UNIT I - PRINCIPLES OF FOOD PRESERVATION

Lesson 2: Food Perishability

Objective

The student will be able to describe factors that contribute to food deterioration.

I. Study Questions:

A. Which food characteristics influence deterioration rate?

B. How does acidity/alkalinity influence the perishability of food products?

C. What is the relationship between water, salt, sugar, and osmotic pressure as they relate to food preservation?

D. How does microbial activity affect food preservation?

E. How are chemical preservatives used in foods?

F. How does the ambient environment affect the perishability of foods?

II. References

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

B. Transparency Master

TM 2.1: Food Additives Used as Preservatives

C. Activity Sheets

1. AS 2.1: Osmosis and Diffusion Across a Semi-permeable Membrane
2. AS 2.2: Bacteria Are Found Everywhere

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TEACHING PROCEDURES

A. Review

Ask students to summarize their conclusions from the previous lesson and describe how these conclusions relate to this lesson.

B. Motivation

1. Place one green banana in plastic bag. Leave one green out. Immature produce can be ripened more quickly if sealed in an air-tight bag. Relate ethylene gas to natural vegetable/fruit hormones and demonstrate its ripening characteristic on sealed produce. Fruits and vegetables produce several hormones. A product of hormonal activity, not a hormone itself, ethylene is a natural ripening agent. Check the bananas the next class period to see how they have ripened.

2. Rank the following food items in the order they would deteriorate at room temperature considering they were freshly packaged the day you purchased them: honey, hot dogs, hamburger, tomato, corn flakes, milk.

3. On a survival trip to the Teton mountains in December, which of the following foods would you take: butter, oranges, dried beans, bacon, soda, potatoes, chocolate, watermelon?

4. To observe deterioration, leave a glass of milk out overnight. Examine milk.

C. Assignment

D. Supervised study

E. Discussion

1. Discuss which food characteristics influence deterioration rate.

Which food characteristics influence deterioration rate?

a. pH
b. Moisture (water activity level)
c. Temperature of the product

d. Oxygen level
e. Physical characteristics

2. Discuss how the degree of acidity/alkalinity influences the perishability of food products.

How does acidity/alkalinity influence the perishability of food products?

a. The more acidic, or lower pH the food is, the slower the deterioration rate.
b. Bacterial growth generally favors a pH near neutral (7.0).

3. Discuss the relationship between water, salt, sugar, and osmotic pressure as they relate to food preservation. AS 2.1

What is the relationship between water, salt, sugar, and osmotic pressure as they relate to food preservation?

a. When sugar or salt is added, the osmotic pressure increases and the water activity (Aw) decreases.
b. When the osmotic pressure is high enough to draw water away from microbial cells, or prevent normal diffusion of water into microbial cells, the cytoplasm within the microbial cell dehydrates.

4. Discuss how microbial activity affects food preservation.

How does microbial activity affect food preservation?

a. Physical changes - more apparent than chemical changes
    1. Slime formation, undesirable odors and flavors, color changes caused by aerobic bacteria and yeasts
    2. Sticky surface caused by aerobic molds
b. Chemical changes - Proteins, lipids, carbohydrates, and other complex molecules are degraded into simpler molecules.

5. Discuss how chemical preservatives are used in foods. Use TM 2.1 during the discussion.

How are chemical preservatives used in foods?

Chemical preservatives, often called additives, are substances added to food to improve appearance, flavor, texture, or storage properties. They generally work by acting directly on biological and chemical reactions that decrease food quality.

