

BREAD SCIENCE

What Makes Dough Rise?

Have you ever wondered what makes dough rise? The answer is leavening agents and gluten. Without these ingredients, bread and other baked products would be dense and flat, rather than light and spongy.

To find out how these ingredients work in bread-making, try these experiments.

Then use what you've learned as you make your own bread.



BAKER'S YEAST OR BAKING SODA?

Leavening Agents Experiment



Baker's yeast and baking soda (sodium bicarbonate) are leavening agents. Once activated, these leavening agents release carbon dioxide gas. This gas, trapped in bread dough, makes the dough rise. Each leavening agent has unique characteristics that give bread and other baked products their own flavour.

Experiment

In this experiment, you'll see the differences between two leavening agents: baker's yeast and baking soda.

Objective

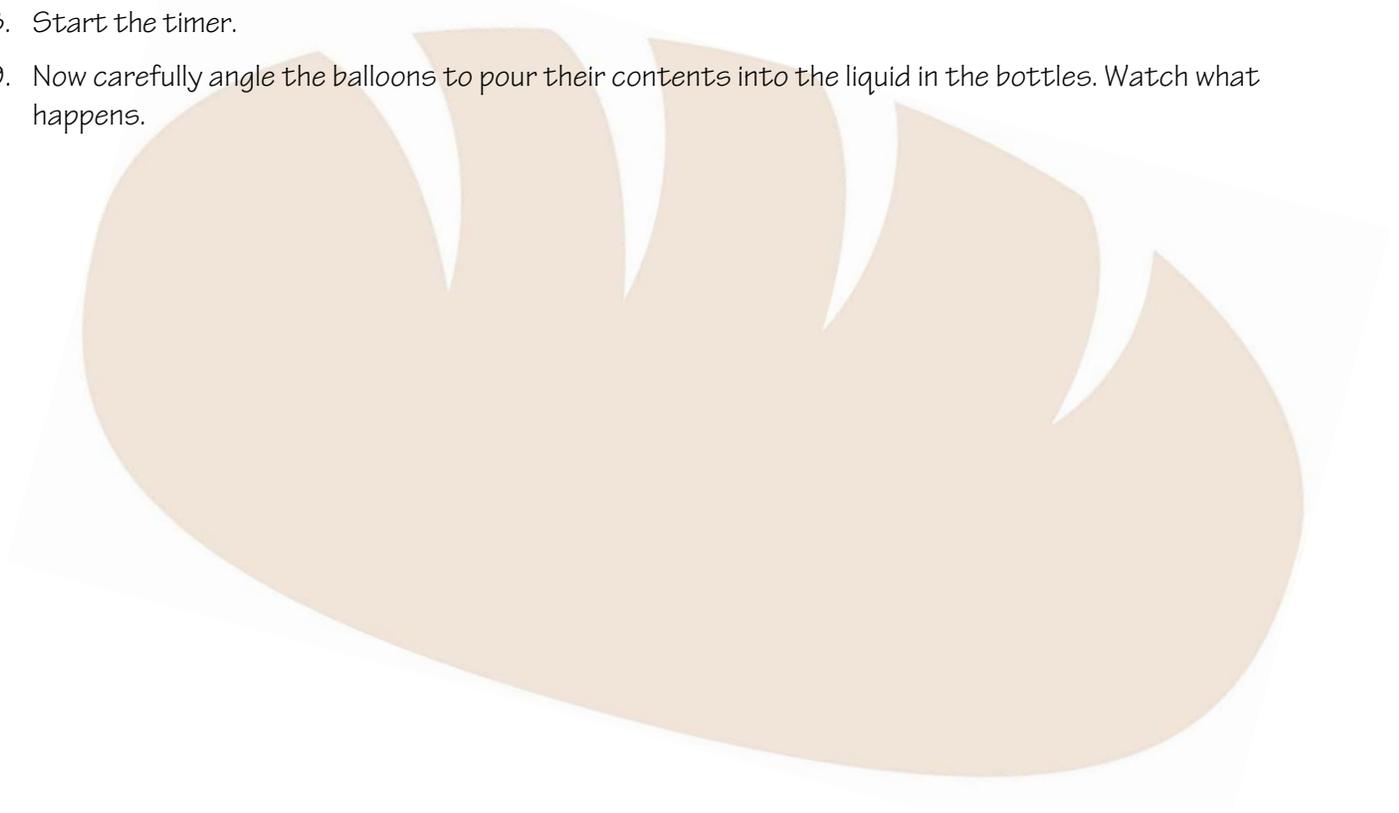
This experiment will help you understand why quick-bread dough has to be baked right away, whereas bread dough made with yeast needs to rise before it's baked.

