UNIT III - THE BIOCHEMISTRY OF FOODS

Lesson 5: Biotechnology in the Food Industry

Objective

The student will be able to describe the role of biotechnology in the food industry.

I. Study Questions

A. What is biotechnology?

B. How has biotechnology affected food production?

C. What are examples of bioengineered foods?

D. What business enterprises are involved in biotechnology research?

E. How will biotechnology influence the food industry in the future?

F. What factors influence new developments in food biotechnology?

II. References

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

B. Activity Sheet

AS 5.1: A Bioengineered Food Product

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TEACHING PROCEDURES

A. Review

In Unit 2, Lesson 2, you studied new food product development. It was stated that new products are developed to enhance the food's convenience and nutritional value. Unit 3, Lesson 1, examined the use of food additives in regard to food safety. Biotechnology in food science encompasses all of these ideas, from bioengineered new food products to bio-designed additives. This lesson looks at biotechnology, specifically in the food industry.

B. Motivation

A package of cheese is a good example of biotechnology in food. The rennet was developed using biotechnology. Begin class with the students writing the many ways technology has worked to produce other products. A visual example would be helpful. Examples - chicken sticks, Miracle Whip®, Cool-Whip®.

C. Assignment

D. Supervised study

E. Discussion

1. Discuss what biotechnology is.

What is biotechnology?

a. The use of living organisms to make commercial products
b. The use of microorganisms, animal cells, plant cells, or components of cells such as enzymes to produce products or carry out processes for human benefit

2. Discuss how biotechnology has affected food production.

How has biotechnology affected food production?

a. Greater variety of foods
b. Increased shelf life/safety of food
c. Greater efficiency in production of food

3. Discuss examples of bio-engineered foods.

   What are examples of bioengineered foods?

   a. Enzymes
      1. Rennet - naturally found in a calf stomach, can be synthetically produced and immobilized
      2. Lactase - cleaves lactose to glucose and galactose, can be immobilized
      3. Low-calorie foods - Non-nutritive sweeteners - aspartame, thaumatin, and monellin are taste active proteins. The genes that code for these proteins may be isolated and transferred to bacteria and produced through fermentation.
      4. Waste management - certain yeast strains can produce a grape aroma when they consume whey, a cheese-making by-product. This could be used as a flavor component for the wine and food industries.
      5. Biological monitoring - DNA fragments from disease-causing microorganisms have been coded and hybridized to probe for the presence of these organisms in food.
      6. Cellulose and collagen casings and co-extruded casings

4. Discuss the types of businesses involved in biotechnology research.

   What business enterprises are involved in biotechnology research?

   a. USDA
   b. Universities
   c. Food processing companies
   d. Commodity organizations
   e. National Live Stock and Meat Board
   f. Other food/agricultural related companies

5. Discuss how biotechnology will influence the food industry in the future.

   How will biotechnology influence the food industry in the future?

   a. A growing population will necessitate a growing food supply on less acres.
   b. Greater weed control, less insect damage, enhanced nutritional quality and safety, greater disease resistance, improved genetics
   c. Longer shelf life, new vaccines, less dependence on petroleum oil, soy- and corn-based product expansion, biological insect control, resistant varieties, more hydroponic-grown food

d. Round-up resistant corn, non-fixing grasses, soy coatings, natural antifreeze

6. Discuss what factors influence new developments.

What factors influence new developments in food biotechnology?

a. Needs of the people
b. Finances
c. Talent pool of researchers
d. Facilities/equipment
e. Weather
f. Time

F. Other activities

1. Have students complete a report on George Washington Carver's advances with the peanut.

2. Show the video, "The Nature of Change," from Monsanto Company, 800 N. Lindberg Blvd., St. Louis, MO 63167, (314) 694-1000.

3. Read and report on "Of the Earth: Agriculture and the New Biology," from the Monsanto Company, 800 N. Lindberg Blvd, St. Louis, MO 63169, (314) 694-1000.

4. Evaluate a news article on biotechnology.

5. Prepare a tissue culture using the Wisconsin fast plants tissue cultures, available from Carolina Biological Supplies.

G. Conclusion

Biotechnology is changing the production and processing of foods. New foods are routinely being developed like the non-nutritive sweeteners: aspartame, thaumatin, and monellin. Biotechnology is also being used to develop synthetic nonfood products like insulin.

H. Competency

Describe the role of biotechnology in the food industry.