6. Discuss how the ambient environment affect the preservation of foods.

   How does the ambient environment affect the perishability of foods?

   a. The absence of O_2 prohibits the growth of all molds and aerobic bacteria and retards cellular respiration.
   b. CO_2 and O_3 have been used in the holds of ships to curtail aerobic growth. CO_2 can cause souring due to carbonic acid formation. O_3, ozone, kills most microorganisms, but may increase rancidity in some products.
   c. Nitrogen (N_2) is used for immersion freezing and as a cooling agent to preserve foods. N_2 boils at -196°C, so liquid N is colder than this. N_2 is also used to displace O_2 in many food packages.
   d. The presence of O_2 permits aerobic bacteria, molds, yeasts, and respiration.
   e. CO_2 used to purge fermented products removes any O_2.
   f. CO_2 used in soft drink production - contributes to acidic preservative action.
   g. CO_2 levels are increased to 2-5 percent while O_2 levels are only 3 percent, the remainder N_2, used to preserve apples and other fruits. This low O_2 level retards respiration and hence deterioration rate. Normal atmosphere O_2 level is 21 percent.
   h. Use of ethylene gas speeds ripening and color development in citrus and bananas.
   i. Eggs are stored in enriched CO_2 storehouses to minimize microbial spoilage.

F. Other activities

1. Take pH readings of various food/beverage solutions: several types of soda, milk, coffee, orange juice, sauerkraut, pickles, green beans, water, egg white vs. egg yolk, etc.

2. Examine food ingredient statements on various food packages and identify chemical preservatives used. What other techniques are used to preserve the product - package, atmosphere, refrigerate after opening, etc.

G. Conclusion

Food preservation relies on a variety of factors. A product's physical characteristics, access to O2, temperature, water activity level, and pH are all critical factors that must be managed to delay deterioration. Unless these variables are carefully monitored, microbial activity/deterioration will take place.

Other controls to prevent spoilage are the use of additives and gaseous atmosphere modifications.

H. Competency

1. Describe factors that contribute to food deterioration.

2. Related Missouri Core Competencies and Key Skills

9D-6: Identify the control, the dependent, and the independent variables in an experiment.
10C-5: Identify the variables and controls in a laboratory experiment involving osmosis and Reach a conclusion from the given data.
10E-1: Compare and contrast organic and inorganic compounds.

I. Answers to Evaluation

1. c
2. d
3. a
4. d
5. a
6. b
7. The dialysis tube would lose water by osmosis because the concentration of salts is greater in the salt water solution. It would collapse.
8. Increased surface area; water and nutrients are more available to microbes; O_2 is more available.
9. Acid denatures a microorganism's protein. Therefore, the greater the acid concentration, the less perishable the food product becomes. Some acids directly poison some microbes.
10. Slime formation; sticky surface; undesirable flavor and odor; color change.
11. Sodium benzoate; nitrates and nitrites; BHA; BHT; TBQH; sorbic acid, sodium and calcium propionates, chlorine compounds, ethylene oxide and ethylene formate, salt; sugar; smoke; acids; sulfer dioxide

J. Answer to Activity Sheets

AS 2.1

Part A
1. Yes
2. Iodine, the starch solution turned brown-black
3. The starch molecule is too large to move through semi-permeable membrane

Part B

1. Should be egg A
2. Egg B
3. The vinegar dissolves the shell.
4. They will absorb water, enlarge to an artificial size, and become susceptible to deterioration.
5. Instructor's discretion

AS 2.2

1. Bacteria are just one type of microorganism. Microorganisms are found everywhere, and include molds, yeasts, protozoa, viruses, and bacteria.
2. A safe rule of thumb is to: keep hot foods hot, keep cold foods cold, and keep all food preparation surfaces and equipment clean.
3. Penicillium is a mold that provides us with the antibiotic, penicillin. However, some molds produce toxins that can make us very sick. Some molds make our food look taste, or smell bad.
4. Some yeasts are used to make foods, for example, the yeast that makes bread rise or the yeast that turns the sugar in grapes to alcohol in wine.
5. Instructor's discretion.

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EVALUATION

Circle the letter that corresponds to the best answer.

