



Reactions in Baking

Chocolate Chip Cookies & Vanilla Cupcakes

Brought to you by Sienna Dudas and Nina Dawood



Materials/ Safety

- Cookie Ingredients
- Cupcake Ingredients
- Sugar (glucose)
- Baking Soda (sodium bicarbonate)
- Baking tools
- Oven mitts



Chemical Reaction in Cookies

When the sodium bicarbonate (baking soda) absorbs heat, a chemical reaction occurs:

- Produces bubbles
- Chewy
- Coarse texture
- Allows cookies to rise

Chemical Equation of Sodium Bicarbonate



This is a decomposition reaction!

Trial 1 = 4.26 g (1 tsp)

Trial 2 = 6.39 g (1.5 tsp)

Trial 3 = 8.52 g (2 tsp)

Stoichiometry

$$2\text{NaHCO}_3 \rightarrow \text{Na}_2\text{CO}_3 + \text{H}_2\text{O} + \text{CO}_2$$

Na = 22.990	Na = 22.990 × 2	H = 1.008 × 2
H = 1.008	C = 12.011	O = 15.999
C = 12.011	O = 15.999 × 3	18.015
O = 15.999 × 3	105.988	
84.006		

C = 12.011

Trial 1 = 4.26 g (1 tsp)	O = 15.999 × 2
Trial 2 = 6.39 g (1.5 tsp)	44.009
Trial 3 = 8.52 g (2 tsp)	

$$\frac{4.26}{84.006} = 0.05 \text{ moles}$$
$$\frac{0.05}{2} = 0.025$$

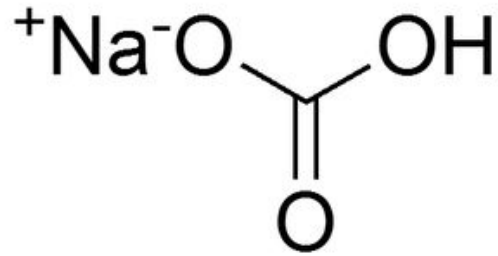
105.988 · 0.025 = 2.64

18.015 · 0.025 = 0.45

44.009 · 0.025 = 1.1



Sodium Bicarbonate



- Ionic bond
- White, solid, crystalline appears powdery



Cookie Ingredients

Trial 1

- 2 ¼ cups baking soda
- **1 teaspoon baking soda**
- 1 teaspoon salt
- 1 cup butter
- ¾ cup granulated sugar
- ¾ cup brown sugar
- 1 teaspoon vanilla extract
- 2 eggs
- 2 cups chocolate chips

Trial 2

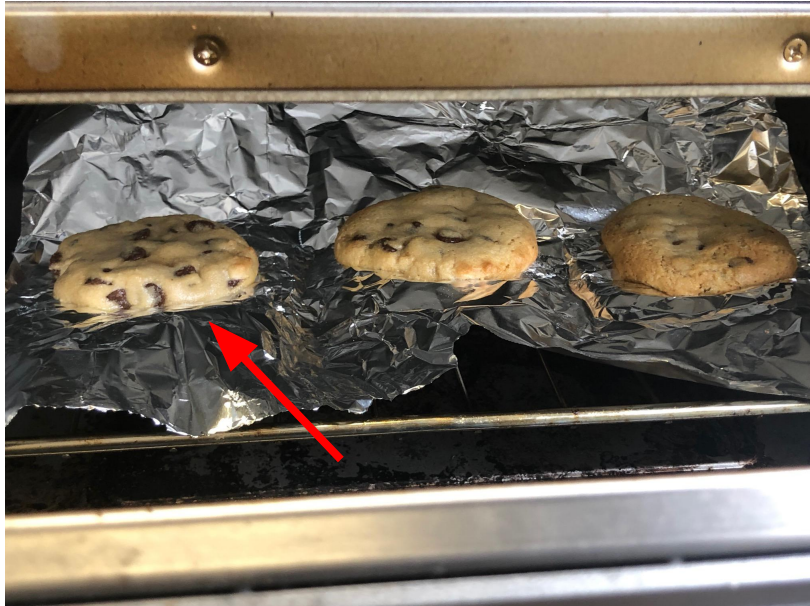
- 2 ¼ cups baking soda
- **1 ½ teaspoon baking soda**
- 1 teaspoon salt
- 1 cup butter
- ¾ cup granulated sugar
- ¾ cup brown sugar
- 1 teaspoon vanilla extract
- 2 eggs
- 2 cups chocolate chips

