

What Makes Cookies Rise?

You work as a chemist at a large food sciences laboratory. You received the following inquiry from a local bakery.

The head baker at a local bakery recently hired an inexperienced baker. The new baker complained to the head baker that none of their cookies would rise. The head baker asked to see the recipe that was used:

The Best Chocolate Chip Cookies

Ingredients:

- 2.5 cups of flour
- 1 teaspoon of salt
- 1 cup of softened butter
- 1 cup of packed brown sugar
- 0.5 cups of granulated sugar
- 2 eggs
- 2 teaspoons of vanilla
- 2 cups of chocolate chips



Instructions:

Preheat oven to 350 °F

Combine flour and salt

In a separate bowl, beat brown sugar, butter, and white sugar with mixer until fluffy

Beat in eggs and vanilla

Add flour mixture to the butter mixture. Stir in chocolate chips.

Drop spoonfuls of dough on baking sheet and bake for 12-14 minutes until lightly browned.

The head baker notices that a raising ingredient is missing. The head baker does not understand the chemistry behind what makes a cookie rise so they have enlisted your help. You are to compose a report consisting of answers to the following questions that can be given to the bakery. This will be used to train newly hired bakers on the chemistry behind baking to avoid this misstep in the future.



Questions and Points of Discussion:



- 1) What ingredient is missing from the recipe that would make the cookies rise?
(Hint: It is a single ingredient that can be purchased from the grocery store).
- 2) What is the chemical formula of the missing ingredient found in question 1?
- 3) What is the balanced chemical reaction through which the ingredient makes the cookies rise? Only one example is required.
- 4) What type of chemical reaction is this?
- 5) Which product of the reaction is responsible for making the cookies rise?
(Hint: add states to the chemical reaction you created in question 3).
- 6) How do you explain the chemistry behind what makes cookies rise?

Submit this report to your teacher to receive a follow up inquiry from the bakers.

Suggested Readings:

- 1- *Understanding Ingredients for the Canadian baker*; The BC Articulation Committee, 2015. <https://opentextbc.ca/ingredients/front-matter/introduction-2/>
- 2- Gisslen, W. *Professional Baking*, 6th ed.; John Wiley & Sons, Inc.; New Jersey, 2013. http://dl.booktolearn.com/ebooks2/cooking/9781118083741_professional_baking_6581.pdf
- 3- OpenStax. *Chemistry*: Chapter 4 Stoichiometry of Chemical Reactions; Rice University, <https://opentextbc.ca/chemistry/chapter/4-2-classifying-chemical-reactions/>

Now you can recommend the addition of a raising agent such as baking powder to the bakers. The bakers took your advice and added baking powder to their cookies in the correct quantity. You receive a follow-up report that the cookies still did not rise. You ask the bakers about the baking powder that they used. They say it has been in a large jar with a broken seal sitting next to a humidifier for a couple of years. The bakers purchase their baking powder in bulk because they believe it is more economical which is why it has been in the kitchen for such a long time.

Create a report for the bakers that answers the following questions:

- 1) Why is it a problem that the baking powder was not properly sealed while it was stored? What allows the reaction between the acidic and basic components of baking powder to occur?
- 2) What would prevent the reaction from occurring in the container if it was properly sealed?
- 3) Is purchasing a large quantity of baking powder really the most economical option for the bakers?
- 4) Design a simple experiment that the bakers can use to check if their baking powder is still active. Explain how the experiment you design accomplishes this task.



There are multiple forms of baking powder available on the market consisting of baking soda and an acid in the form of a powder. There are also other acids that can be used with baking soda as a raising agent while baking. The bakers have decided to create their own raising ingredient consisting of baking soda and an acid, for economic benefits. They store the acids and bases in separate containers for long-term storage. Attached is a list of ingredients that can be used to allow cookies to rise and the products that are associated with the reaction. Determine the correct reactions based on the reactants and products available and balance the equations. (**Hint:** you should be able to create 5 reactions with the provided list of ingredients and some components will be used more than once).

NaHCO_3	CO_2	$\text{H}_2\text{C}_4\text{H}_4\text{O}_6$	$\text{Al}(\text{OH})_3$	$\text{NaAl}(\text{SO}_4)_2$
Na_2SO_4	H_2O	$\text{Ca}(\text{H}_2\text{PO}_4)_2$	$\text{Na}_2\text{C}_4\text{H}_4\text{O}_6$	CaHPO_4
$\text{NaC}_2\text{H}_3\text{O}_2$	$\text{KHC}_4\text{H}_4\text{O}_6$	Na_2HPO_4	$\text{C}_2\text{H}_4\text{O}_2$	$\text{KNaC}_4\text{H}_4\text{O}_6$