TRB 6:5 - Act. 4 -- Microbe Experimentation: Sour Milk

Summary

Students will conduct experiments to learn that microbes in common materials, such as milk, can cause both helpful and harmful changes.

Materials

For Each Team of 3 to 4 Students
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- 3 to 6 test-tube racks, depending on the number of teams. Teams can share test-tube racks.
- Refrigerator with freezer compartment, if possible
- 30 ml of pasteurized, whole milk (10 ml/test tube)
- 30 ml of ultra high temperature milk (shelf stable, UHT) or reconstituted powered milk
- 6 sterile test tubes
- 6 sterile test-tube caps or aluminum foil to cover the test tubes
- Two sterile 10 ml pipettes
- One or two sterile 5 ml pipettes or eye droppers
- 20 Sterile plastic pipettes
- Methylene blue 1%
- Permanent marker to label test tubes
- Blue's the Clue Observation sheet (See attachment below.)

Additional Resources

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- Methylene blue 1% (Educational Reagent Aqueous Solution available at most science supply stores or catalogs)
- Yount, Lisa. The Importance of Louis Pasteur San Diego: Lucent Books, c1994.
- "Science and our Food Supply" FDA and NSTA, 2001. Order free copy from http://www.foodsafety.gov/~fsg/teach.html

Background for Teachers

Pasteurization is a heat treatment and is performed at milk processing plants. Pasteurization destroys harmful bacteria without affecting the quality of the milk. Milk may be pasteurized using a low heat method (63°C, 145°F for 30 minutes) or a high heat method (72°C, 162° F for 15 seconds). Pasteurization does not kill all bacteria contained in raw milk, but it does kill those that may cause disease. Bacteria that remain after pasteurization eventually cause milk to sour (spoil). Pasteurization also inactivates enzymes in the milk and destroys yeasts, molds, and other bacteria.

Bacterial populations in milk are a direct indication of milk quality. Processing plants check 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. Milk lots are also tested daily for 10 days after they are bottled. There are two tests used primarily. The first test checks the concentration of microorganisms in raw and pasteurized milk. The second test detects viable and dead microorganisms.

In both pasteurized and raw milk, various microorganisms succeed one another as the chemical environment of the milk changes. The microbes themselves bring about these changes.

Milk sours in stages as one type of bacteria is replaced by another. Bacilli convert protein into ammonia products, and the pH rises. The odor of spoiled milk becomes apparent once this has happened.

UHT or "ultra high pressure" treated milk is milk that is "ultra" pasteurized, making the milk sterile.

Ultra high temperature, higher than pasteurization, and pressure is applied to the milk resulting in a sterile product that can be stored without refrigeration. UHT milk is specially packaged in airtight containers. UHT milk may be difficult to obtain locally. Powdered milk that has been reconstituted can be substituted. Powdered milk is not a "sterile" product, but when prepared with clean water it is nearly "sterile".

Intended Learning Outcomes

1- Use science process and thinking skills
4- Communicate effectively using science language and reasoning
6- Understand the nature of science

Instructional Procedures

Invitation to Learn

:

Ask students if they have ever poured a glass of milk and taken a big sip only to discover it tasted awful. Have they have ever wondered why their parents are always asking them to put the milk back in the refrigerator? What might happen to that milk if it's left out at room temperature over-night? What might be present in milk, that if left out, may cause the milk to spoil? Explain that this activity will help them understand the reasons behind milk spoilage.

Instructional Procedures:

Preparation:

Prepare the lab by sterilizing the test tubes, test-tube caps, pipettes (if using glass and not plastic sterilized pipettes). Purchase pasteurized whole milk and ultra high temperature (shelf stable) whole milk or powdered milk. (Shelf stable UHT milk can usually be found in the juice aisle. Ask your store manager to order it if it isn't available in your supermarket.)

Pour a small amount of methylene blue into dropper bottles. Place all the equipment on a lab table. Provide each student with "Blue's the Clue" data table. (See attachment under Materials section.) Discuss pasteurization and UHT (shelf stable) or powered milk with students.

