Chemistry Chip Cookies

A Mole Day Activity

Introduction

The following recipe for chemistry chip cookies provides a fun and interesting activity to celebrate Mole Day, October 23! The activity offers a useful review of metric and unit conversions and mole calculations.

Reagents

- *Theobroma cacao*, 66.66 dozen
- Gluten, 317.25 g
- Sodium hydrogen carbonate, 0.0595 moles
- Sodium chloride, 0.1134 moles
- Partially hydrogenated tallow triglyceride (softened), 0.225 kg
- Sucrose, 150000 mg
- Unrefined, dark crystalline sugar, 199.5 g
- 4-hydroxy-3-methoxybenzaldehyde or (methyl ether of protocatechuic aldehyde), 5000 µL (microliters)
- Matured ovum with yolk overlaid with albumen proteins from *Gallus domesticus* female, 100g

Procedure

All reactants should be at room temperature. Do not double the recipe.

Use Conversion Sheet to identify reactants and measurements using kitchen equipment.

1. Preheat oven to 463 Kelvin.
2. Combine gluten, sodium hydrogen carbonate, and sodium chloride. Mix until a homogeneous mixture is obtained.
3. In a separate bowl, add partially hydrogenated tallow triglyceride, Sucrose, Unrefined, dark crystalline sugar, 4-hydroxy-3-methoxybenzaldehyde, and Matured ovum with yolk overlaid with albumen proteins from *Gallus domesticus* female… Beat well after each addition. Stir until well blended.
5. Form 24.00-g balls of mixture.
6. Place 12 balls on a 304.8 mm x 4.572 x 10^-4 km cookie sheet lined with aluminum foil (shiny side up). Procedure should make about 36 balls total.
7. Place the cookie sheet into the oven set at 463 K.
8. Bake for 0.007 days.
9. Carefully remove from oven using a hot mitt. Place on a heat-protected surface and allow to come to room temperature (25 °C).
10. Ingest, digest, and egest, but most of all, *enjoy*!
Conversion Worksheet

Conversion Factors

*Theobroma cacao* = Chocolate Chips
1 cup = 400 Chips

Partially hydrogenated tallow triglyceride = Butter
1 cup = 225g
1 stick = 0.5 cup

Unrefined dark crystalline sugar = Dark brown sugar
1 tablespoon = 16.625 g of dark brown sugar
16 tablespoons = 1 cup

Matured ovum with yolk overlaid with albumen proteins from *Gallus domesticus* female = Chicken egg
1 large chicken egg with shell removed = 50 g

Gluten = All-purpose flour
1 cup of all-purpose flour = 141 g

Sodium chloride = Table salt
1 mole = 58g
1 teaspoon table salt = 6.63 g

Sodium hydrogen carbonate = sodium bicarbonate, NaHCO₃ = Baking soda
1 mole = 6.02 x 10²³ molecules
1 mole = 84g
1 teaspoon baking soda = 5 g

4-hydroxy-3-methoxybenzaldehyde = Vanilla Extract
1 metric teaspoon = 5 mL

Sucrose = Table sugar
1 cup = 200 g sucrose
16 tablespoons = 1 cup
1 tablespoon = 12.5 g sugar

Other Factors

°C + 273 = Kelvin
5/9 (°F – 32) = °C
1 inch = 2.54 cm
1000 m = 1 km
10 mm = 1 cm
1 day = 24 hours
1 hour = 60 minutes
Calculations: Each calculation number reference a step in the baking direction. Convert each unit to an appropriate unit for baking.

1. 463 Kelvin to °F

2a. 317.25 g Gluten to cups

2b. 0.0595 moles of sodium hydrogen carbonate to teaspoons

2c. 0.1134 moles of sodium chloride to teaspoons

3a. 0.225 kg partially hydrogenated tallow triglyceride to sticks

3b. 150000 mg Sucrose to cups

3c. 199.5 g unrefined, dark crystalline sugar to cups

3d. 5000 µL 4-hydroxy-3-methoxybenzaldehyde to teaspoons

3e. 100 g matured ovum with yolk overlaid with albumen proteins to eggs

4. 50 dozen Theobroma cacao to cups

6. 304.8 mm x 4.572 * 10^-4 km cookie sheet, convert dimensions to inches

8. 0.007 days to minutes
10. 25 °C to °F
Chocolate Chip Cookie Lab Work
Name: __________________________

<table>
<thead>
<tr>
<th>Directions</th>
<th>The Chemistry of It</th>
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<tr>
<td>Preheat oven to _________ degrees</td>
<td>Changing temperature changes the _________ energy of the particles in the mixture.</td>
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<td>Steps 2 &amp; 3</td>
<td>Only ________________ changes.</td>
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<td>Step 4</td>
<td>You add flour late in the process so that you won't &quot;work&quot; the dough for too long, keeping the gluten complexes small.</td>
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<td>Step 5</td>
<td>Definitely a ________________ mixture.</td>
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<td>Step 6: Drop dough by rounded tablespoonfuls 2 inches apart onto cookie sheet.</td>
<td>Size matters. CO2 bubbles form throughout the entire cookie. Only the outside gets hot enough to caramelize.</td>
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<td>Step 8: Bake _____ to _______ minutes or until light brown. The centers will be soft.</td>
<td>When the batter heats up, the sucrose (sugar) breaks down into glucose and fructose, forming a polymer chain, giving the cookie its light brown, shiny crust. When sodium bicarbonate (baking soda) heats up, it causes a chemical reaction: (2 \text{NaHCO}_3 \rightarrow \text{Na}_2\text{CO}_3 + \text{H}_2\text{O} + \text{CO}_2). The CO2 gas that's formed makes the &quot;bubbles&quot; in the cookies. NaCl (salt) keeps the bubbles from getting too big by slowing the production of CO2. The fat (butter) keeps the flour from forming an overly extensive network of gluten, giving the cookie a lighter texture. The fat and protein (egg yolk) hold the dough together and the albumin (egg whites) support the bubbles.</td>
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<td>Step 9: Remove from oven and let cool for one minute. Remove from cookie sheet and place on wire rack to finish cooling.</td>
<td>Cooling allows caramelizing to be completed and allows structure developed by gluten and egg to set.</td>
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