Related Missouri Core Competencies and Key Skills:

9D-5: Describe the relationship between technologies which improve our lives and the environmental problems that can result from them.
10D-1: Describe general ways in which human activities affect environmental quality.

I. Answers to Evaluation

1. a
2. c
3. d

4. The use of microorganisms, animal cells, plant cells, or components of cells to produce products or carry out processes for human benefit.

5. Two of the following: greater variety, increased shelf life/safety, greater efficiency in food production.

6. USDA
Universities
Food processing companies
Commodity organizations
National Live Stock and Meat Board
Other food/agricultural related companies

7. Teacher's discretion.

J. Answers to Activity Sheets

AS 5.1

1. Too high or low a temperature will render the enzyme inactive or it will not coagulate the curd. (You may want to allow some groups to form curd using high and low temperatures.)

2.

Function	Enzyme
hydrolysis of starch to glucose	glucoamylase
coagulation of milk for cheese production	rennet
clarification and production of fruit juices	pectinase

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EVALUATION

Circle the letter that corresponds to the best answer.

1. Which of the following is a non-nutritive sweetener that has been bioengineered?

   a. Aspartame
   b. Corn syrup
   c. Cane sugar
   d. Beet sugar

2. What enzyme is used during cheese making?

   a. Glucose
   b. Lactose
   c. Rennet
   d. Thaumatin

3. What type of casing has been bioengineered to replace natural casings?

   a. Biocasings
   b. Digestive tract casings
   c. Fatty casings
   d. Cellulose casings

Complete the following short answer questions.

4. Define biotechnology.

5. Name two ways biotechnology has affected food production.

6. What are two business enterprises involved in biotechnology research?

7. Use the terms: biotechnology, herbicide-resistant varieties, shelf life, soy coatings, food safety, increased efficiency, in an essay that discusses biotechnology's future role in food production.

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A Bioengineered Food Product

Objective: Process hard curd (the primary step in cheese production) using rennin.

Activity Length: 1 class period

Background Information: Chymosin, also known as rennin, is an enzyme that is used in cheese making. When added to milk at the beginning of the cheese-making procedure, it causes the milk to coagulate, or "set," within 30 minutes so that it can be separated into curds and whey. The only source of chymosin for many years was from calf rennet, the extract from stomachs of calves which were slaughtered for veal production. The extract contained, besides chymosin, many impurities. The supply of chymosin also depended on the supply of veal calves (as the cow gets older, its stomach stops producing chymosin). The gene for chymosin has been isolated from cells of calves and inserted into a bacterium. The resultant product, recombinant chymosin, is produced by bacterial cultures in large and controllable quantities. Also, because its production can be highly controlled, it can be easily purified and therefore used without impurities. Chymosin is the first recombinant product to be approved by the FDA for use in food and is now being produced and sold commercially. This procedure demonstrates hard curd production. Hard curds are used in the production of many cheeses, such as, cheddar, Swiss, and Gouda. (Purdue University Cooperative Extension Service, 1992)

Materials and Equipment:

Thermometer
Skim milk - 1 c.
Double boiler
Hot plate
Cups
Plastic spoons and knives
Safety glasses
Rennet solution*
Water

*rennin (rennet solution: crush one junket tablet and dissolve in a tablespoon of water. If material does not dissolve completely, be sure that it is thoroughly dispersed

immediately before adding to milk. Junket tablets can be purchased in most grocery stores.)

Procedure:

1. Put on your safety glasses.

2. Place 1 cup of skim milk into the top half of the double boiler.

3. Place water in the bottom of the double boiler on a hot plate. Heat the milk to 95°F-113°F (do not allow the thermometer to rest on the bottom of the pan).

4. With constant stirring, slowly add the rennet solution.

5. Allow the milk to remain at 95-113°F for 15-20 minutes, until a firm gel is formed.

6. Cut the gel into small pieces with a plastic knife.

7. Increase the heat slowly to 113-122°F to firm the curd.

8. Allow the curd to settle.

9. The liquid in the boiler pan is called sweet whey. Pour the sweet whey into a clean cup. Taste when cooled.

10. Examine the curd. Determine the texture/consistency of the curd by squeezing it between your thumb and fingers. You may place a small piece of curd in your mouth and chew it.

Key Questions:

1. What effect does temperature have on this process?

2. What are some major industrial uses of enzymes to produce and process food?

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