



Food Science/ Healthy Living:

Project: Grains – Gluten in Flours

Supplies:

- Vital wheat gluten (available at well-stocked supermarkets or health food stores)
- Whole wheat flour (preferable whole wheat bread flour), and gluten free flour
- Salt
- ½ cup dry measuring cup
- Tablespoon measuring spoon
- 3 small spoons for mixing
- Water: ½ to ¾ cup for each flour you're using
- 3 Bowls: one for each flour you're using
- Sticky notes
- Cutting board or work surface
- Clock or timer
- Lab notebook or table below

Time: 1 hour

What to Do:

1. Combine a pinch of salt with one half cup of vital wheat gluten in your mixing bowl. Add three tablespoons of water and mix, first with a spoon, then with your hands. Add one or two more tablespoons of water, if needed, until the flour sticks together and forms a nice soft ball. It should have the consistency of play dough. Leave the ball in the bowl.
2. Repeat the previous step with one half cup of wheat flour and then again with one half cup of gluten-free flour. *How do the different flours feel? Does one stick together better than the other?*
3. Knead your gluten dough for three minutes. To knead, start by flattening the ball of dough a little. Then fold the dough over itself and flatten as you end the fold. Give the dough a quarter turn and repeat the folding, flattening and turning.
4. Repeat the previous step with the wheat flour dough and the gluten-free dough. *Are some doughs easier to knead than others?* You might notice that some doughs fall apart as you try to knead them. If so, just take note and skip kneading that dough.
5. Let your dough balls rest for one half hour.
6. While you wait, look at the nutritional content label of the flours printed on the packages. *Which one has more carbohydrates per one quarter-cup serving, and which one has more protein?*
7. In a moment you will test how elastic the doughs are and how easily they can be stretched.
 - a. Elasticity measures how well a material recovers its original form after a deformation. *Which dough do you expect to be elastic, meaning it bounces back after you punch it? Which dough do you expect to be starchiest? Do you expect you will be able to stretch any of the doughs paper-thin?*
8. Now that you have given the gluten network in the doughs some time to develop, you can put them to the test. Lightly punch your dough balls—all three with the same force—to evaluate their elasticity. *Do you see signs of elasticity in any of your doughs? Can you rank them from most elastic to least, or non-elastic?*
 - a. A second characteristic is stretchiness. A dough that stretches well can trap gas bubbles, providing well-risen, fluffy baked goods. Take a ball in two hands and stretch it out between your hands. *Does it stretch easily or*

does it break instantly? Do you need to apply force to get it to stretch out or does it stretch readily? Do this with all three doughs.

- b. Some pastries require a paper-thin layer of dough. *How thin can you stretch out or roll out your doughs? Can you make any of them so thin that you can almost look through them?*

Reflect:

1. What type of baked product would each dough be good for (cake, cookies, breads, etc.)? Why do you think this is the case?
2. Was the gluten dough elastic and stretchable?
3. Did the gluten free dough fall apart, showing neither elasticity nor stretchiness?

	Gluten flour	Whole wheat flour	Gluten-free flour
How do the different flours feel?			
Does one flour stick together better than the others?			
Which flour has more carbohydrates?			
Which flour has more protein?			
Rank doughs from most to least elastic			

Apply:

Combine gluten and water, and a network of long, unorganized, knotted gluten strings will form. Kneading aligns these strings, creating a dough you might be able to stretch so thin you can almost see through it. The more gluten, the more elastic, stretchy and strong the dough will be. Mixing gluten and water results in a dough that almost feels like rubber. Wheat flour contains 6 to 12 percent gluten, enough to provide a gluten network that holds the carbohydrates together. This dough is elastic and stretchy, but not as strong and tough as the gluten dough. A gluten-free dough, on the other hand, is crumbly; it falls apart easily. Bakers add ingredients such as xanthan gum, guar gum and/or ground seeds to keep the baked goods together—but making a gluten-free version of some fine pastries, fluffy croissants and delicate wheat breads can be challenging!

Background: Wheat flours mainly consist of carbohydrates and protein, with some fiber. They are classified according to their gluten (or protein) content for a good reason. Getting the right portion of gluten (the protein that naturally occurs in wheat) is essential to getting the right texture in your baked goods. Wonder why? From the moment you bring a liquid ingredient (such as milk or water) in contact with wheat flour, the individual gluten proteins in the flour unravel and hook onto one another, creating strong bonds. With time, an elaborate network of interconnected gluten strings forms. This network holds the dough together, giving it its structure. Kneading the dough slowly unfolds the entangled network and aligns the long gluten strings in a stretchy, layered web. A pinch of salt helps as well because it neutralizes electrically charged parts of the gluten, allowing them to better slide along one another. The result is an elastic, stretchable dough that traps gas bubbles. Sometimes a dough can be stretched so thin it becomes translucent, making the network of gluten visible with a magnifying glass or microscope. It is the absence of this intricate gluten network that makes gluten-free baking a challenge.

Ready to test and measure your strength against some incredibly stretchy dough? Once you've explored the dough, you'll be ready to bake up a perfect treat!

Info regarding gluten experiments: <https://www.scientificamerican.com/article/the-scientific-secret-of-stretchy-dough/>