IFT Experiments in Food Science Series

Microbiology in Food Systems

Activity #1

What Affects Yeast Growth?

A Science Unit for Secondary School Curriculum

Institute of Food Technologists
The Society for Food Science and Technology

STUDENT ACTIVITY GUIDE

What Affects Yeast Growth?

ACTIVITY OBJECTIVE

In this activity, you will (1) determine what factors affect the growth of yeast cells during fermentation, and (2) observe that one by-product of the fermentation process is carbon dioxide (CO_2).

MATERIALS REQUIRED

Safety goggles
125-mL Erlenmeyer flasks or small (8-oz) glass soft-drink bottles
Balloons, 7.8-cm (7-inch) size
Table sugar (sucrose)
Fructose, lactose, and glucose from science supply catalog or health food store
pH paper
Wax pencil or marker
Masking tape
Large bottle or 16 packages of rapid-rise yeast
Vinegar
Ammonia
Clock or stopwatch
Warm water bath (40°C and 80°C)
Triple-beam balances or scales
100-mL graduated cylinders
Eyedropper
Thermometers

BACKGROUND INFORMATION

Yeasts are microscopic plants that exist naturally on the surface of the Earth. They are noted for their ability to ferment carbohydrates to produce various food products, including bread, beer, wine, and cheese. During fermentation, yeast cells convert complex sugars into simple sugars which are further hydrolyzed into CO_2 and ethyl alcohol (ethanol). Yeast growth is affected by several factors, including temperature, pH, and nutrient content.

EXPERIMENTAL PROCEDURE

Group 1—Temperature Experiment

Label flasks A through D. Add 80 mL of tap water (neutral pH only) to each flask and place the flasks in the following conditions:

Flask A—in ice bath.
Flask B—at room temperature.
Flask C—in 40°C water bath.
Flask D—in 80°C water bath.

Dissolve 5 g of sucrose in each flask. Add 4 g of rapid-rise yeast to each flask and stir. Then place a balloon on each flask and seal it securely with masking tape. Periodically stir the contents by spinning the flask slowly.

Group 2—Water Activity Experiment

Label flasks E through H. Add 80 mL of 40°C water (neutral pH only) to each flask and dissolve the following amounts of sucrose in each:

Flask E—0 g (water only)
Flask F—5 g
Flask G—30 g
Flask H—50 g

Add 4 g of rapid-rise yeast to each solution and stir. Then place a balloon on each flask and seal it securely with masking tape. Periodically stir the contents by spinning the flask slowly.

Group 3—pH Experiment

Label flasks I through L. Add 80 mL of tap water (neutral pH only) to each flask and add vinegar or ammonia to adjust the pH as shown below. Use pH paper to verify the pH.

Flask I—add vinegar to adjust the pH to 3.
Flask J—add vinegar to adjust the pH to 5.
Flask K—add vinegar or ammonia to adjust the pH to 7.
Flask L—add ammonia to adjust the pH to 10.

Dissolve 5 g of sucrose in each flask and warm the solutions to 40°C. Add 4 g of rapid-rise yeast to each solution and stir. Then place a balloon on each flask and seal it securely with masking tape. Periodically stir the contents by spinning the flask slowly.

Group 4—Nutrient Experiment

Label flasks M through P. Add 80 mL of tap water (neutral pH only) at 40°C to each flask and dissolve 5 g of each of the following sugars:

Flask M—fructose
Flask N—glucose
Flask O—sucrose

Flask P—lactose

Add add 4 g of rapid-rise yeast to each solution and stir. Then place a balloon on each flask and seal it securely with masking tape. Periodically stir the contents by spinning the flask slowly.

All Groups—Observations

1. After 15 minutes, record initial observations in the table provided for each test. Then make additional observations at 10-minute intervals, and final observations. These observations should include a description of the fermentation activity and a measure of the amount of gas produced, either by measuring the actual volume of gas produced (see ancillary activities below) or by measuring the circumference of the balloon. To measure the circumference, wrap a string around the balloon at its widest point, then measure the length of the string.

2. Prepare bar graphs of balloon circumference (or cm^3 of gas produced) against each of the following:
   - Temperature
   - pH
   - Type of sugar
   - Water activity

QUESTIONS

1. What observations did you make about the flasks prior to the addition of the yeast?

2. Which flasks showed the greatest yeast growth, i.e., most production of CO_2 gas?

3. Did the contents of the flasks look and smell the same at the end of the test time? Why?

4. Knowing what you have learned about yeast "food," do you think yeast will hydrolyze gelatin or fat?

5. Which were the most favorable conditions for growth?

6. Which were the least favorable conditions for growth?

DATA TABLE

Test/Flask	Conditions	Fermentation observed	Gas produced[a]
Temperature			
A	**Sucrose + Ice bath**		
B	**Sucrose + Room temperature**		
C	**Sucrose + 40°C**		
D	**Sucrose + 80°C**		
Water activity			
E	**40°C + No sucrose**		
F	**40°C + 5 g sucrose**		
G	**40°C + 30 g sucrose**		
H	**40°C + 50 g sucrose**		

[a] **Balloon circumference in cm or volume of gas produced in cm^3**

DATA TABLE, continued

Test/Flask	Conditions	Fermentation observed	Gas produced[a]
pH			
I	**40°C + pH 3**		
J	**40°C + pH 5**		
K	**40°C + pH 7**		
L	**40°C + pH 10**		
Nutrient			
M	**40°C + Fructose**		
N	**40°C + Glucose**		
O	**40°C + Sucrose**		
P	**40°C + Lactose**		

[a] **Balloon circumference in cm or volume of gas produced in cm^3**