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Abstract

While breads can be made from flours produced from various crops; those made from wheat are the most common because of the superior qualities offered by gluten. This protein, found in the endosperm of the seed, allows the bread to rise after the physical action of kneading causes the gluten to become elastic, which then traps carbon dioxide produced by fermentation of yeast. In this lab, students first make yeast dough using wheat and non-wheat flours, and then make a dough with the addition of gluten. Properties including consistency, elasticity, strength, stickiness, and expansion due to gas retention are compared across flours. The influence of gluten is most noticeable in dough made from flours from non-wheat sources such as tapioca or garbanzo beans and least noticeable in those made from bread flour.

Objectives

General

- Develop an interest in botany by investigating properties of various flours and breads, topics of familiarity to students
- Evaluate results using qualitative and quantitative data
- Provide opportunities for inquiry-based experiments

Specific

- Explain the relationship between flour and plant products
- Explain the relationship between elasticity and properties of gluten and relate these to properties of dough
- Analyze dough using qualitative characteristics
- Compare gas retention of yeast dough using quantitative data
- Write report to practice scientific writing



Getting Started

1. **Conduct a student survey** to stimulate interest in the laboratory and learn about their knowledge of bread and bread making. Students rate the following characteristics of bread:

- Appearance, crust, internal texture, moistness, aroma, and taste

2. **Introduce background information**

How do the ingredients of bread influence its qualities?

- Yeast (Generate carbon dioxide from fermentation to produce a light bread)
- Sugar (Provide nutrients for yeast and taste)
- Flour (Whole grain or milled; coarse or fine; may or may not have gluten)
- Salt (Improve hydration; controls yeast; taste)
- Water (Hydration; may vary with starch size)



Figure 1. Flours available in grocery stores

Top row: Bread*, All Purpose*, Cake*, Whole Wheat*

Second row: Semolina*, Rye, Rice, Corn

Third row: Buckwheat, Tapioca, Gluten-free, wheat berries*

* flours made of wheat

3. **Investigate properties of gluten before making dough**

Hydrate a small amount of gluten (4 gm in 3gm of water), mix and form a ball. (Gluten is available in grocery stores.)

After hydration, describe its properties and relate them to the composition of powdered gluten extract.

25% carbohydrate and 67% protein

Gluten proteins include gliadin and glutenins. Gliadins promote flow and elasticity ('plasticizers'); glutenins offer resistance to elasticity.

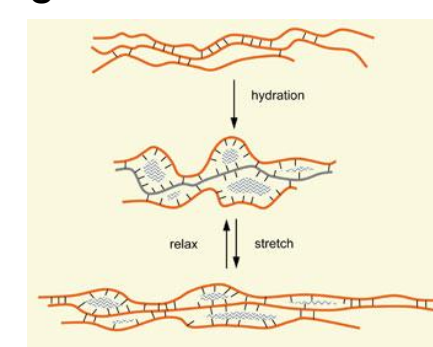


Figure 2. Changes in gluten as it is physically worked with starch. This matrix traps carbon dioxide produced from fermentation by the yeast. (Reuben, B. and Coultate, T. 2009.)

First Dough: Control

1. **Compare flours**

- Origin of flours: seeds and roots; whole (coarse) or milled (fine)

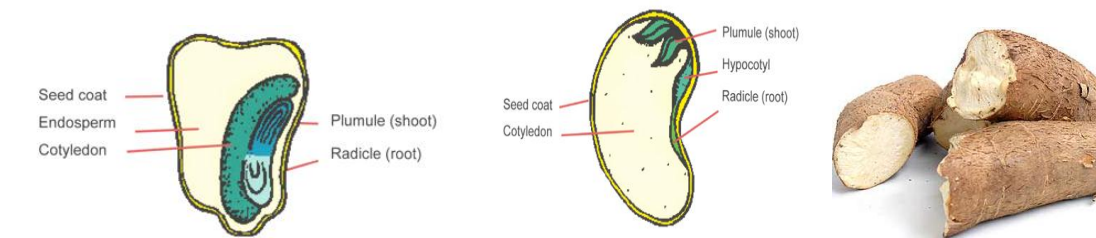


Figure 3. Monocot and dicot seeds and cassava roots (source of tapioca) (left to right).

(<http://www.ext.colostate.edu/mg/gardennotes> for seeds and <http://www.whynbiotech.com> for cassava)

2. **Make dough balls**

- Activate yeast
- Hydrate flour and add yeast
- Knead to form dough

3. **Characterize the dough**

- *Consistency*: How much water is needed to hydrate the flour?
- *Elasticity*: Does the dough stretch after kneading? If so, it has gluten.
- *Stickiness*: Does the dough form a ball?

Second Dough: Effect of gluten

1. **Repeat making dough with the addition of wheat gluten (Hodgson Mill Vital Wheat Gluten)**

- Add 8 gm/100 g flour. knead it, and allow it to proof (30 minutes).



Figure 3. Dough made with tapioca flour. Left + gluten; right – gluten.

2. **Analyze gas retention.**

- Measure the diameter of 20 cm dough balls after incubating for 30 min at 30 C.



Figure 4. Dough balls before incubation.

Results and Conclusions:

Table 1. Characteristics of dough made from various flours (Student data)

Flour source	Ease of making dough ball	Elasticity before kneading	Elasticity	Stickiness after kneading	Gas Retention
Bread—Wheat	easy	Little	Very	High	88%
Semolina—wheat	easy	Little	Medium	High	50%
Gluten-free flour	Medium	None	None	None	17%
Same flour + gluten	Easy	None	Medium	Medium	85%
Tapioca—Cassava	No ball (fluid)	None	None	Very	0
Same flour + gluten	Medium	None	Medium	None	40%

Conclusions

1. Only wheat flours contain gluten. The proteins are located in the endosperm of the seed.(not the embryo)
2. Wheat flours vary in gluten content and addition of gluten causes more gas retention and thus make better breads..
3. Elasticity and gas retention are associated with gluten content, which can be added to flours to obtain these characteristics.

Sources

- Leventin, E., McMahon, K., and Reinsvold, R. 2002 .*Laboratory Manual for Applied Botany*. McGraw Hill.
- Reuben, B. and Coultate, B. 2009. On the Rise. *Chemistry World* 28456 (10):54-57.
- Van Der Borgh, et al. 2005. Fractionation of wheat and wheat flour into starch and gluten: overview of the main process and the factors involved. *Journal of Cereal Science* 41:221-237.