapidly to 112°F to 115°F. Watch the temperature carefully as it falls rapidly once it reaches 125°F. Remove pan from cold water.

7. Remove one cup of the warm milk and blend it with the yogurt starter culture. Add this to the rest of the warm milk. Temperature should now be 110°F to 112°F.

8. Pour water out of the yogurt container.

9. Pour the yogurt immediately into the clean hot container(s), cover and place in prepared incubator. Close incubator.

10. Incubate about 4 hours. Yogurt should be set. The longer the incubation time, the more tart or acidic the flavor.

11. Refrigerate immediately. Rapid cooling stops the development of acid. Yogurt will keep for about ten days if held at 40°F or lower (normal refrigerator temperature).

For Thick, Firm Yogurt: (Follow steps 1 through 3 above.)

4. Place cold, pasteurized milk in the top of a double boiler and stir in nonfat dry milk powder. Stir in sugar or honey if sweeter, less tart yogurt is desired. *Sprinkle gelatin over the milk.* Let stand for 5 minutes to soften gelatin.

5. Heat milk to 200°F and hold for 20 to 30 minutes, stirring gently to dissolve gelatin. Continue from Step 6 under *Thin Yogurt*.

Key Questions:

1. For thick yogurt, why was gelatin added?

2. If yogurt developed an acid taste, which of the following could be true?

    a. temperature reached was too cool
    b. too short incubation period
    c. insufficient dry milk used
    d. too long incubation period

3. If yogurt does not become firm, what may be the cause?

    a. incubation temperature too high
    b. incubation temperature too low
    c. inactive culture
    d. soiled containers
    e. all of the above

Adapted from: *Making Yogurt at Home*, University of Missouri Extension Guide #GH1183.