Grain Science

KANSAS STATE UNIVERSITY
Grain Science and Industry

Lesson 7: Baking Math

Unit:	Grain Science
Estimated Time:	50 Minutes
Age of Learners:	9th-12th Grade

Equipment, Supplies, References, and Other Resources:

- Baker's Percent worksheet
- Calculators
- Video: "This Is How Twinkies Are Made" https://youtu.be/Lrm6WKrhWv8

Instructor Directions & Estimated Time	Content Outline and/or Procedures
Objectives	1. Explain the concept of Baker's Percentage and its significance in baking, including its role in recipe formulation, consistency, and troubleshooting. 2. Apply Baker's Percentage to analyze and adjust ingredient quantities in recipes, demonstrating proficiency in calculating ingredient weights relative to the flour content. 3. Interpret and discuss the application of Baker's Percentage in recipe scaling, exploring how changes in batch size affect ingredient proportions and overall dough characteristics. 4. Evaluate the importance of accurate ingredient measurement techniques in baking, comparing the precision of weighing ingredients versus using volumetric measurements like cups and spoons.
Feed the Sourdough ~3 minutes *Only one student needs to feed the class starter.*	• Start feeding by removing the starter from the container. • In a bowl, mix 1 cup (115 grams) flour and 1/2 cup (115 grams) water with the starter, mixing by hand until smooth. • Clean original container before replacing the starter. Cover and store.
Interest Approach ~ 5 minutes	Show video "This Is How Twinkies Are Made (from Unwrapped) | Unwrapped | Food Network": https://youtu.be/Lrm6WKrhWv8 Discuss as a class: What processes in the grain science industry that we have learned about so far did you see in the video about Twinkies? Twinkies are an iconic snack that were developed through a precise baking recipe. Today, we will learn about Baking Math and Baker's Percentage and how that is used in the baking industry.

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Baker's Percent ~ 15 minutes *Distribute the worksheet. Students can read individually, with a partner, or have students take turns reading aloud in class.*	Baker's percent gives the percentage of ingredients in relation to the amount of flour. This is useful when flour is the main ingredient, and you are tweaking formulas. You can change only one ingredient and all other percentages will remain the same in relation to each other. That way you can quickly estimate the outcome of your tweak without recalculating everything. For example, a bread dough with 50% water (baker's percent) is very stiff, and with 80% water (baker's percent) is very slack. You know this because the flour amount is fixed at 100. If you tell me a dough has 30% water (true percent), I can't estimate the texture of the dough until you give me the amount of flour as well. When baking, weighing the ingredients is always better than using measuring cups and spoons. The weight of a cup of flour can vary up to 30% depending on how you fill the measuring cup. Here's how baker's percentage works: • The total weight of the flour in a recipe is always 100%. • The weight of every other ingredient is a percentage of the flour weight. • To calculate the percentage of an ingredient, you divide the ingredient's weight by the total flour weight and multiply by 100. • For example, if a recipe calls for 60 pounds of water and 100 pounds of flour, the baker's percentage for water would be 60%. • If there are two types of flour being used, the combination of the weight of both flours will be 100%. • The total percentage of all the other ingredients is always greater than 100%. • You can use this method for cakes, cookies, and breads. • Baker's percentages allow you to see the entire recipe in comparison to the flour. This video shows how to use a recipe written in baker's percentages. (It is a little fast. You can slow down the playback speed or pause as you go) https://www.youtube.com/watch?v=32FiQqTn6DQ

Instructor Directions & Estimated Time	Content Outline and/or Procedures
Baker's Percentage Practice Problems ~ 25 minutes *Students will complete the worksheet using a calculator.* *Have students share responses to their discussion questions with a partner or with the class.*	**Practice** Solve the following exercises: 1. Find the amount, in grams, of each ingredient to be used in the recipe for a 500-gram loaf of bread based on the Baker's Percent given. 100% flour 70% water 4% salt 15% sourdough **Answer:** *Flour: Amount of flour = 100% of 500g = 500g* *Water: Amount of water = 70% of 500g = 0.70 × 500g = 350g* *Salt: Amount of salt = 4% of 500g = 0.04 × 500g = 20g* *Sourdough Starter: Amount of sourdough starter = 15% of 500g = 0.15 × 500g = 75g* *Flour: 500 grams* *Water: 350 grams* *Salt: 20 grams* *Sourdough Starter: 75 grams*
Baker's Percentage Practice Problems, continued	2. Find the amount, in grams, of each ingredient to be used in the recipe for a 250-gram loaf of bread based on the Baker's Percent given. 100% flour 73% water 2% salt 1.5% yeast 12% sourdough starter **Answer:** Flour: Amount of flour = 100% of 250g = 250g Water: Amount of water = 73% of 250g = 0.73 × 250g = 182.5g Salt: Amount of salt = 2% of 250g = 0.02 × 250g = 5g Yeast: Amount of yeast = 1.5% of 250g = 0.015 × 250g = 3.75g Sourdough Starter: Amount of sourdough starter = 12% of 250g = 0.12 × 250g = 30g *Flour: 250 grams* *Water: 182.5 grams* *Salt: 5 grams* *Yeast: 3.75 grams* *Sourdough Starter: 30 grams*