Materials

- 2 small-mouthed, clear plastic bottles
- 2 balloons
- timer
- baker's yeast
- sugar
- lukewarm water
- vinegar
- baking soda
- measuring spoons
- measuring cup
- funnel
- measuring tape
- pen

Instructions

1. Use the pen to write the word “Yeast” on one balloon. Then write “Soda” on the other one.
2. Slide the opening of the Yeast balloon over the spout of the funnel. Pour 15 ml (1 tablespoon) of yeast into the top of the funnel and shake it gently until all the yeast has dropped into the balloon. Detach the balloon from the funnel and set it aside.
3. Slide the opening of the Soda balloon over the spout of the funnel. Pour 15 ml (1 tablespoon) of baking soda into the top of the funnel and shake it gently until all the baking soda has dropped into the balloon. Detach the balloon from the funnel and set it aside.
4. Using the funnel, pour 50 ml ($\frac{1}{4}$ cup) of lukewarm water into one of the plastic bottles. Add 15 ml (1 tablespoon) of sugar and shake the bottle to dissolve the sugar.
5. Carefully attach the Yeast balloon to the bottle containing the sweetened water, making sure that the contents of the balloon don't fall into the bottle.
6. Using the funnel, pour 50 ml ($\frac{1}{4}$ cup) of vinegar into the other plastic bottle.
7. Carefully attach the Soda balloon to the bottle containing the vinegar, making sure that the contents of the balloon don't fall into the bottle.
8. Start the timer.
9. Now carefully angle the balloons to pour their contents into the liquid in the bottles. Watch what happens.



Observations

- Use the measuring tape to find the circumference (measurement around the middle) of each balloon at 1-minute intervals, before and while they expand.

Time	Circumference of Balloons	
	Yeast	Soda
Before pouring balloon contents into bottles		
1 minute		
2 minutes		
3 minutes		
4 minutes		
5 minutes		
6 minutes		
7 minutes		
8 minutes		
9 minutes		
10 minutes		
11 minutes		
12 minutes		
13 minutes		
14 minutes		
15 minutes		

- Record the number of minutes it takes for the balloons to reach their maximum size.

Yeast	Soda

Questions

1. Take one bottle at a time and gently pull the balloon opening sideways from the neck of the bottle for long enough to let the air escape, and then let it snap back. Watch to see what happens after about 10 minutes. Do either of the balloons fill up with air again? If so, why do you think this happens?

2. Why does quick-bread dough need to be baked as soon as the ingredients are combined?

3. Why do we need to wait before baking bread dough made with yeast?

Leavening Agents Experiment

Answer Sheet

1. Take one bottle at a time and gently pull the balloon opening sideways from the neck of the bottle for long enough to let the air escape, and then let it snap back. Watch to see what happens after about 10 minutes. Do either of the balloons fill up with air again? If so, why do you think this happens?

Only the Yeast balloon fills up with air again, while the Soda balloon stays limp. This is because the yeast in the first balloon is alive and active: it keeps on changing the sugar into carbon dioxide gas and ethanol (alcohol), which makes the balloon expand again. But in the second balloon, the baking soda has stopped reacting with the vinegar: no more carbon dioxide gas is being produced, which means the balloon won't expand again.

2. Why does quick-bread dough need to be baked as soon as the ingredients are combined?

Quick-bread batter needs to be baked immediately because the chemical reaction between the baking soda and the vinegar doesn't last very long, as we saw in the experiment. If it's baked after the chemical reaction has been exhausted, the quick bread would be more like a dense pancake than a spongy loaf.

3. Why do we need to wait before baking bread dough made with yeast?

Before baking yeast bread dough, we need to wait until the yeast has changed the sugar into enough carbon dioxide gas to make the dough rise. As we saw in the experiment, yeast changes sugar into carbon dioxide gas slowly, in an ongoing process.

Now you know

Baker's yeast is a living organism that is part of the fungus family. This leavening agent makes bread dough rise through fermentation. The yeast changes the sugar in the dough into carbon dioxide gas and ethanol (alcohol). The gas, trapped in the dough, makes it rise; the alcohol produced during fermentation evaporates during baking. Dough made with baker's yeast rises slowly over a long time.

