

UNIT III - THE BIOCHEMISTRY OF FOODS

Lesson 1: Factors That Affect Food Safety and Quality

Objective

The student will be able to identify the factors that affect food safety and quality.

I. Study Questions

- A. What factors contribute to food spoilage?
- B. How do contaminants influence food safety?
- C. What production factors assure food safety and quality?
- D. How do food additives influence food safety and quality?
- E. How is food safety monitored?
- F. How do consumers assess the risk associated with food safety?

II. References

- A. Martin, Phillip R. *Food Science and Technology* (Student Reference). University of Missouri-Columbia: Instructional Materials Laboratory, 1994. Unit III.
- B. Activity Sheets
 - 1. AS 1.1 Nitrates in Meat
 - 2. AS 1.2 Food Safety Issues
 - 3. AS 1.3 Food Safety Concerns Survey

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Lesson 1: Factors That Affect Food Safety and Quality

TEACHING PROCEDURES

A. Introduction

Define biochemistry in relation to food science. Biochemistry is the scientific study of the chemical properties of living matter, in this case food.

B. Motivation

1. Show the video, The Nature of Change, and discuss BST: The Facts, which are available from:
Monsanto Publication
800 N. Lindbergh Blvd
St. Louis, MO 63167
(314) 694 - 1000
2. Brainstorm with students to get their ideas on where biotechnology in food science might be going. One example is the fast-paced development of seedless watermelons.

Dennis J. Gray and Gary W. Elmstrom, of the University of Florida, have developed a tissue culture process that clones thousands of seedless watermelon plants in just months instead of years. Seedless watermelons could gain a large market share if their reproductive efficiency can be heightened.

Seedless watermelons do produce a small number of seeds, but only enough to postpone the complete development of a new cultivar for 10-15 years. A parent line with two copies of each chromosome in each cell is crossed with another parent line consisting of four copies of each chromosome/cell. The offspring is seedless because only three copies of each chromosome are present in each cell.

C. Assignment

D. Supervised study

E. Discussion

1. Discuss with students the factors that contribute to food spoilage.

What factors contribute to food spoilage?

- a. Microorganisms
 - b. Natural enzymes
 - c. Insects, parasites, and rodents
 - d. Temperature
 - e. Moisture/dryness
 - f. Air - oxygen
 - g. Light
 - h. Time
2. Discuss how contaminants influence food safety.

How do contaminants influence food safety?

- a. Microorganisms ferment sugars; hydrolyze starches and fats; digest proteins; form acids, pigments and discolorations. These lead to rancid flavors, putrid odors, gas and foam production, and poisonous toxin production.
 - b. Enzymes catalyze reactions that lead to microbial invasion, rancid flavors, and browning.
 - c. Insect spoilage leads to microbial invasion; parasites inhabit the consumer; rodents spread diseases, and fecal material.
 - d. Natural dehydrating causes skin breakage which allows bacterial invasion. Freezing causes cell swelling, which causes the cell membrane to rupture.
 - e. Temperature, moisture, air, light, and time can lead to microbial invasion.
3. Discuss what production factors assure food safety.

What production factors assure food safety and quality?

- a. Quality Assurance Programs - document production and food processing practices
- b. Proper control of temperature and humidity
- c. Use of pesticides
- d. Use of animal drugs
 1. Follow withdrawal guidelines to avoid residues
 2. Proper injection procedures
 3. Proper handling of animals
- e. Grain producers - grade standards regulate grain quality

4. Discuss how food additives influence food safety. Food additives are to improve a food's appearance, flavor, texture, nutritional value or storage properties. The Food Additives Amendment of 1958 covers both intentional and incidental additives. See the student reference for definitions and examples of the food additives. Have students complete AS 1.1.

How do food additives influence food safety and quality?

- a. Preservatives
 - b. Antioxidants
 - c. Stabilizers/thickeners
 - d. Sequestrants
 - e. Nutrient supplements
 - f. Surface active ingredients
 - g. Bleaching and maturing agents
 - h. Buffers, acids, alkalies
 - i. Nitrates/nitrites
 - j. Food colors
 - k. Non-nutritive and special dietary sweeteners
 - l. Flavoring agents
 - m. Miscellaneous
5. Discuss how food safety is monitored.

How is food safety monitored?

- a. USDA's Food Safety and Inspection Service - inspectors
 - b. FDA inspects processing plants
 - c. Local, county, and state health departments
6. Discuss how consumers assess the risk associated with food safety. Have students complete AS 1.2 and AS 1.3. Discuss their answers to AS 1.3.

