Shimmy, Shimmy Soda Pop: Develop Your Own Soda Pop Recipe

Difficulty	
Time Required	Average (6-10 days)
Prerequisites	None
Material Availability	You will need to purchase citric acid at a specialty store or online. See the Materials and Equipment list for details.
Cost	Low ($20 - $50)
Safety	No issues

Abstract

Carbonated bevarages are quite popular in the United States (despite the health risks of drinking too much of the sugary ones). Many people love them their their bubbly, fizzy flavors. But how do the bubbles, fizz, and taste get into the water? In this cooking and food science project, you will work with baking soda, citric acid, and sweetener to create a your own soda pop. Once you develop your recipe, try it out on your friends and family. Who knows? You might create the next soda pop sensation!

Objective

To determine a ratio of baking soda, citric acid, and sweetener that makes an enjoyable soda pop.

Credits

Michelle Maranowski, PhD, Science Buddies

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APA Style

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Introduction

A nice way to spend a warm and lazy Saturday afternoon is to go to your local park and have a picnic. What kinds of things would you take on your picnic? Potato salad? Sandwiches? Barbecued chicken? Despite the health risks associated with drinking too many sugary drinks, many people enjoy carbonated drinks like soda pop. The average American drinks 50 *gallons* of soda pop a year! (Public Health Advocacy, 2009). But what *is* soda pop and is it easy to make?

Soda pop is essentially carbonated water with a sweetener (sugar or artificial) added. **Carbonated** water is water into which a **gas** called **carbon dioxide** has been **dissolved** under high **pressure.** When you open a can or bottle of soda, the pressure is released and the carbon dioxide starts to come out of the solution. The escaping carbon dioxide is what causes the bubbles in the beverage. Figure 1 shows carbon dioxide bubbles escaping from a soda pop drink.

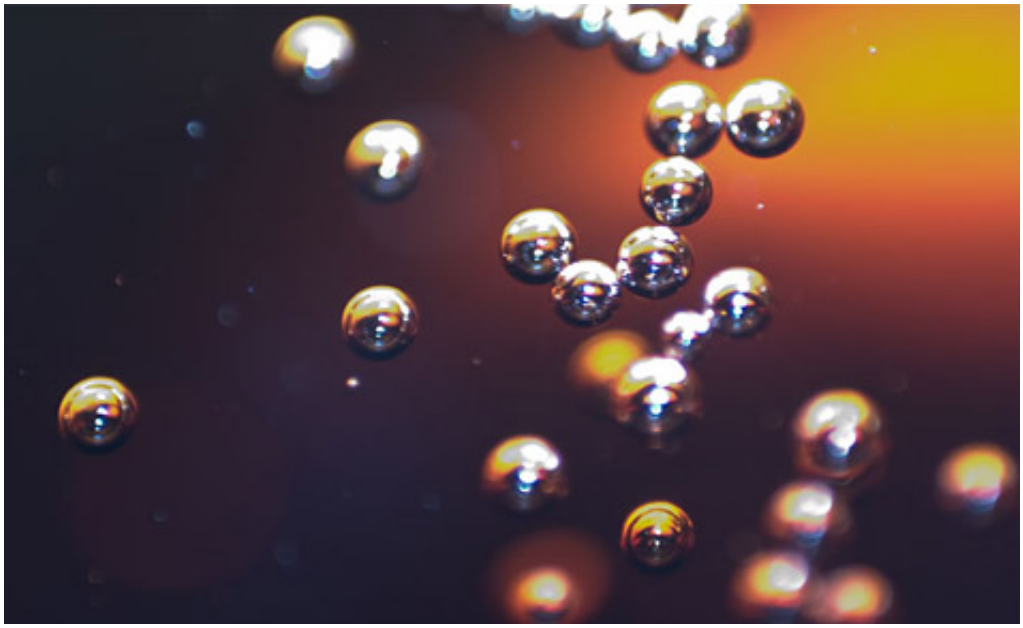

Figure 1. Carbon dioxide bubbles in soda. (Wikipedia, 2005.)