Baking soda (sodium bicarbonate) is inorganic. It is an alkaline (pH basic) chemical compound. When this leavening agent comes into contact with an acidic compound (such as buttermilk or vinegar), the chemical reaction that takes place produces carbon dioxide gas, which makes bread dough expand. This type of bread is called quick-bread because the batter expands rapidly and must be baked right away.

Chemical yeast (baking powder) is another leavening agent. It is a mixture of baking soda and tartaric acid. When chemical yeast is moistened, the tartaric acid reacts with the baking soda and the carbon dioxide gas that is released makes the batter expand.

BANANA BREAD

500 ml	whole wheat or enriched flour	2 cups
375 ml	white sugar	1½ cups
15 ml	baking powder (chemical yeast)	1 tablespoon
5 ml	salt	1 teaspoon
125 ml	canola oil	½ cup
5	egg yolks	5
125 ml	water	½ cup
250 ml	mashed bananas	1 cup
5 ml	vanilla extract	1 teaspoon
250 ml	egg whites	1 cup
3 ml	cream of tartar	½ teaspoon

Equipment

- | | | |
|---------------------|---------------------------|---------------|
| - large mixing bowl | - small mixing bowl | - whisk |
| - mixing spoon | - measuring cup and spoon | - 2 loaf pans |



Allergy Warning!
Contains wheat and eggs.

Preparation

1. Preheat the oven to 180°C (325°F). Grease the loaf pans with margarine or butter.
2. In the large bowl, combine the flour, sugar, baking powder (chemical yeast) and salt.
3. Add the oil, egg yolks, water, bananas and vanilla extract. Blend all the ingredients well.
4. In the small bowl, whisk the egg whites and the cream of tartar until they are well blended and foamy.
5. Add the egg-white mixture to the ingredients in the large bowl and mix well.
6. Pour half the batter into one loaf pan and half into the other one. Don't taste the batter. Uncooked flour and eggs may contain bacteria that could make you sick.
7. Bake for 65 to 70 minutes. To test whether the bread is done, insert a toothpick in the middle of the loaf. If it comes out clean, the bread is ready. If batter sticks to the toothpick, put the bread back in the oven and check on it again in a few minutes.

You can also make muffins with the batter. In this case, bake for 30 to 40 minutes, depending on the size of the muffins.

MAKING A GLUTEN BALL

Wheat Flour Experiment



Did you know that only bread made from wheat flour is light and spongy?

This is because wheat flour contains the proteins glutenin and gliadin, which, when mixed with water, form “gluten chains.” Gluten can stretch and return to its original shape, like an elastic.

The tiny air pockets that you see in a slice of bread are made by carbon dioxide gas that’s been trapped by the gluten in the dough. Without the gluten chains, the gas would escape and the bread would be dense and flat.



Allergy Warning!

Do not conduct this experiment if you are allergic to wheat.

Experiment

In this experiment, you’ll “wash” wheat flour, to change the proteins in the bread dough into gluten chains.

Objective

This experiment will help you understand how gluten chains function in bread-making.

Materials

- all-purpose flour
- water
- measuring spoons
- bowl or small bucket
- different types of flour

Instructions

1. Mix 30 ml (2 tablespoons) of lukewarm water with 60 ml (4 tablespoons) of all-purpose flour. Use your hands to form a ball of dough.
2. Fill the bowl or small bucket with cold water and put the ball in it. Let it rest for 30 minutes, then replace the water with cool fresh water.
4. Squeeze and gently rub the dough ball under water until it's no longer sticky or pasty.
5. Knead the "washed" dough.

Don't taste the "washed" dough. Raw flour may contain bacteria that could make you sick.

Observations

1. What changes did you observe during the experiment above?

- a) What colour was the dough ball at the start? _____
- b) What colour was the washed ball? _____
- c) What colour was the water after you washed the dough ball? _____

The white you see in the water is actually the starch in the flour (the wheat's endosperm). The starch remains floating in the water because it's insoluble (it does not dissolve in water).

2. Compare the consistency and characteristics of the new dough ball with the flour or the dough ball at the start.

- a) Was the original dough ball easier to stretch than the washed ball? _____
- b) Did the washed ball return to its original shape after being stretched? _____
- c) Could you do the same thing with the original dough ball? _____

What you have in your hands is a ball of gluten chains. Gluten chains give bread dough its elasticity and pliability, which allow it to trap the carbon dioxide gas produced by yeast and to rise. Without gluten, the dough would let the gas escape.