Design and Conduct Experiment:

Introduce the materials teams may use for their experiments: regular pasteurized milk, ultra high temperature (shelf stable) milk or powdered milk, and methylene blue. Tell them they can use any of the other materials on the lab table. Also mention there is a refrigerator and freezer they can use.

Explain that one container of milk came from the refrigerated dairy case of the supermarket and the other from an unrefrigerated shelf. Let students examine each containers.

Explain to students that methylene blue is an indicator dye used to determine the presence of bacteria in milk. It will turn the milk blue at first and as bacteria alter the milk it will turn white again. Students should add enough drops of methylene blue to turn the milk blue (2-3 drops).

Ask students to form teams of 3 or 4 and encourage each team to develop a hypothesis on how temperature affects bacterial growth. Then ask them to design an experiment to test their hypothesis.

Let teams discuss their hypotheses and experimental designs for 10 to 15 minutes. Then, begin posing the following questions to help students design well-thought-out experiments:

What are some variables you could test? (*storage temperature, milk type*)

How many variables can you test in one experiment? (*ONE*)

What will be the control? (*a part of the experiment left unchanged, for example, if temperature is being tested, the control would be in the refrigerator, the test sample should be left out at room temperature*)

How can you tell if bacteria are growing in the test samples? (*Add methylene blue to each*

sample. If bacteria are growing, the methylene blue will become colorless and the milk will change from blue to white. This is not immediate, but happens over a few days.)

Have each group present their hypothesis and experimental design to the class. Encourage students to discuss the merits of each suggested test. (*Students will often want to test temperature and milk type together in the same experiment. This should be discouraged because the results will not be clear*.)

After the group discussions, give the teams time to revise their hypotheses and experimental designs.

Let teams conduct experiments according to their designs.

Note: The test tubes must be checked each day after the experiment has begun. Since the color change happens over time, you could miss important findings if you don't check every day. Students should design data collection charts and tables to record information.

Observe and Record

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Students should make daily observations and record their results in journals or lab sheets. They can make drawings or written observations

Have teams present their findings to the class. They should report their results and discuss ways they would improve their experimental design.

Remind students to include the relationship of their findings to food safety.

Results you can expect from this experiment:

Room temperature samples

The pasteurized milk will turn white on the second day indicating that there are some spoilage bacteria in milk. At a temperature conducive to bacterial growth, they will multiply.

The UHT milk will still be blue by the second day. This is because the UHT milk has fewer spoilage bacteria than regular pasteurized milk. Thus, it takes longer to see any bacterial growth. Bacteria do not quickly multiply in the UHT milk.

After leaving the UHT milk at room temperature for another day or two, the color will turn white, indicating that spoilage bacteria will ultimately grow in the UHT milk.

Chilled and frozen samples

Both the pasteurized and UHT chilled and frozen milk samples will still be blue by the second day, indicating that cold temperatures retard bacterial growth.

After leaving the chilled and frozen samples at room temperature for another day or two, the color will change to white. This indicates that when the temperature rises to room temperature bacteria can grow. It may take longer for the UHT milk to change to white because there are fewer spoilage bacteria in UHT milk than in regular pasteurized milk.

Extensions

Compare the spoilage rate and bacterial growth in milk samples of varying fat content, such as powdered, skim, 1%, 2%, whipping cream, canned milk, and half-and-half.

Study and discuss the numerous contributions of Louis Pasteur. (See Additional Resources under the Materials section.)

Test UHT milk that has an expiration date that has passed and UHT milk that has an expiration date in the future. See if the "expired" milk changes more quickly than the fresher milk.

Bibliography

This lesson is part of the Sixth Grade Science Teacher Resource Book (TRB3) http://www.usoe.org/curr/science/core/6th/TRB6/. The TRB3 is designed to be your textbook in teaching science curriculum to your students. This book covers all the objectives of each standard and benchmark. If taught efficiently, a student should do well on the End-of-Level (CRT) tests. The

TRB3 is designed for teachers who know very little about science, as well as for teachers who have a broad understanding of science.

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