

Lesson 6.7: Quick Bread Science Lab

Unit: Unit 6, From Farm to Table (Food Systems and Production) **Topic:** 6.2 Food Preparation Methods and Science **Grade:** 6 to 8 (written at grade 7; see Differentiation for the grade 6 support and grade 8 stretch) **Days:** 2 class periods of 40 minutes (Day 1 the science, the hypothesis, and the prediction sheet; Day 2 mix, bake, measure, taste, and conclude) **Room:** FACS lab with three or four kitchen stations of about seven students and an oven (a no-oven version is below)

Standards

- NYS module line: NYS FSP 1. Basic Culinary Skills d) Demonstrate accurate measuring of dry/solid, liquid, and small quantity ingredients
- NYS module line: NYS FSP 1. Basic Culinary Skills e) Prepare a simple recipe
- NYS module line: NYS FSP 2. Food Preparation d) Demonstrate the skills and techniques common to food preparation of the region
- CTE theme line: CTE PSI 1. Problem Solving a) Describe the scientific method of inquiry as it relates to real-world problem solving
- CTE theme line: CTE PSI 1. Problem Solving e) Demonstrate personal development of problem-solving skills through practice of these skills in a variety of classroom applications
- NYS FACS Learning Standard 1 (Intermediate), Key Idea: Students will use an understanding of the elements of good nutrition to plan appropriate diets for themselves and others. They will know and use the appropriate tools and technologies for safe and healthy food preparation.; Performance Indicator A: Students understand the relationships among diet, health, and physical activities; evaluate their own eating patterns; and use appropriate technology and resources to make food selections and prepare simple, nutritious meals.; Performance Indicator B: Students apply principles of food safety and sanitation.
- CDOS Standard 3a Universal Foundation Skills: Thinking Skills
- National FCS 3.0: 8.5.10 Prepare breads, baked goods, and desserts safely and with professional technique.
- National FCS 3.0: 9.5.6 Run sensory evaluations of food products.

(This is a controlled experiment, not a recipe day. The PSI lines carry the method and the FSP lines carry the measuring and the baking.)

Enduring understanding and essential question

Big idea: Baking is chemistry you can eat. A quick bread rises because something in the batter makes gas. Change one thing on purpose, keep everything else the same, and the food itself tells you what that one thing does. **Essential question:** Four batches, one difference. Can you prove which ingredient made the bread rise?

Objectives

By the end of this lesson, students will be able to:

1. (Low: understand) Explain how leavening works in one or two sentences: baking powder and baking soda make carbon dioxide gas, the gas makes bubbles, the bubbles lift the batter, and baking soda needs an acid to start.
2. (Mid: apply) Name the independent variable, the dependent variable, and at least four constants in the class's four-batch experiment, and write a hypothesis that predicts an outcome for each batch.
3. (High: evaluate) Using the height, crumb, and taste data from all four batches, write a conclusion that says whether the hypothesis held, names the evidence, and identifies one thing that could have gone wrong with the test.

Vocabulary

Tier 2 (general academic): hypothesis, variable, constant, evidence, conclusion Tier 3 (FACS): leavening, baking powder, baking soda, acid, carbon dioxide, quick bread, crumb, rise, control batch. See the unit vocabulary list (Vocabulary 06.md) for Turkish, Portuguese, and Spanish.