3. Conduct the experiment again, using a different type of flour, and compare the results.

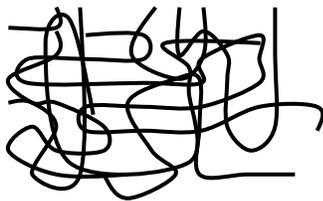
The only other type of flour with enough protein to produce gluten is rye flour. However, because rye flour contains much less gluten than wheat flour, it forms fewer gluten chains, and produces dough that doesn't rise as high and is less elastic.

Now you know

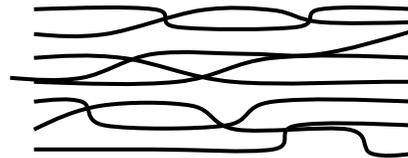
When wheat flour is mixed with water, two proteins, **glutenin** and **gliadin**, form a pliable, elastic mass called gluten. Gluten chains trap the carbon dioxide gas that's produced by yeast. This process is what allows bread dough made with wheat flour to rise higher and produce bread that's light and spongy.

Gliadin molecules look like balls of tangled wool; glutenin molecules look like springs. When combined and mixed with water, these two proteins join together and absorb twice their weight in water (because the water molecules are trapped between the proteins).

As dough is kneaded, the matted gluten chains untangle, lengthen and align themselves, to produce interlocking layers of gluten.

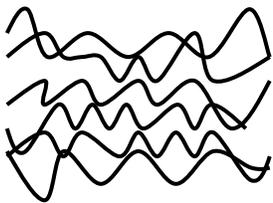


Before kneading

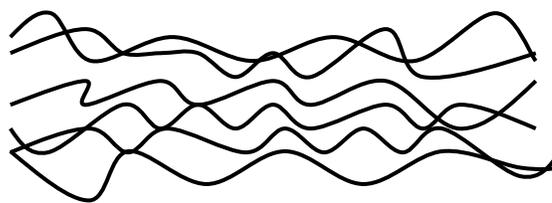


After kneading

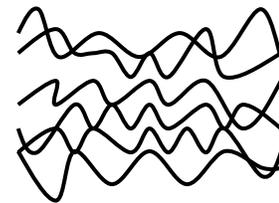
The dough then becomes pliable and elastic. It changes shape under pressure, but returns to its original shape when pressure is removed.



With no pressure



Under pressure



With no pressure

These characteristics allow bread dough made with wheat flour to expand and trap the carbon dioxide gas produced by yeast, while making the dough sturdy enough that it won't tear under the pressure from the gas. Wheat flour is unique. It is the only type of flour with sufficient gliadin and glutenin to form enough gluten chains to produce bread that's light and spongy.

PIZZA CRUST

250 ml	lukewarm water	1 cup
1 package	Yeast	1 package
5 ml	Sugar	1 teaspoon
5 ml	Salt	1 teaspoon
30 ml	extra virgin olive oil or canola oil	2 tablespoons
2	cloves garlic, minced	2
5 ml	dried basil	1 teaspoon
5 ml	dried oregano	1 teaspoon
500 to 750 ml	whole wheat flour	2 to 3 cups
	olive oil	

Equipment

- large mixing bowl
- pizza pan or cookie sheet
- mixing spoon
- parchment paper (not waxed paper) for baking



Allergy Warning!
Contains wheat.

Preparation

1. Preheat the oven to 190°C (375°F).
2. In the large bowl, dissolve the yeast and sugar in the lukewarm water. The water should be around bath temperature, that is, between 37°C and 43°C (100°F and 110°F). Let the mixture sit for 5 minutes.
3. Add the salt, oil, garlic and herbs. Mix gently.
4. Gradually add the flour. Mix well after each addition until all liquid is absorbed. The dough should not stick to your fingers or the sides of the bowl.
5. On a lightly floured work surface (sprinkle 2 or 3 tablespoons of flour on the counter), knead the dough for 3 to 4 minutes or until it is smooth and even-textured. If the dough seems sticky, add a little flour. See **Appendix A** for instructions on how to knead. Let the dough sit for 5 to 10 minutes. Don't eat the uncooked pizza dough. Uncooked flour may contain bacteria that could make you sick.
6. Flour a rolling pin (rub a little flour on it). On a lightly floured work surface, carefully roll out the dough until it is shaped the way you want it. If necessary, sprinkle a little more flour on the work surface to prevent the dough from sticking.
7. Line the pizza pan or cookie sheet with parchment paper to prevent the dough from sticking. Place the dough on the pan.
8. Using a baker's brush, lightly brush the dough with olive oil.
9. Add your favourite pizza toppings.
10. Bake the pizza for 20 to 25 minutes.