Trial 3

- 2 ¼ cups baking soda
- **2 teaspoons baking soda**
- 1 teaspoon salt
- 1 cup butter
- ¾ cup granulated sugar
- ¾ cup brown sugar
- 1 teaspoon vanilla extract
- 2 eggs
- 2 cups chocolate chips



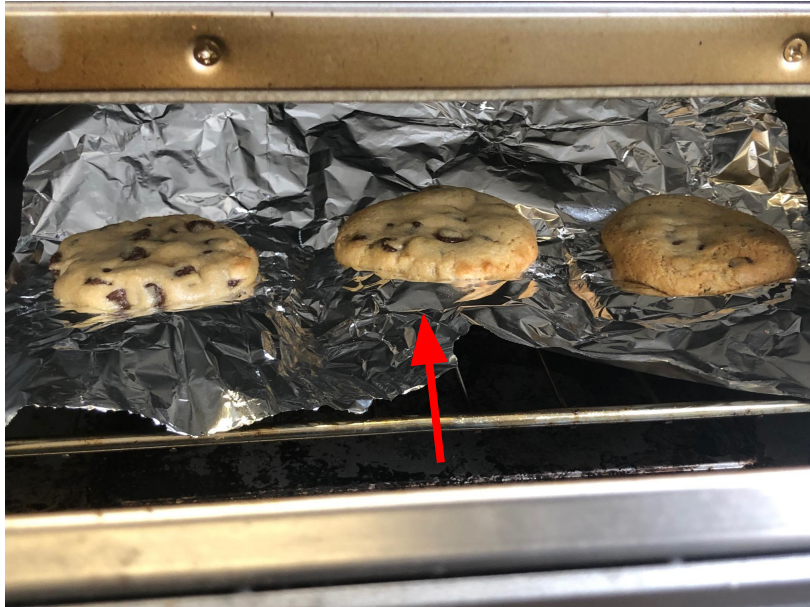
Trial 1



- Baked for 12 minutes 350°
- 1 tsp baking soda
- More gooey throughout baking
- After halfway through edges were still doughy



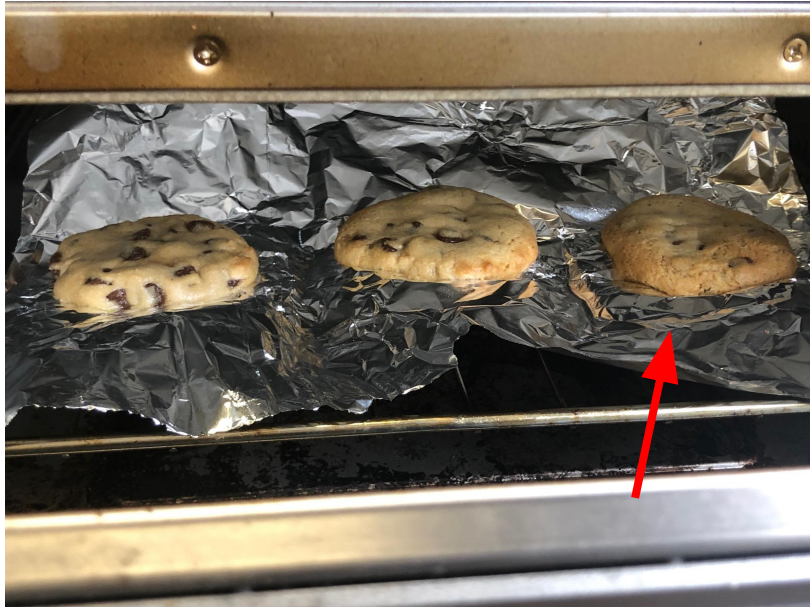
Trial 2



- Bakes at 12 min 350°
- 1 ½ tsp baking soda
- Dough a little stickier
- A little browned halfway through baking



Trial 3



- Baked for 12 min 350°
- Dough more sticky
- Halfway through baking edges browned
- Crispiest