Materials and setup

Day 1, the fizz demonstration, per class:

- 4 clear cups, water, white vinegar, 1 teaspoon of baking soda, 1 teaspoon of baking powder, 4 spoons, a tray to catch overflow. Cups 1 and 2 test baking soda in water and baking soda in vinegar. Cups 3 and 4 test baking powder in water and baking powder in vinegar. Cost about \$2 for the vinegar, which is a pantry item afterward.
- Handout 06.07 - Quick Bread Lab Sheet.md, one per student

Day 2, per station of about seven students, four batches of four small muffins each:

- Dry, per batch: 1 cup all purpose flour, 2 Tbsp sugar, 1/4 tsp salt, plus the leavening treatment for that batch (see the table)
- Wet, per batch: 1/2 cup milk, 2 Tbsp vegetable oil, 1 egg, pre-cracked into a cup by the teacher
- Leavening treatments: Batch A (control) 1 tsp baking powder. Batch B 0, no leavening at all. Batch C 2 tsp baking powder. Batch D 1 tsp baking soda and no acid anywhere in the batter.
- Tools per station: 4 medium bowls labeled A, B, C, D with tape, 4 spoons or whisks, dry measuring cups, measuring spoons, a straight edge for leveling, 1 liquid measuring cup, 1 muffin tin with 16 paper liners (or 4 tins of 4), 1 ruler per station, 2 oven mitts, 1 trivet, paper plates and forks, 1 sanitizing spray and 2 cloths
- Oven at 400 degrees. Bake about 12 to 14 minutes. The teacher opens the oven and moves the tin, every time.
- Slides: Slides 06.07 - Quick Bread Science Lab (Day 1 and Day 2 marked)

- Setup notes: label the four bowls before class or the batches get mixed up, which ruins the experiment and the period. Pre-crack the eggs into a cup per station. Put the leavening jars at the teacher's table, not the station, and dispense them yourself, because a student who adds baking powder to Batch B by accident has ended the experiment. Set the oven at the start of Day 2's do now. Sanitation routine, same six steps as every lab: hair back, sleeves up, wash hands, sanitize surfaces, clean as you go, station check before dismissal. Allergy check the day before: wheat, dairy, and egg are all in this recipe. Substitutions are in Differentiation. Nobody is required to taste. Cost per station about \$2.50 to \$3.50 plus pantry draw; see the cost table in Teacher notes.

Pre-assessment

Day 1 do now asks what makes a muffin different from a slice of bread from a bakery. Students who say "yeast" already have half the concept and can take the grade 8 stretch. Day 1 also reuses the prediction sheet as a pre-assessment: the four predictions are written before any batch exists, and they get compared to the data on Day 2.

Do now and hook (Time: Day 1, 4 min; Day 2, 3 min)

Day 1, on the board: "A muffin and a loaf of bakery bread both rise. Do you think they rise the same way? Write yes or no and one guess about what makes each one rise."

Debrief: take four answers, no corrections. Then the hook: pour vinegar into the cup of baking soda without warning. It climbs over the rim onto the tray. "That gas is what lifts a muffin. Today you figure out exactly which ingredient makes it and what happens when it is missing."

Day 2, on the board: "Read your prediction for Batch B. Do you still believe it? Yes or no, one sentence."

Debrief: thirty seconds. Then the hook: "Four bowls, one difference, no cheating. Whatever comes out of that oven is the answer, and it is not up for a vote."

Procedure

Step	Teacher will	Students will	Time
Day 1, 1. Direct instruction: how leavening works	Explain it in four sentences: baking powder and baking soda both make carbon dioxide gas in a batter; the gas makes bubbles; the bubbles get trapped and push the batter up; and the heat sets the batter around them so the bread	Write the four sentences in their own words on the lab sheet. Mark which of the two needs an acid.	9 min

	stays up. Then the difference: baking powder already has its own acid mixed in, so water and heat are enough to set it off, and baking soda has no acid of its own, so it needs an acid in the recipe (buttermilk, yogurt, vinegar, lemon juice, brown sugar, cocoa) or it mostly sits there and leaves a soapy taste.		
Day 1, 2. The four-cup fizz test	Run all four cups in order, calling the result out loud each time: soda plus water (a little), soda plus vinegar (a lot), powder plus water (a lot), powder plus vinegar (a lot). Ask the class to state the rule from the evidence.	Record all four results on the lab sheet, then write the rule in one sentence: "Baking soda needs , baking powder does not because ."	7 min
Day 1, 3. Set up the experiment: variable and constants	Put the four batches on the board with the treatment table. Name the independent variable out loud (the leavening), the dependent variable (how high it rises, plus crumb and taste), and the constants (flour, sugar, salt, milk, oil, egg, bowl size, batter per liner, oven temperature, bake time, same	Fill the variable and constants table on the lab sheet. Write at least four constants. Circle the independent variable.	9 min