1. The _____ the pH of a food item, the longer the food will keep.

   a. More constant
   b. Greater
   c. Lower
   d. Higher

2. Which of the following do all microorganisms require for survival?

   a. Temperature above 50°F
   b. Oxygen
   c. pH 5.0 or higher
   d. Moisture

3. When the level of salt is increased, the osmotic pressure _____ while the water activity _____.

   a. Increases, decreases
   b. Increases, Increases
   c. Decreases, increases
   d. Decreases, decreases

4. Microbial conversion of carbohydrates to organic acids is an example of a _____ change.

   a. Physical
   b. Mechanical
   c. Technical
   d. Chemical

5. What does aerobic mean?

   a. In the presence of O_2

b. In the presence of CO_2
c. In the absence of O_2
d. In the absence of CO_2

6. What gas is most frequently used for immersion freezing?

a. Carbon dioxide
b. Nitrogen
c. Oxygen
d. Ozone

Complete the following short answer questions.

7. Describe what would happen if you placed a dialysis tube completely filled with pure water into a salt water solution.

8. Give two reasons why retail cuts of meat are more vulnerable to deterioration than a whole carcass.

9. Describe how acidity influences the perishability of food.

10. Name one physical change of food due to microbial activity.

11. Name three food chemical preservatives.

TM 2.1

Food Additives Used as Preservatives

Acetic acid
Ascorbic acid
Benzoic acid
Butyl paraben
Calcium lactate
Calcium propionate
Calcium sorbate
Citric acid
Ethylene oxide
Heptylparaben
Methylparaben
Potassium propionate
Propylparaben
Salt
Sugar
Sodium benzoate
Sodium erythorbate
Sodium nitrate
Sodium propionate
Sodium sorbate
Sorbic acid
Sucrose
Sulfur dioxide

UNIT I - PRINCIPLES OF FOOD PRESERVATION AS 2.1

Lesson 2:Food Perishability Name _____

Osmosis and Diffusion Across a Semi-permeable Membrane

Objective: Students will identify the variables and controls in a lab experiment involving osmosis and diffusion across a semi-permeable membrane.

Activity Length: Part A: 60 minutes
Part B:60 minutes

Materials and Equipment:

Part A dialysis tubing, small plastic sandwich bags, or sausage casing
0.5% starch solution (1 tsp. cornstarch to 1 cup hot water, stir well)
1.0% tincture of iodine solution (4 or 5 drops of tincture of iodine to 1 cup water, stir well)
2 - beakers

Part B 4 eggs per group
vinegar
salt
corn syrup
beakers
water

PART A: Osmosis

Procedure:

1. Obtain two beakers and two strips of dialysis tubing (small plastic sandwich bags and sausage casing may be substituted). Tie one end of tubing with string and open the other end by gently rolling the tubing between your thumb and forefinger. Fill this tube with starch solution and close the tubing. (Use a tight knot to be sure it does not leak.) Rinse the tubing under water and then submerge the bag in a beaker filled with iodine solution.

2. Prepare the second tube by filling it with iodine solution, closing the ends and rinsing under water before submerging the bag in a beaker filled with starch solution. Allow both bags to remain undisturbed for at least 30 minutes before completing your observations.

Key Questions:

1. Is there any evidence that either substance has moved through the membrane of the dialysis tubing?

2. Which molecule moves through the membrane, starch or iodine? How can you tell?

3. Why does the other molecule not move through the membrane?

PART B: Diffusion Name

Procedure:

Each group obtains four fresh eggs. Label the eggs A, B, C, and D. Measure the circumference of each egg and include in Table 1.1. Place egg A in a zip-lock bag filled 1/2 full with water. This is your control. Place egg B in a zip-lock bag filled 1/2 full with salt water. Use one tablespoon of salt per 1 cup of water. Place egg C in a zip-lock bag filled 1/2 full with corn syrup. Put egg D in vinegar solution. Allow eggs to set undisturbed for 30 minutes and then observe. Take circumference readings again and include in Table 1.1.

