

Factors that Affect Kimchi Fermentation

Developed by Jackie Katz

Grade Level: 6-12

Topic: Factors that affect fermentation process when making kimchi

Essential Question: What factors affect the fermentation process when making kimchi? How can the effect of environmental factors on kimchi fermentation be objectively measured?

Time Commitment: This lesson will run for a week to collect all the necessary data. However, 3 days of the process only require 10 to 15 min for data collection. You can shorten the duration by having the students work on their final communication as homework. If the communications are created digitally the students can also view and provide feedback digitally.

Standards:

- MS-PS1-2: Analyze and interpret data on the properties of substances before and after the substances interact to determine if a chemical reaction has occurred.
- HS-LS2-3: Construct and revise an explanation based on evidence for the cycling of matter and flow of energy in aerobic and anaerobic conditions.
- HS-PS1-5: Apply scientific principles and evidence to provide an explanation about the effects of changing the temperature or concentration of the reacting particles on the rate at which a reaction occurs.
- Science and engineering practices:
 - Analyzing and interpreting data
 - Constructing explanations and designing solutions
 - Engaging in argument from evidence
 - Using mathematical and computational thinking

Learning Objectives:

- SWBAT plan and carry out a controlled experiment to determine the effect of one factor on kimchi fermentation
- SWBAT analyze data to build a model about the factors that affect fermentation

Materials (per 6 lab groups):

- 2 Napa Cabbages
- Resealable bags, 1-gallon (2-3 per lab group)
- Sea salt($\frac{1}{2}$ cup/group)
- Fish sauce (1 tbsp/group)
- Green onions (evenly divide 5 chopped between groups)
- 3 Small white onion ($\frac{1}{2}$ onion/group)
- Garlic cloves (2 cloves/group)
- White sugar (2 tbsp/group)
- Ground ginger (1 tsp/group)
- Korean chili powder (5 tbsp/group)
- Bowl (1/group)
- Spoon (1/group)
- Measuring spoons (1/class)
- Knife (1/class)
- Scales (1/group)
- Sharpie (1/group)
- Cutting board (1/class)
- Colander (1/group)

<ul style="list-style-type: none"> ● pH strips/pH probe ● Glucose test strips ● Thermometer (1/group) ● Student experimental design planning sheet ● Suggested Readings: <ul style="list-style-type: none"> ○ Images for preparing kimchi ○ Understanding kimchi reading (suggest students read page 1) ○ Kimchi recipe (students can use these as a basis for their own procedure) 	
<p>Student prior knowledge needed:</p> <ul style="list-style-type: none"> ● Basic equation of cellular respiration ● Aerobic vs. anaerobic respiration ● Enzymes (including factors that affect enzyme activity) ● Osmosis 	
Time	Lesson Sequence
<i>Class 1</i>	
15-45 min (depending on how much time you want to spend)	<p>Phenomenon Launch:</p> <ol style="list-style-type: none"> 1. Students should independently observe at least 3 different types of kimchi (you can purchase this from the store or make 3 different recipes) <ol style="list-style-type: none"> a. They can fill out an “observe-reflect-question” table while independently observing. They should split the table so they can record thoughts for the different types of kimchi provided. b. Students are welcome, but not required to taste the kimchi (be aware of allergies) c. If you do not have access to store that sell kimchi, have students explore the following to observe, reflect and question: <ol style="list-style-type: none"> i. 10 images of kimchi ii. 7 types of kimchi video 2. Students should share their observations. Make a class “observe-reflect-question” table on the board. 3. Ask students what could be causing the differences observed 4. Record these initial ideas on the board. You can revisit these at the end of the lesson
<i>Between Class 1 & 2</i>	
30 min	<p>Teacher Prep:</p> <ol style="list-style-type: none"> 1. Cut the cabbages (2 heads) in half, lengthwise, and trim the ends 2. Rinse and cut the remaining cabbage into pieces, about 5cm chunks 3. Place the cabbage into 4 large resealable bags. 4. Sprinkle salt (1 cup between 4 bags) on the leaves. Use your

	<p>hands to rub salt into the leaves</p> <ol style="list-style-type: none"> 5. Seal the bags and leave them at RT for 6 hours 6. Cut other vegetables <ol style="list-style-type: none"> a. Chop green onions b. Mince white onions 7. Combine 1 tbsp fish sauce, 5 green onions, ½ white onion, 2 pressed garlic cloves, 1tsp. Ginger, 5 tbsp. Korean chili powder
<i>Class 2</i>	
45 min	<p>Lab Planning & Set-up:</p> <ol style="list-style-type: none"> 1. Have each lab group design an experiment to test one of the factors that could be causing the differences in kimchi observed <ol style="list-style-type: none"> a. Factors include: Salt content, sugar content, time of fermentation, temperature of fermentation, light exposure, water, oxygen content b. Provide students with lab planning sheet and basic kimchi recipe 2. It is recommended that the teacher review the procedure prior to students setting up their experiment <ol style="list-style-type: none"> a. Things to check for prior to approving procedure: Single independent variable with necessary constants, objectively measurable dependent variable, about 3 days to allow fermentation to occur 3. Once the group's procedure is approved have them set-it up <ol style="list-style-type: none"> a. Divide the prepped cabbage and sauce between the lab groups
10-15 min (<i>this will need to occur during class 3, 4, and 5 as well</i>)	<p>Data Collection:</p> <ol style="list-style-type: none"> 1. Lab groups should design a lab table for both qualitative and quantitative data 2. Lab groups should collect data each day for 3 days <ol style="list-style-type: none"> a. Urge groups to take photos each day
<i>Class 6</i>	
45 min	<p>Communication Preparation:</p> <ol style="list-style-type: none"> 1. Lab groups should prepare to share their findings. This could come in the form of an oral presentation, scientific poster, lab report, CER, etc. (see guidelines below for each method) 2. Provide students guidelines for their scientific communication 3. Provide class time for students to analyze their data and put together their scientific communication.
<i>Class 7</i>	
45 min (optional)	<p>Share-out:</p> <ol style="list-style-type: none"> 1. Depending on the format of the communication, students share out with either a gallery walk/symposium or

	presentation session. 2. Have students provide constructive feedback to one another during the share-out.
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Options to Communicate Findings

1. [Oral presentation](#)
2. [Scientific Poster](#)
3. [CER](#)
4. [Lab Report](#)

Additional Information:

- [History of Kimchi](#)
- [Kimchi in other cultures](#)
- [The science of onggi](#)
- [The microbes of kimchi podcast](#)
- [Chemistry of kimchi video](#)
- [Health effects of kimchi](#)