Carbonation also occurs in nature, when water underground comes in contact with a source of carbon, such as limestone. The reaction between the water, limestone, and the high pressure of the earth creates carbon dioxide and dissolves it into the water. When the water eventually rises to Earth's surface, the pressure is released and bubbly water is the result. In the 1700's, this naturally carbonated water was thought to be a healthy beverage that could cure all kinds of ailments like arthritis, indigestion, and constipation. In 1767, an Englishman named Joseph Priestley discovered a way to **artificially** carbonate water, which inspired many doctors and **pharmacists** to figure out ways to reliably carbonate large batches of water for their patients. By the late 19th century, there were soda shops and soda fountains in pharmacies (where Mom and Dad get the medicine prescribed by your doctor) all over the United States. Yes, that's right, in pharmacies. Why? Because carbonated water, or soda, was still considered to be a healing beverage! Pharmacists were actually the first people to create flavored sodas. They used crushed fruits, nuts, and roots to make the drink more tasty. In fact, pharmacists created most of the soda pop recipes with which you are

familiar now.

In this cooking and food science project, you will use **baking soda** (also called *sodium bicarbonate*), **citric acid,** and sweetener to develop your own recipe for soda pop. When you mix baking soda and citric acid together with water, a **chemical reaction** (like the one in the earth, mentioned above) takes place that creates carbon dioxide. The results of two chemicals reacting together are called the **products** of the reaction. So, in the chemical reaction when you combine baking soda and citric acid, the products of the reaction are carbon dioxide, water, and sodium citrate. Sodium citrate, just like the others you will be working with, is a harmless substance and is safe to eat or drink.

How much of each ingredient will you need to make a soda that has a good amount of bubbly fizz and the right touch of sweetness? How long will the bubbly fizz last? Get your taste buds ready for an adventure!

Terms and Concepts

- Carbonization
- Gas
- Carbon dioxide
- Dissolve
- Pressure
- Artificial
- Pharmacist
- Baking soda
- Citric acid
- Chemical reaction
- Reaction product
- Chemical equation
- Data
- Mathematical average

Questions

- What causes a soda pop drink to become what we call *flat*?
- Where in the world are there natural springs that produce carbonated water? *Hint:* If you have trouble finding an answer, go to the grocery store and read some labels!
- Do you drink soda pop? What flavors of your soda pop do you enjoy?
- What methods are used now to artificially carbonate water?
- What are the health effects of drinking too much soda pop?
- What is baking soda?
- What is citric acid? Which fruits naturally contain citric acid?
- What is the **chemical equation** that describes the reaction between baking soda, citric acid, and water?

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For help creating graphs, try this website:

- National Center for Education Statistics, (n.d.). *Create a Graph*. Retrieved June 2, 2009, from http://nces.ed.gov/nceskids/createagraph/ (http://nces.ed.gov/nceskids/createagraph/)

Materials and Equipment

A project kit containing most of the items needed for this science project is available for puchase from AquaPhoenix Education (https://www.aquaphoenixeducation.com/sciencebuddies/ProductDetails/tabid/122/ProductID/29/Default.aspx). Alternatively, you can gather the materials yourself using this shopping list:

- Baking soda, 8-ounce (oz) box
- Citric acid, 50 grams (g). You can find food-grade citric acid at your local health foods store or online at Amazon (http://www.amazon.com/gp/product/B0001FUGTE/ref=as_li_ss_tl?ie=UTF8&tag=sciencebuddie-20&linkCode=as2&camp=1789&creative=390957&creativeASIN=B0001FUGTE).
- Teaspoon (tsp.), ¼-tsp. measure
- Teaspoon, 1/8-tsp. measure
- Plastic cups, clear (6)
- Liquid measure cup, 1-cup capacity
- Wooden coffee stirrers (10)
- Digital kitchen timer
- Paper towels (1 roll)
- Sugar or artificial sweetener, 50g
- Lab notebook
- Optional: Graph paper