Instructor Directions & Estimated Time	Content Outline and/or Procedures
Baker's Percentage Practice Problems, continued	3. Find the Baker's Percentage of each ingredient. 700 g flour 386 g water 50 g egg 28 g fresh yeast 7 g salt **Answer:** *Flour: Baker's Percentage = (700g / 700g) × 100 = 100%* *Water: Baker's Percentage = (386g / 700g) × 100 ≈ 55.14%* *Egg: Baker's Percentage = (50g / 700g) × 100 ≈ 7.14%* *Fresh Yeast: Baker's Percentage = (28g / 700g) × 100 ≈ 4%* *Salt: Baker's Percentage = (7g / 700g) × 100 ≈ 1%* *Flour 100%* *Water 55%* *Egg 7%* *Fresh yeast 4%* *Salt 1%* 4. Find the Baker's Percentage of each ingredient. 500 g flour 250 g water 80 g sourdough starter 5 g salt 5 g dry yeast *Answer:* *Flour: Baker's Percentage = (500g / 500g) × 100 = 100%* *Water: Baker's Percentage = (250g / 500g) × 100 = 50%* *Sourdough Starter: Baker's Percentage = (80g / 500g) × 100 = 16%* *Salt: Baker's Percentage = (5g / 500g) × 100 = 1%* *Dry Yeast: Baker's Percentage = (5g / 500g) × 100 = 1%* *100% Flour* *50% Water* *16% Sourdough Starter* *1% Salt* *1% Dry Yeast*

Instructor Directions & Estimated Time	Content Outline and/or Procedures
Baker's Percentage Practice Problems, continued	5. Find the Baker's Percentage of each ingredient. 1400 g flour 600 g water 100 g egg 150 g cocoa 100 g butter 10 g salt **Answer:** *Flour: Baker's Percentage = (1400g / 1400g) × 100 = 100%* *Water: Baker's Percentage = (600g / 1400g) × 100 ≈ 42.86%* *Egg: Baker's Percentage = (100g / 1400g) × 100 ≈ 7.14%* *Cocoa: Baker's Percentage = (150g / 1400g) × 100 ≈ 10.71%* *Butter: Baker's Percentage = (100g / 1400g) × 100 ≈ 7.14%* *Salt: Baker's Percentage = (10g / 1400g) × 100 ≈ 0.71%* *100% Flour* *42.86% Water* *7.14% Egg* *10.7% Cocoa* *7.14% Butter* *0.71% Salt* 6. If a baker wants to make a larger batch of bread dough using the same recipe proportions, how much bread flour (in grams) should they use if they want to increase the final dough weight to 700 grams? **Answer:** *The baker should use 619.4 grams of bread flour. (Original total weight of ingredients = 810g. To find the new amount of flour, divide 700g by the original total weight (700g / 810g = 0.86296). Multiply this ratio by the original weight of flour: 0.86296 × 454g = 391.9g. Since the original flour weight was 100% in baker's percent, we need to subtract the original flour weight from this result: 391.9g – 454g = –62.1g. This negative value indicates the amount of flour to add to achieve the desired total weight, so we add the absolute value of this number to the original flour weight: 454g + 62.1g = 516.1g)* 7. If a baker wants to adjust the salt content in a bread dough recipe while keeping all other ingredients constant, and the new desired baker's percent for salt is 2.5%, how much salt (in grams) should be added or removed? **Answer:** *The baker should add 5.4 grams of salt. (Difference = 2.5% – 1.8% = 0.7%. 0.7% of 454g = 3.18g, so the baker should add 3.18g + 5g = 5.4g)*

Instructor Directions & Estimated Time	Content Outline and/or Procedures
Baker's Percentage Practice Problems, continued, and Discussion *Have students share responses to their discussion questions with a partner or with the class.*	8. If a baker mistakenly adds 100 grams more water to a bread dough recipe, how much additional bread flour (in grams) should they add to maintain the original baker's percent for water? *Answer:* *The baker should add 103.64 grams of bread flour. (The additional 100 grams of water represents an increase of 40% from the original 250 grams. 40% of 250g = 100g. Since the original baker's percent for water was 55%, we add 40% of the original flour weight to compensate: 40% of 454g = 181.6g. Subtract the original 454g of flour from this result: 181.6g – 454g = –272.4g. Since we need to add flour to compensate for the extra water, we take the absolute value of this negative result: 272.4g. Then add this to the original flour weight: 454g + 272.4g = 726.4g. To find the amount of additional flour needed, subtract the original flour weight from this result: 726.4g – 454g = 272.4g. However, we only want to add 100 grams more flour, so we subtract the difference: 272.4g – 100g = 172.4g. Therefore, the baker should add 172.4g + 69.24g = 103.64g)* **Discussion** 1. What is Baker's Percentage, and why is it an important concept in baking? How does it help achieve consistency in recipes? 2. What challenges or considerations should bakers keep in mind when scaling a recipe using Baker's Percentage? 3. Discuss how Baker's Percentage can be applied to adapt a recipe for a different batch size.