Table 1.1 Egg Circumference

Circumference	Egg A	Egg B	Egg C	Egg D
Before experiment				
After 30 minutes				
Percent increase or decrease				

Key Questions:

1. Which egg had the largest increase in size?

2. Did any egg shrink?

3. Why do you think an acid rinse (vinegar) is not used on eggs?

4. In egg processing, why are eggs not allowed to soak in water while cleaning?

UNIT I - PRINCIPLES OF FOOD PRESERVATION AS 2.2

Lesson 2:Food Perishability

Bacteria Are Found Everywhere

Objective: To recognize that microorganisms are found everywhere and can grow under favorable conditions. Students will compare and contrast organic and inorganic compounds by observing the microbes they carry.

Activity Length: Three class periods

Materials and Equipment:

Petri dish or film with sterile nutrient agar (1 per student)
Scott tape and masking tape
Cotton swabs
Inoculation sources (coin, raw meat)
Marking pens

Procedure:

1. Each student should have a petri dish (make sure that lids are not removed until you are told to remove them).

2. Select a contamination source.

3. Obtain inoculation sources from instructor.

4. Inoculate petri film with <u>one</u> of the following:

   Open the petri dish just before adding the contaminate.

   •hands--gently touch fingers to the agar, or gently lay your hand on the agar and remove it, or lightly trace an S pattern on the agar with your finger tip.

   •lips -- touch your lips lightly to the agar.

   NOTE: agar is nontoxic.

   •hair--remove a piece of hair from your head and gently lay it on the agar. Try to avoid touching the agar with your fingers.

•cough--hold the plate 2-3 inches from your mouth and cough directly onto the agar.

•coin--place a coin (not a penny, the copper will keep many microorganisms from growing) on top of the agar in the middle of the plate. Or, gently rub or roll the coin over the surface of the agar (try not to dig a hole in the agar).

•saliva--place a clean cotton swab in your mouth and moisten it with saliva. Gently rub the moistened swab over the surface of the agar.
•raw meat--place a small piece of raw meat (i.e., ground beef) on top of the agar in the center of a plate, or gently rub the meat over the surface of the agar.

•floor--drag finger across the floor, then trace an S pattern on the agar with the same finger.

•fork--wipe the eating surface of a clean fork on the agar.

•cup--wipe the drinking surface (top of cup) on the agar.

5. Immediately close the petri dish.

6. Use scotch tape to seal the plates. (Wrap the tape around the edge of the plate.)

7. Use masking tape or marking pens to label each plate with your name and the source of bacteria. (Label plates on the bottom, write small enough that you will be able to see the bacteria once they grow.)

8. Incubate the plates upside down at 85°F. (You can incubate the plates at room temperature, but it will take longer for the microorganisms to grow.) NOTE: Keep the plates away from windows since UV light kills bacteria. You incubate them upside down so that the moisture droplets that form don't fall on the agar.

9. WASH YOUR HANDS AFTER HANDLING THE PETRI DISHES!
CAUTION: Some microorganisms on the dishes could make you sick. Always wash your hands after handling the petri dishes!!!

10. The plates will incubate for two days, but you will examine them after 24 hours.

11. Examine the plate after 48 hours.

12. Observe the number of colonies, color of colonies, shape of colonies, and any other characteristics.

NOTE: Do not remove lids from petri plates.
SAFETY NOTE: Agar plates should be autoclaved after the experiment is completed. This prevents the possible transmission of disease to anyone or anything that might come in contact with the trash. The biology instructor or local hospital may be able to help.

Key Questions:

1. What are bacteria?

2. What are three things that can be done to limit bacteria growth in the foods students prepare at home?

3. Name a type of mold that is helpful.

4. Some yeasts are used for what purpose?

5. How many colonies were found on your agar and what was their color?

Adapted from: Frick, Marty. *Food Science, Safety and Nutrition*. The National Council for Agricultural Education, 1993 and *Safe Food Preparation: It's on Your Hands.* University Extension Guide #GH1165.