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Experimental Procedure

Making the Soda

1. In your lab notebook, make a data table, like Table 1, below, where you can record data as you experiment.

Amount of Baking Soda	Amount of Citric Acid	Trial	Initial Bubbliness	Initial Grittiness	Bubbliness After 1 Minute	Grittiness After 1 Minute
1/16 tsp.	1/4 tsp.	1				
		2				
		3				
1/8 tsp.	1/4 tsp.	1				
		2				
		3				
1/4 tsp.	1/4 tsp.	1				
		2				
		3				
1/2 tsp.	1/4 tsp.	1				
		2				
		3				
1 tsp.	1/4 tsp.	1				
		2				
		3				

Table 1. In your lab notebook, make a data table like this one to record your results in while you test recipes with different amounts of baking soda.

2. Add 1/16 tsp. (fill half of the 1/8-tsp. measuring spoon) of baking soda to the plastic cup. Add ¼ tsp. of citric acid to the same plastic cup. Gently swirl the cup to mix the baking soda and the citric acid together.
3. Using the measuring cup, add ¼ cup of cool, clear water to the plastic cup. Use the wooden stirrer to quickly mix the solution together, and then taste the beverage.

4. Are there a lot of bubbles? Is the liquid mildly bubbly or is it bubbling a lot? Rate the bubbling on a scale of 1–5, where 1 is not bubbly at all and 5 is too bubbly, in the *Initial Bubbliness* column of the data table (*Initial,* in this case, means "at first").
5. Taste a little bit of the beverage. How does it feel on your tongue? Is the liquid too gritty? Do you find the feeling of the liquid in your mouth pleasant? Rate the grittiness of the beverage on a scale of 1–5, where 1 is not gritty at all and 5 is too gritty, in the *Initial Grittiness* column of the data table.
6. After tasting the beverage, feel free to spit out the liquid. It will not harm you to swallow it, but it might not taste very much like soda yet (mostly because sweetener has not yet been added) and you also do not want to over-acidify your stomach (which could give you a slight stomachache), because there is still more testing to do.
7. Set the timer for 1 minute and leave the beverage alone. After 1 minute has gone by, take a sip of the beverage again. How are the bubbliness and grittiness after sitting undisturbed for 1 minute? Note how the beverage tastes, and rate the bubbliness and grittiness, using the same scale you used in steps 4–5, in the *Bubbliness After 1 Minute* and *Grittiness After 1 Minute* columns in your data table. Again, if you choose, spit out the liquid into the other plastic cup.
    a. *Tip:* To be consistent about how long the mixture is sitting before you taste it the second time you may want to start the 1 minute timer right after you mix the solution above in step 3.
8. Pour any remaining liquid down the drain. Rinse out both plastic cups and wipe them out with a paper towel. Make sure that there is not any extra baking soda or citric acid in the bottom of the cup that you are using to mix the ingredients.
9. Repeat steps 2–8 four more times, using the amounts of baking soda and citric acid listed in Table 1, above.
10. Pour any remaining liquid down the drain. Rinse out all plastic cups and wipe them out with a paper towel. Make sure that there is not any extra baking soda or citric acid in the bottom of the cup that you are using to mix the ingredients.
11. Now repeat steps 2–10 two more times for a total of three trials for each measurement. It is always necessary to repeat your experiments to ensure that the data you have collected is reliable and reproducible. Record all data in your data table.

Adding the Sweetener

1. Once you have developed the base recipe (the recipe you enjoyed best), it is time to add sugar or artificial sweetener to sweeten the drink. Make a data table in your lab notebook, like Table 2, below.

Amount of Sweetener	Trial	Sweetness Observations
1/4 tsp.	1	
	2	
	3	
1/2 tsp.	1	
	2	
	3	
1 tsp.	1	
	2	
	3	

Table 2. In your lab notebook, make a data table like this one to record your results while you try different amounts of sugar or sweetener in your soda pop recipe.