How do consumers assess the risk associated with food safety?

- a. Common sense/rational thinking
 - b. Irrational/fearful
- F. Other activities
 1. Have students survey their parents' concern about food safety. Have them complete AS 1.3.
See how the parents' concerns compared to the class.

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2. Have students prepare a paper from topics provided by the instructor. The paper should include: a summary of the facts; their personal views and the views of a classmate; and a journal article supporting their position.
3. Have students complete an activity from The Chemistry of Food Additives by Flinn Scientific, P.O. Box 29, Batavia, IL 60510, (708) 879-6900.

G. Conclusion

Various factors contribute to food spoilage. Microbes digest food and leave behind unpleasant reminders. Proper quality-assured handling can greatly promote food safety. Food quality is regulated by local, state, and federal authorities.

H. Competency

Identify the factors that affect food safety and quality.

Related Missouri Core Competencies and Key Skills:

- 9D-5: Describe the relationships between technologies which improve our lives and the environmental problems that can result from them.
- 10L-5: Identify the pros and cons of an environmental issue, take a position, and support.

I. Answers to Evaluation

1. Four of the following: microorganisms; natural enzymes; insects, parasites, rodents; temperature; moisture/dryness; air - oxygen; light; time
2. a
3. c
4. a, c
5. a
6. b
7. a
8. Two of the following:
 - a. Follow withdrawal guidelines - leave no residues
 - b. Proper injection procedures - do not damage tissue
 - c. Proper handling - avoid bruising
 - d. Honesty - consistent quality of entire truck with grain sample
9. d
10. c

11. f
12. a
13. l
14. h
15. c
16. d
17. e
18. k
19. g
20. j
21. b
22. i

J. Answers to Activity Sheets

AS 1.1

1. The sample with nitrite added is the one that looks more like ham since this is the treatment ham gets.
2. Students will choose the sample containing nitrate. The color alone does not justify the addition of nitrite since it also affects the taste (flavor). Without it, the ham would taste like a salty pork roast. Nitrites also act as powerful antioxidants. Nitrates also inhibit the growth of *clostridium botulinum* that causes botulism. This is an excellent opportunity to discuss the risk benefit of food additives.
3. Answer will vary.

The changes of color illustrate the reactions explained in the chart. Since the meat was not totally processed and the possible microorganisms are still present in the sample, meat should be disposed of and not consumed. One needs to know that nitrite in large concentrations is toxic, therefore, potentially dangerous.

The meat utilized in the experiment will be in the oxymyoglobin although the surface may be brown (metmyoglobin). The addition of nitrate to one portion will form the dark red nitrosomyoglobin after 24 hours in the refrigerator.

Heating the nitrosomyoglobin will form the more stable nitrosohemochrome (light pink). In the untreated sample, oxymyoglobin (bright red) will be in the interior, and on the surface. A gray brown denatured myoglobin (brown)

in the control sample will result after heating. This is the characteristic color of uncured, cooked meat.

AS 1.2 Instructor's discretion.

AS 1.3 Discuss student's responses. According to the United States Food and Drug Administration (FDA) the ranking for most important food safety considerations is as follows:

1 Disease--causing microorganisms

3 Environmental contaminants (lead poisoning for example)

6 Food additives

4 Naturally occurring toxins (poisonous plants for example)

5 Pesticide residue

2 Poor nutrition

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Date _____

EVALUATION

Match the spoilage with the agent that caused it.

- | | |
|---|-----------------------------------|
| 1. ____ Ferment sugars | a. Microbes |
| 2. ____ Enzymatic browning | b. Insects, parasites, rodents |
| 3. ____ Cause rancidity | c. Enzymes |
| 4. ____ Hydrolyze starch and fats | |
| 5. ____ Spread disease | |
| 6. ____ Cause microbial invasion | |

Complete the following short answer questions.

7. Name four factors that contribute to food spoilage.
8. Name two production procedures and how they ensure food safety.

Circle the letter that corresponds to the best answer.

9. Who monitors food safety?
- a. USDA only
 - b. FDA only
 - c. USDA and county and state inspectors
 - d. USDA, FDA, and local, county, and state inspectors

10. Risk assessment should be based on:

- a. Emotions
- b. Only the media
- c. Common sense
- d. Traditions

Match the type of food additive on the right with the best description on the left.