HOW TO KNEAD BREAD DOUGH

Follow these instructions to learn how to knead bread dough. Be careful not to stick your fingers into the dough, because they will be very difficult to clean off. At first, your dough will seem like a sticky mess. But as you knead, the gliadin and glutenin will absorb more of the water in the dough, and it will stick less and less. Try not to add too much flour to the dough while kneading so that it remains as smooth and elastic as possible.

Never taste or eat raw dough. Uncooked flour may contain bacteria that could make you sick.

1. Get ready

Take off any jewellery you're wearing such as rings, watches and bracelets. Pull up your sleeves and wash your hands.

2. Prepare the dough ball

Turn the bowl over on top of a floured surface so that the dough falls out.



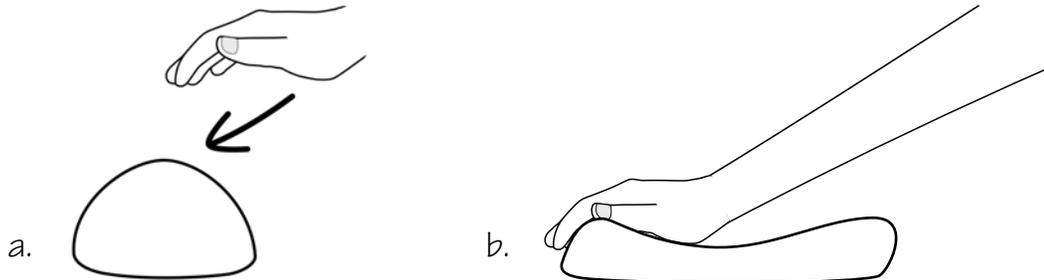
Keeping your hands flat, gather the pieces of wet dough to form a ball.

Press down on the ball and reshape it until all the pieces of dough stay stuck together.

If the dough is too sticky, you can dust it with a little bit of flour.

3. Start kneading

Press down on the ball with the palm of your hand (a) while pushing forward to flatten and stretch the dough (b).



Grab the edge of the flattened dough and fold it back on itself.



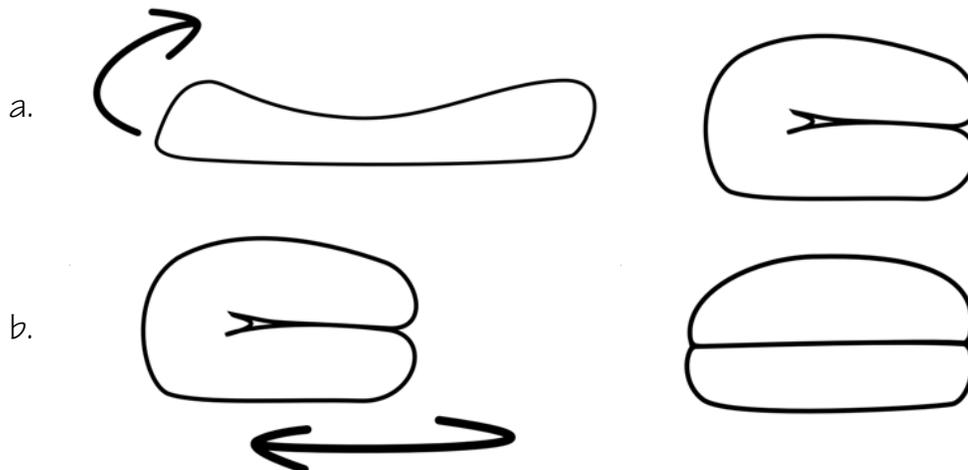
Repeat 3 or 4 times.

4. Rotate the dough

The ball should now look more like a long roll.



You must now fold that roll on itself (a) and turn it 90 degrees on your work surface (b).



5. End

Repeat steps 3 and 4 until the dough is smooth and elastic, for about 10 minutes. The final texture should resemble that of your ear lobe.

Make a ball with the dough and place it in an oiled bowl. Cover the bowl with a damp cloth to prevent the dough from drying out while it is proofing.