	oven, same shelf). Say why the control batch exists.		
Day 1, 4. Predictions	Release the prediction sheet: one prediction per batch, height ranked 1 to 4, plus one sentence on taste and texture for Batch D. Then assign roles for Day 2 from Handout 06.08 - Role Cards Lab 3.md with the measuring roles spread across the four batches.	Write four predictions and rank the four batches by expected height. Read their role card and find their tag-in partner.	7 min
Day 2, 1. Prep phase: mix the four batches	Run the six-step sanitation routine and start the timer. Walk the room checking aprons, hair, and hands. Dispense the leavening yourself, batch by batch, calling out "Batch B gets none" so the whole station hears it. Watch the leveling.	Mix all four batches in the labeled bowls: dry ingredients measured and leveled, wet added, stirred just until combined (about 15 strokes, lumps are fine), then 1/4 cup of each batch into four labeled liners. Do not overmix.	13 min
Day 2, 2. Bake and measure the before	Collect the tins, load the oven, set the timer for 13 minutes. Nobody touches the oven. While it bakes, run the measurement drill: each station measures and records the batter height in the liner for all four batches.	Measure and record the before height for each batch with the ruler. Write the time the tin went in. Clean the mixing bowls and tools while the batches bake.	8 min

Day 2, 3. Data: height, crumb, taste	Pull the tins yourself and set them on trivets. Wait one minute. Plate one muffin from each batch per station and hold the rest. Run the three measurements out loud in order: height with the ruler, crumb by splitting one open and counting holes as none, few, or many, then taste with the protocol (own fork, own plate, tasting is a choice).	Measure and record the after height, the crumb, and the taste for all four batches. Rank the four by actual height. Compare the ranking to the prediction.	9 min
Day 2, 4. Conclusion and clean	Give the conclusion frame on the board and take two conclusions out loud. Call “clean” at minute 35 and walk the station check.	Write the conclusion on the lab sheet: what the data showed, whether the hypothesis held, the evidence, and one thing that could have gone wrong. Then clean the station by zone and pass the station check.	5 min

Questions to ask

Monitor understanding:

- Which bowl is the control, and what is a control for?
- Batch D has baking soda and no acid. What do you expect to taste?
- Your Batch C rose the highest and then sank in the middle. Is that a failure or data?
- Why does every batch get the same amount of batter in the liner?

Deepen learning:

- If we had changed the oven temperature for one batch, could we still say the leavening caused the difference? Why not?

- The recipe on a box of baking soda tells you to add buttermilk. Now you know why. What else in a kitchen would work as the acid?
- Batch B barely rose and it is still edible. Name a food where you want that, where you do not want it to rise.
- Your before heights were not all identical. Does that break the experiment? How much difference is too much?

Check for understanding

Day 1: the rule sentence after the fizz test. A “got it” says baking soda needs an acid and baking powder brings its own. Day 2: the clipboard check during Step 1, one question per station, “which bowl gets none, and who is watching that it stays none?” Any station that cannot answer both parts gets the leavening dispensed last.

Closure (Time: Day 1, 4 min; Day 2, 2 min inside the clean phase)

Day 1: one line on the exit card: “The one thing we are changing is **. Batch** will rise the highest because ____.” Two students read. Sort into “got it” and “needs more”; a card that names two variables instead of one gets a thirty-second fix before Day 2’s timer starts.

Day 2: the station check is the closure. When I sign a station, the Station Manager reads the station’s one-sentence conclusion out loud. The lab sheets are collected at the door.