End Results

Trial 1 cookie: Doughy center, lightly crisped edges, lightest in color

Trial 2 cookie: Slightly less doughy center, harder edges, more golden in color

Trial 3 cookie: Crispy throughout, crunchy edges, brown color

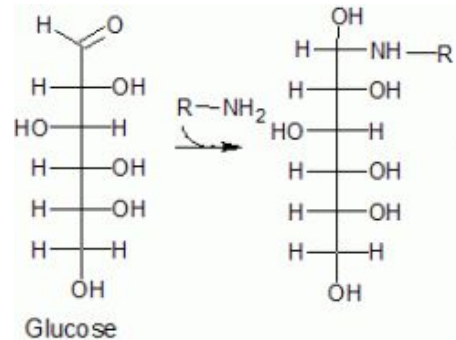
Vanilla Cupcakes

Maillard Reaction

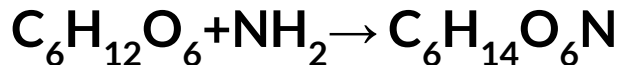


Maillard Reaction

- Maillard Reaction occurs between amino acids and reducing sugars in the presence of heat, resulting in the coloration in foods.
- Chemical reactions are affected by temperature change
- Increasing the temperature will cause a raise and browning in the cupcakes



Chemical Equation



- Glucose has covalent bonds
- 120 grams of sugar multiplied by the molar mass of glucose, equals moles.
- Molar mass of NH₂ multiplied by moles of glucose.
- Molar Mass of C₆H₁₄O₆N multiplied by moles of glucose.

Glucose 1/1 ratio

$$\text{C}_6\text{H}_{12}\text{O}_6 + \text{NH}_2 \rightarrow \text{C}_6\text{H}_{14}\text{O}_6\text{N}$$

sugar

120 grams of sugar

$12.011 \times 6 = 72.066$	$1.008 \times 12 = 12.096$	$15.999 \times 6 = 95.994$	14.007	$+ 2.016$
72.066			16.023 molar mass	
180.156 molar mass			196.179 molar mass	

$120 \div 180.156 = 0.666 \text{ moles}$

$0.666 \times 16.023 = 10.67 \text{ grams}$

$0.666 \times 196.179 = 130.65 \text{ grams}$



Cupcake Ingredients

- 1 1/2 sticks unsalted butter
- 1 1/2 cups sugar
- 2 eggs
- 2 teaspoons pure vanilla extract
- 2 1/2 teaspoons baking powder
- 1/4 teaspoon salt
- 2 1/2 cups flour
- 1 1/4 cups milk
- Prep 15 minutes
- Cook 15 minutes
- Ready in 30 minutes

Step 1

- Preheat oven to 350 degrees F
- Put foil or cupcake liners on the cupcake pan or cookie sheet
- Sift together the the baking powder, the flour, baking soda. Cocoa and salt.



Step 2

- In a large bowl, cream together the butter and sugar until light and fluffy.
- Add the eggs one at a time, beating well with each addition, then stir in the vanilla.
- Add the flour mixture alternately with the milk; beat well. Fill the muffin cups 3/4 full.



Step 3

- Bake for 15 to 17 minutes in the preheated oven, or until a toothpick inserted into the cake comes out clean.
- Frost with your favorite frosting when cool.



Trail #1

- Regular ingredients
 - Heat 350 degrees
 - Time 15:00
- Outcome
- Fluffy inside
 - Slight crunch outside



Trail #2

- Added $\frac{1}{8}$ tsp of sugar
- Heat 350 Degrees
- Time 15:00

Outcome

- Browner Outside
- Harder outer shell



Trail #3

- Added ½ tsp of sugar
- Heat 350 degrees
- Time: 20:00

Outcome

- Browner
- Outer shell is harder
- A bit dry



End Results

- The more sugar added the darker the cupcake turned. (Caramelization)
- The more sugar added the harder the outside shell became.
- Within each trial the cupcake got drier.





Enthalpy

- Endothermic reaction
- Heat derived from oven to turn into a solid
- Heat is being absorbed while baking and is also being released after.
-



Real World Application

- Cooking is an everyday activity- sugar and baking soda are crucial to many recipes
- They will determine how well your food comes out

Thank you!!!

Questions?