FACS: Blue's the Clue: Souring Milk for Science (Ag)

Summary

Students will use a hands-on experiment to explore the effects of microbes and the methods available for controlling their growth.

Time Frame

2 class periods of 45 minutes each

Group Size

Large Groups

Life Skills

Thinking & Reasoning

Materials

- 500 milliliters or about 2 cups of pasteurized 2% milk
- UHT (Ultra High Temperature) boxed milk*
- Small pipette for measuring out milk*
- Methylene blue solution*
- 6 test tubes with stoppers (or other clear glass or plastic containers with secure covers)*
- Blue's the Clue! Worksheet
- Optional: half-and-half, cream, whole milk, 1% milk, etc.

**These materials are provided in the "Blue's the Clue kit," available through the Utah AITC e-store.*

Background for Teachers

Careers in the dairy field encompass everything from breeders working to increase yields from individual dairy cows, to quality control workers who ensure that the milk processing procedures are clean and safe for consumers, to researchers who are continually improving the safety methods and maximizing productivity.

The technology of dairy science is continually improving, but some fundamentals remain the same. Pasteurization is a heat treatment performed at the processing plant which destroys harmful bacteria without affecting the quality of the milk. Though bacteria are ubiquitous, milk may be pasteurized using a low heat method (145° F, 63° C for 30 minutes) or a high heat method (162° F, 72° C for 15 seconds). Ultra high temperature (UHT) pasteurization methods (280° F, 138° C for only a few seconds), as used by Gossner Foods (Logan, Utah), creates milk that is stable at room temperature for nearly as long as the packaging remains sealed. Pasteurization does not kill all the bacteria contained in raw milk, but it does kill those pathogens that may cause disease. Bacteria that remain after pasteurization eventually cause milk to sour (spoil). Pasteurization inactivates enzymes and destroys yeasts, molds, and other bacteria.

Quality control workers in processing plants check for bacteria in the milk before they load it into a truck, again before the truck is unloaded at the processing plant, in the storage tank at the processing plant, before it is pasteurized, and after it is pasteurized. A quality control worker will continue to test the milk lots daily for 10 days after they are bottled. The are two minimum tests that must be conducted: 1) check the concentration of microorganisms in raw and pasteurized milk, and 2) check

and detect the viable and dead microorganisms.

In UHT and refrigerated pasteurized milk various microorganisms succeed one another as the chemical environment of the milk changes. The microbes themselves bring about these changes. The stages of microbial growth are Streptococcus, then Lactobacillus, then yeasts and molds, and finally Bacillus.

Streptococci convert the milk sugar (lactose) into lactic acid. The acidity of the milk increases to the point where further Streptococci growth is inhibited. Lactobacilli then begin to grow and convert the remaining lactose into lactic acid. Acidity increases further until Lactobacilli growth is suppressed. The lactic acid sours the milk and curdles (coagulates) the milk protein. Yeasts and molds grow well in this acid environment, and they convert acid into non-acid products. Finally, Bacilli multiply in the environment where protein is the only nutrient available.

Bacilli convert protein into ammonia products, and the pH (acidity) rises. These bacteria also digest the remaining protein through enzymatic action. The odor of spoiled milk becomes apparent once this has happened. Microbial activity causes changes in the pH of the milk. Fluctuations in pH are due to fermentation and petrification (decomposition) processes.

During this process, oxygen is used by bacteria in different stages. Adding methylene blue to milk will turn it a blue color, and it will remain blue as long as oxygen is present inside the milk. The more bacterial activity there is, the faster the oxygen will be used and the sooner the milk will turn white, indicating that it is spoiled. For the following activities, you will be monitoring the speed at which the milk changes from blue to white and forming comparisons between the different methods of pasteurization described above.

This rudimentary experiment will give you a sense of the differences between milk, but it is not typically used by scientists to test the quality of milk. Rather, quality control studies are performed by examining the bacteria present in the milk, ensuring higher accuracy than the blue test and helping workers to find the source of bacterial contamination.

Instructional Procedures

If using the kit materials, first assemble the test-tube rack and line up the tubes in the rack.
Using the pipette, add 15 ml of the included UHT milk into three test tubes or containers. Repeat with the 2% pasteurized milk in the remaining three test tubes or containers.
Place a single drop of the methylene blue solution into each container. Be extremely careful with the solution--it will stain clothing and surfaces blue. Secure the caps and gently swirl the tubes to diffuse the dye evenly.
Label the samples "UHT" or "2% Pasteurized."
To measure the effect of temperature on the rate of spoilage, keep one of each (UHT and 2% pasteurized) in the stand, put one of each in the refrigerator, and one of each in the freezer.
Observe the color of the milk over the next few days or weeks. The blue tint will begin to fade as the milk spoils. Record the color of each of the tubes according to the following scale:
5 - Very Blue (Blue color just added)
4 - Blue
3 - Fading Blue
2 - Slightly Blue
1 - White (the color of milk)
As the milk in the tubes becomes completely white you can begin to make a comparison and

draw conclusions about how processing treatments deter bacterial growth.

Additional Activities

Compare the spoilage rate and bacterial growth in milk samples of varying fat content, such as 2%, whipping cream, and half-and-half.

Talk about sources of contamination, and compare contaminated samples with samples straight out of the milk jug. Possible sources of contamination can include a student taking a drink out of a glass and then testing the remaining milk, leaving the lid off of a test tube, putting a shoelace tip into a test tube of milk, etc. This can lend itself to a discussion about inoculation and contamination when bacteria enters a system. In some occupations, people want certain bacteria to be present. Try making yogurt with your class as an example. Lesson plans available through Utah AITC, www.agclassroom.org/ut.

Learn more about milk in "Milk Matters! Discovering Dairy" instructional unit or take a "virtual field trip".

Authors

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