Differentiation and supports

- ELL: the treatment table is a picture table (four bowls, four labels, the leavening drawn as a spoon); the fizz test needs no English to read; the conclusion has a four-part frame printed on the sheet (“The data showed **. My hypothesis was** . My evidence is **. One thing that could have gone wrong is** .”); leavening, rise, gas, acid, and crumb are on the vocabulary card in Turkish, Portuguese, and Spanish (see Vocabulary 06.md).
- IEP and 504 (general): the data table is fill-in numbers, not prose; the ruler measurement can be reported as taller or shorter than the batch beside it for a student who cannot read a ruler to the eighth of an inch; role cards are checklists; a student who should avoid heat takes Prep Cook, Toppings Chief, or Plate Builder and never handles the tin; extended time by writing the conclusion at the start of Lesson 6.8.
- Allergy substitutions: wheat, one labeled batch made with a gluten free flour blend and run as a fifth batch or as that station’s Batch A; dairy, plant milk one for one; egg, 3 Tbsp of applesauce or 1 Tbsp ground flax in 3 Tbsp water per batch, with the note on the sheet that this changes the texture and is itself a variable. *[Sal: confirm every substitution against the nurse’s allergy list, not the student’s word.]*
- Grade 6 support: three batches instead of four (A control, B none, C double) and the prediction is a ranking only, with no taste sentence. The crumb count is “few holes or many holes,” not a number.
- Grade 8 stretch: add a fifth batch, baking soda plus 1 tsp of vinegar, and answer whether it rises more like Batch A or Batch D and what that proves. Stretch students also identify one confounding variable in the class’s own test and say how they would control it next time.

- UDL checkpoint used: multiple means of representation (a live fizz test, the printed treatment table, and the food itself as the data) and multiple means of action and expression (the conclusion can be written in the frame, drawn as four labeled muffins with heights, or recorded out loud to the teacher at the station check).
- No-oven alternative: the microwave mug version, same four treatments. Per station, four mugs labeled A, B, C, D. Each mug gets 1/4 cup flour, 1/2 Tbsp sugar, a pinch of salt, the treatment leavening (1/4 tsp baking powder for A, none for B, 1/2 tsp powder for C, 1/4 tsp baking soda for D), 2 Tbsp milk, 1/2 Tbsp oil, and 1 Tbsp of beaten egg. Stir with a fork, microwave one at a time for 60 to 75 seconds, cool two minutes, then measure the height against the inside of the mug with a ruler or a marked popsicle stick. Everything else in the lesson is identical, and the rise is easier to see in a clear mug than in a liner. The timing shifts: Day 2 Step 1 drops to 10 minutes and Step 2 becomes the microwave rotation at 11 minutes.

Assessment

Objective	Standards met	Learning task	Assessment (formative or summative; tool)
1. Explain how leavening works	FSP 1. e); PSI 1. a)	The four sentences and the fizz rule, Day 1 Steps 1 and 2	Formative; lab sheet checked for the acid rule; exit card sorted. Assessed summatively on the Cooking Methods Check, item 9
2. Name the variable and constants and write a hypothesis	PSI 1. a); PSI 1. e); CDOS 3a Thinking Skills	Variable table and prediction sheet, Day 1 Steps 3 and 4	Formative; four constants and one independent variable required. Assessed summatively on the Cooking Methods Check, item 10 (the experiment's variable)
3. Write a conclusion from the data with evidence and a limitation	FSP 1. d); FSP 2. d); Std 1 PI A and PI B; National FCS 8.5.10, 9.5.6	The lab, Day 2 Steps 1 to 4	Summative; Rubric 01 - Lab Rubric.md, the three objective rows plus the safety and sanitation row, 16 points, scored on the clipboard during Step 3 and Step 4 and from the lab

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Homework

None. The conclusion is finished in class or in the first five minutes of Lesson 6.8.

