BREAD BREAKDOWN
PROTEIN & STARCH

ROYAL CITY SCIENCE
#RCSOAC21
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In wheat flour, gluten is the main protein. Proteins aren't just something you find in a steak! They are part of every living organism, and are the building blocks that make up cells. Proteins can have very different shapes and jobs—some are small, but others can be complicated, with lots of smaller proteins playing some role in the work of a large protein.

Gluten is actually made from two smaller proteins linked together: glutenin (GLU-tuh-nin) and gliadin (GLY- uh-din). Glutenin and gliadin are separate in flour, but bind to each other to form gluten when flour is mixed with water.

Each protein plays a role in making a viscoelastic (stretchy, and able to flow) dough. We can see gluten, because it is a large protein that is not water soluble. In this activity, we are going to form gluten first, by mixing flour with water to form a dough. In bread, gluten forms a network that allows the dough to trap air produced by yeast. Flour with more gluten proteins can make a better, stronger, gluten network. The two flours used in this experiment have different amounts of protein, and therefore behave differently. Flours high in gluten are good at making airy, chewy bread.

We can separate the gluten by mixing the dough in a lot of water to remove the starch. The starch stays in the water, while the yellow, slimy mass (gluten) does not. We can use the separated protein and starch to observe their function in foods! The function of gluten is to make the dough stretchy, so that it can hold air. This is a test that can be done by commercial bakeries to measure how large the bread volume can be.

Materials

- 2 bowls (microwave safe)
- ½ cup of water, divided
- 8 cups water, divided
- ½ cup of high protein flour
    - Bread flour
- ½ cup of low protein flour
    - Cake/pastry flour, gluten free flour, etc.
- A straw
- Spoon

Instructions

Experiment 1: Protein

1. Mix ½ cup of high protein flour (flour #1) with ¼ cup of water until the dough is stretchy, and there are no lumps.

2. Repeat with the low protein flour (flour #2).

3. Knead until the dough does not stick to your hands.

4. **Observe:** use your observation page to explore the dough you made.
5. Fill the microwave safe bowls with lots of water.

6. Put each dough ball into separate bowls, and mix/knead them under water. Keep mixing until the ball no longer has white powder coming out. This has now become a gluten mass. **Save the bowls of white powder & water for later!*

7. One at a time flatten a "dough" (gluten mass) in the palm of your hand. Place the end of a straw in the middle, and fold the gluten around it.

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8. Blow into the straw! Pay attention to how large each of the bubbles are with the different types of flours.

9. **Observe:** use your observation page to explore the dough bubbles you made. Set aside bowls of starchy water for part 2.

Experiment 2: Starch
Starch is the main component in cereal flours. Starch in flour is naturally present in crystalline (solid and highly ordered) granules. There are two main types of starch in these granules- *amylose* and *amylopectin*.

When starch is heated in an excess of water, it gelatinizes. Gelatinization is a process where starch granules permanently lose their crystalline structure. As the starch is heated, gelatinization happens in four stages.

In stage 1, the granules are intact. *At stage 2*, water enters the granule, and it begins to swell. *In stage 3*, the starch starts to lose crystallinity. The amylose molecules start to leave the granules, and thicken the mixture. The granules break due to the increased heat and stirring.

Stage 4 happens as the starch solution cools down. The starch molecules (amylose and amylopectin) partially return to their structured form. The amylose molecules join with other amylose, and form a gel, making the liquid much thicker, or even solid.

The process of gelatinization gives many baked goods their characteristic texture. Cake, for example, gets its airy texture from rapid gelatinization when you bake it.
The thickened starch (stage 3) traps air formed by baking powder.

10. Take one bowl of starchy water from the first experiment.

11. Be careful! Heat the bowl of starch-water in the microwave in one minute intervals and stir the bowl well each time.

12. After 5 minutes, stop heating the starchy water.

13. **Observe:** use your observation page to write down the differences between the heated and unheated starch bowls.

14. Let the bowl you heated cool down.

15. **Observe:** use your observation sheet to note changes between the hot and cold starch slurries.

Share your Experiments!

Take pictures throughout your experiments with gluten protein and starch. Email your pictures to oac.assistant@uoguelph.ca!

Additional Resources

- University of Guelph, Department of Food Science

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Observation Sheet

Experiment 1: Protein

Stretch out the dough you made. What do you feel? Does it return to the shape it started in?

Which flour created a stretchier dough?

Which flour had more gluten proteins after washing it? (Hint, which flour had more mass)

Which flour made a bigger, better bubble?

Experiment 2: Starch

Does the heated or unheated starch have more viscosity (thickness)?

What colour is the unheated starchy liquid? Did the colour change after you heated it?

What happens to the thickness of the liquid after the heated starch cools? Why?