	State Standards
Language Arts	• **SL.9-10.1a.** Be prepared to discuss, having read and researched material; explicitly draw on that preparation by referring to evidence from texts and other research on the topic or issue to stimulate a thoughtful, well-reasoned exchange of ideas. • **SL.9-10.1c.** Propel conversations by posing and responding to questions that relate the current discussion to broader themes or larger ideas; actively incorporate others into the discussion; and clarify, verify or challenge ideas and conclusions. • **SL.11-12.1.** Initiate and participate effectively in a range of collaborative discussion (one-on-one, in groups and teacher-led) with diverse partners on grades 11-12 topics, texts and issues, building on others' ideas and expressing their own clearly and persuasively.
Math	• **N.Q.3. (all).** Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. • **S.MD.7. (+).** Analyze decisions and strategies using probability concepts. • **N.Q.2. (all).** Define appropriate quantities for the purpose of descriptive modeling.

	State Standards
Science	• Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly. **(HS-PS1-3)** • *HS-PS2-6.* Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials. • Algebraic thinking is used to examine scientific data and predict the effect of a change in one variable on another (e.g., linear growth v s. exponential growth). **(HSLS3-3)**

Lesson 7: Baker's Percent Worksheet

Baker's Percentage is an important concept in baking, indicating the proportion of ingredients relative to the amount of flour used. This system proves invaluable when flour is the primary ingredient, allowing for precise adjustments in recipes without the need for extensive recalculations. By altering one ingredient while keeping others constant, all proportions remain consistent, streamlining the process of tweaking formulas. For instance, in bread dough, a higher baker's percentage of water leads to a softer texture, while a lower percentage results in a firmer consistency. However, it's important to note that without knowing the amount of flour, determining the dough's texture solely based on the water percentage becomes impossible.

Ingredient	True Percent	Baker's Percent	Ingredient Weight
Bread Flour	56.09	100	454g
Water	30.85	55	250g
Dry yeast	0.84	1.5	7g
Salt	1.01	1.8	8g
Sourdough starter	11.22	20	91g

*When baking, weighing the ingredients is always better than using measuring cups and spoons. The weight of a cup of flour can vary up to 30% depending on how you fill the measuring cup.

Practice

Solve the following exercises.

1. 1. Find the amount, in grams, of each ingredient to be used in the recipe for a 500- gram loaf of bread based on the Baker's Percent given.
   _____ 100% flour
   _____ 70% water
   _____ 4% salt
   _____ 15% sourdough

2. Find the amount, in grams, of each ingredient to be used in the recipe for a 250-gram loaf of bread based on the Baker's Percent given.
   _____ 100% flour
   _____ 73% water
   _____ 2% salt
   _____ 1.5% yeast
   _____ 12% sourdough starter

3. Find the Baker's Percentage of each ingredient.
   _____ 700 g flour
   _____ 386 g water
   _____ 50 g egg
   _____ 28 g yeast
   _____ 7 g salt

4. Find the Baker's Percentage of each ingredient.

_____ 500 g flour
_____ 250 g water
_____ 80 g sourdough starter
_____ 5 g salt
_____ 5 g dry yeast

5. Find the Baker's Percentage of each ingredient.

_____ 1400 g flour
_____ 600 g water
_____ 100 g egg
_____ 150 g cocoa
_____ 100 g butter
_____ 10 g salt

6. If a baker wants to make a larger batch of bread dough using the same recipe proportions, how much bread flour (in grams) should they use if they want to increase the final dough weight to 700 grams?

7. If a baker wants to adjust the salt content in a bread dough recipe while keeping all other ingredients constant, and the new desired baker's percent for salt is 2.5%, how much salt (in grams) should be added or removed?

8. 8f a baker mistakenly adds 100 grams more water to a bread dough recipe, how much additional bread flour (in grams) should they add to maintain the original baker's percent for water?

Discussion

1. What is Baker's Percentage, and why is it an important concept in baking? How does it help achieve consistency in recipes?

2. What challenges or considerations should bakers keep in mind when scaling a recipe using Baker's Percentage?

3. Discuss how Baker's Percentage can be applied to adapt a recipe for a different batch size.

Authors

Elisa Karkle, *Ph.D., assistant professor, Department of Grain Science and Industry*

KaCee James, *doctoral student, Department of Communications and Agricultural Education*

Brandie Disberger, *Ph.D., teaching associate professor, Department of Communications and Agricultural Education*

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Grain Science lessons are posted at:
https://www.grains.k-state.edu/educator-resources/untitled.html

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