Connections

Science: this is the science teacher's lesson with food in it. Send them the lab sheet; if they have already taught variables and controls, say their words out loud here instead of new ones, and if they have not, this is their preview. Math: the height measurements are fractions of an inch and a ranking, and the before-and-after difference is subtraction with units. *[Sal: ask the science teacher which words they use for independent and dependent variable. Using their exact wording is free and it makes both classes stronger.]*

Sources

- NYS Middle Level CTE FACS Content Module 06, Food Systems and Production (nyctecenter.org, June 2018), lines 1. d), 1. e), and 2. d). Copy in 02 Standards/NYS Module PDFs/.
- NYS Middle Level CTE Theme Module 05, Problem Solving and Innovation, lines 1. a) and 1. e). Same folder.
- NYS Learning Standards for Health, Physical Education, and Family and Consumer Sciences (1996), Standard 1, Intermediate, FACS strand, Performance Indicators A and B. Wording per 02 Standards/STANDARDS SOURCES - web research.md, section 2. *[Sal: confirm against the NYSED PDF.]*
- CDOS Intermediate Standard 3a Universal Foundation Skills, Thinking Skills. Same file, section 3.
- National Standards for Family and Consumer Sciences Education 3.0 (LEAD FCS Education, 2018), competencies 8.5.10 and 9.5.6.
- Unit 1, Lesson 1.8, for the science connection on baking powder that Sal's own mug cake recipe sheet already carried, and Rubric 01 - Lab Rubric.md for scoring.
- Sal's own materials: the four-phase workflow, the role card structure, and the clean-up zones come from his King Kullen lesson packages (Education/TeachingWork/LessonPlans), rewritten for a station of seven.

Teacher notes

- Dispense the leavening yourself. This is the one place where handing a jar to a station ruins the data. It takes ninety seconds to walk four bowls with a measuring spoon.
- If Day 2 runs short, cut the taste row and keep height and crumb. If the oven is slow, the microwave version fits in the same period with no oven at all.
- Batch C often rises fastest and then collapses. That is real and it is the best data in the experiment: too much gas makes a structure that cannot hold itself. Do not treat it as a mistake.

- Batch D will taste metallic or soapy to most students. Warn them before they taste so nobody thinks something is wrong with them, and tell them that is exactly the evidence.
- Common mistake: overmixing. Say “fifteen strokes and stop, lumps are fine” out loud and once at each station. Overmixed batter is tough and it confounds the test.
- Keep one muffin from each batch under plastic wrap for the review before the Cooking Methods Check. Four muffins in a row are a better review slide than a slide.
- Per-station cost estimate (store brand, Long Island supermarket, and every price marked [update from this week’s circular]):

Item	What one station of seven uses	Estimated cost per station	Notes
Milk, 1 quart	2 cups across four batches	about \$0.90 of a \$1.79 quart	One quart covers two stations
Eggs	4 eggs	about \$1.20 of a \$3.49 dozen	Teacher pre-cracks into a cup per station
Vegetable oil	1/2 cup	pantry	48 oz bottle, about \$4.49, lasts the year
Flour, sugar, salt	4 cups flour, 1/2 cup sugar, 1 tsp salt	pantry	From the Unit 1 pantry startup
Baking powder and baking soda	3 tsp powder, 1 tsp soda	pantry	About \$2.49 and \$1.29 for the year
Paper muffin liners	16	about \$0.35 of a \$2.49 pack of 100	
Total per station		about \$2.50 to \$3.50	Well under the \$20 per station cap
Class of four stations		about \$10 to \$14 plus pantry draw	Add white vinegar, about \$1.79, for the Day 1 fizz test

- *[Sal: this is the cheapest lab in the unit and the one that gets the most out of a period. If the budget is tight the week you plan Unit 6, run this one and the pasta lab and make the quesadilla lab the optional third.]*