2. Take a new, clean plastic cup and duplicate the recipe that you enjoyed best from the first section.
3. Add ¼ tsp. of sugar or sweetener to the beverage and quickly stir in the sugar/sweetener with a clean, wooden stirrer.
4. Taste the beverage and record your observations in the data table in your lab notebook. Is the beverage sweet enough? Rate the sweetness of the beverage on a scale of 1–3, where 1 is not at all sweet and 3 is too sweet. Record your data in your lab notebook.
5. Repeat steps 2–4, but add ½ tsp. of sugar/sweetener.
6. Repeat steps 2–4, but add 1 tsp. of sugar/sweetener.
7. Discard all extra liquid and rinse out the plastic cups.
8. Repeat steps 2–7, two more times for a total of three trials for each sugar/sweetener amount. It is always necessary to repeat your experiments to ensure that the data you have collected is reliable and reproducible.

Analyzing Your Data

1. Average the bubbliness and grittiness data that you collected in the first data table. Average the data for the three trials for each recipe or combination of baking soda and citric acid. Equation 1 describes how to calculate the average. Ask an adult if you need help with the math.

   Equation 1:

   $$\frac{\text{Trial 1} + \text{Trial 2} + \text{Trial 3}}{}$$

Average = 3

2. Use a data table like Table 3, below, to collect your average data.

Amount of Baking Soda	Amount of Citric Acid	Average Bubbliness	Average Grittiness
1/16 tsp.	1/4 tsp.		
1/8 tsp.	1/4 tsp.		
1/4 tsp.	1/4 tsp.		
1/2 tsp.	1/4 tsp.		
1 tsp.	1/4 tsp.		

Table 3. In your lab notebook, make a data table like this one to average your bubbliness and grittiness data in.

3. Calculate the average sweetness for the data that you collected in the second table. Use a data table like Table 4, below, to collect your data.

Amount of Sugar or Sweetener	Average Sweetness
1/4 tsp.	
1/2 tsp.	
1 tsp.	

Table 4. In your lab notebook, make a data table like this one to average your sweetness data in.

4. Now plot the data on a graph. You can plot the data by hand using graph paper, or you can plot the data online at a website such as Create a Graph (http://nces.ed.gov/nceskids/CreateAGraph/default.aspx). Label the x-axis *Recipe* and label the y-axis *Average Bubbliness*. Make an identical plot for the average grittiness. And finally, make another plot for the average sweetness. According to your data, which combination of baking soda, citric acid, and sugar/sweetener yields the most enjoyable soda? Why do you think you got the results that you did?

Variations

- Ask your friends and family to taste the final recipe that you developed above. Do they enjoy the beverage as

much as you do? Collect their feedback and see if you can develop a recipe that everyone enjoys.
- Add flavorings, like vanilla, cinnamon, or a little bit of crushed fruit, to develop your own unique soda pop.
- Some fruits contain citric acid. Try recreating your soda recipe using fruit juice from a fruit that contains citric acid, instead of using food-grade citric acid. How does the amount of fruit juice compare to the quantity of food-grade citric acid in your ideal flavor combination?

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Food Scientist or Technologist

There is a fraction of the world's population that doesn't have enough to eat or doesn't have access to food that is nutritionally rich. Food scientists or technologists work to find new sources of food that have the right nutrition levels and that are safe for human consumption. In fact, our nation's food supply depends on food scientists and technologists that test and develop foods that meet and exceed government food safety standards. If you are interested in combining biology, chemistry, and the knowledge that you are helping people, then a career as a food scientist or technologist could be a great choice for you! Read more (http://www.sciencebuddies.org/science-engineering-careers/earth-physical-sciences/food-scientist-or-technologist)

Food Science Technician

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Dietitian or Nutritionist

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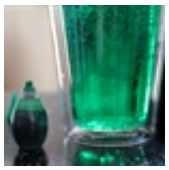

Bubbly Soda Science: Weekly Science Activity (http://www.sciencebuddies.org/news/article?id=123217), *Science Buddies Blog*, March 31, 2015

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