- | | |
|--|-------------------------------|
| 11.____Emulsify oil-in-water and water-in-oil mixtures, ex., lecithin | a. Preservatives |
| | b. Antioxidants |
| 12.____Extend shelf life and prevent deterioration, ex., sodium benzoate | c. Sequestrants |
| | d. Stabilizers |
| 13.____Low-calorie sweeteners, dietetic and diabetic foods | e. Bleaching/maturing agents |
| 14.____Modify pH | f. Surface active ingredients |
| | g. Nutrient supplements |
| 15.____Chelate trace metals, prevent oxidation and off-coloring, ex., EDTA | h. Buffers, acids, alkalies |
| 16.____Thickeners, ex., pectin | i. Food colors |
| 17.____Whiten flour and milk | j. Flavoring agents |
| 18.____Contribute to pink color in meat | k. Nitrates/nitrites |
| 19.____Added to foods deficient in necessary nutrients | l. Non-nutritive additives |
| 20.____Spices, herbs, extracts | |
| 21.____Prevent breakdown of vitamins and lipids, ex., BHA | |
| 22.____Caramel, extract of annatto, natural grape red | |

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AS 1.1

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Name _____

Nitrites in Meat

Objective: To observe the differences between fresh red meat with and without sodium nitrate added, and observe the changes after both samples are heated.

Activity Length: Two 50-minutes periods

Background Information: Cured meat is the result of a process whereby the addition of a nitrate salt causes flavor and color changes in fresh meat. The cure also acts as a preservative and inhibits the growth of pathogenic microorganisms. The nitrate salt in this process is always used in conjunction with at least some other additive such as salt, sugar, spices, and/or smoke.

Materials and Equipment:

200 g ground beef
Scale
0.016 g Sodium nitrate
2 Beakers
1 Plastic bag
Wax paper
Refrigerator
Stove or hot plate
Pan for steaming meat
Labels (masking tape will do)
Pen

Procedure:

1. Divide the freshly ground hamburger into two samples of 100 g each.
2. Put one of the samples of hamburger in a plastic bag and add 0.016 g of sodium nitrate. Mix thoroughly by kneading the bag for about 3 minutes. Label beakers A and B.

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3. Empty the contents of each bag in a beaker. Pack meat down to get rid of as much air as possible. Cover the beakers with a piece of wax paper. Record which beaker contains nitrate. Also put your name on each beaker.
4. Examine and record both the surface color and the interior color of each sample. Do not taste either sample.
5. Place beakers in a refrigerator overnight.
6. After 24 hours, remove the beakers from the refrigerator and examine the surface and interior of the meat, compare colors.
7. Heat each beaker over a steam bath for 15-20 minutes.
8. Once again, examine the samples as before. Do not taste either sample.
9. Record your results on Table 1.1.

Table 1.1

	Control (no nitrite)		Experimental (with nitrite)	
	Surface	Interior	Surface	Interior
Before Storage				
After Storage				
After Cooking				

Key Questions:

1. Which of the samples, after cooking, most closely resembles sausage?
2. Which of the cooked samples looks the most appetizing?

3. Would you purchase meats processed with nitrates? Explain your answer.

Adapted from: Frick, Marty. *Food Science, Safety and Nutrition*. The National Council for Agricultural Education, 1993.

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AS 1.2

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Food Safety and Issues

Objective: Examine an issue regarding food safety.

Directions: Select a food safety issue. Research the topic and prepare a report to answer the following questions:

1. Why is this issue important?
2. What effect does this issue have on people?
3. What is the history behind the issue?
4. What are the risks caused by the issue?
5. Is there a definite right and wrong side to the issue?
6. What are possible solutions?
7. What is my opinion of the issue?

Topic Ideas:

- Are hormones given to beef cattle present in the meat eaten by humans?
- Do pesticides affect the quality of food in the U.S.?
- Is organically grown food more nutritious than foods grown with pesticides and fertilizers?
- Does food coloring affect food quality?

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AS 1.3

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Food Safety Concerns Survey

Please rank your greatest food safety concern #1 and your least concern #6, and rank all of the numbers in between in a similar manner. Do not put your name on this paper. The purpose of this exercise is to see how your answers compare with others.

The following food safety concerns are listed in alphabetical order.

- ___Disease--causing microorganisms
- ___Environmental contaminants (lead poisoning for example)
- ___Food additives
- ___Naturally occurring toxins (poisonous plants for example)
- ___Pesticide residue
- ___Poor nutrition

