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Getting a Rise Out of Bread

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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. In this lab, students compare properties of dough made from an assortment of wheat and non-wheat flours and made with and without gluten. Properties include consistency, elasticity, strength, stickiness, and expansion due to gas retention. The influence of gluten is most noticeable in dough made with non-wheat flours such as tapioca or garbanzo beans and least noticeable in those made from wheat flours; however, wheat flours differ in their bread-making qualities.

Keywords: flour, bread-making, gluten, seed composition

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Extended Abstract

While many students come into biology courses lacking a curiosity about plants, they are interested in food. This simple laboratory project allows students to learn about plants by introducing them to the process of bread making. Topics that can be introduced in this laboratory are flexible and can include comparing seed structure of monocots and dicots, the starch and protein composition of various flours, and the properties of bread dough made with and without the addition of gluten from these flours.

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 raise after the physical action of kneading causes the gluten to become elastic and form balloon-like structures in the dough, which then trap carbon dioxide produced by yeast during fermentation (Reugen and Coultate, 2009; van der Borght, et al., 2005). To observe the elastic properties provided by gluten, students first mix gluten (4 gm) with water (3 ml) and form a ball. Because the elasticity of the ball is obvious, students can easily evaluate the elasticity of dough regardless of the type of flour (Table 1) subsequently studied.

Table 1. Representative flours available at local grocery stores

Wheat	*Non-Wheat*
All purpose	Buckwheat
Bread	Corn
Cake	Gluten-free bean
Semolina	Rice
Whole wheat	Rye
	Tapioca

Next using different flours, students make several types of yeast dough to compare their properties including consistency, elasticity, strength, stickiness, and expansion due to gas retention (Levetin, McMahon, and Reinsvold, 2002). Many recipes for making bread are successful for this experiment; they all include activation of the yeast (e.g. dissolve 1 g of dry yeast in 6 ml of warm water), the addition of water (15 ml) and the yeast suspension to a flour-sugar mixture (50 gm flour with 1 gm sugar). Additional water may be required to hydrate the flour. Tapioca, for example, forms an incompressible slurry and will not form a ball unless gluten is added to the flour (Fig. 1). After kneading the dough for about 10 min, students make 10 1-cm dough balls, cover them with a moist paper towel so they will not dry out, allow them to proof at room temperature for 30 min, and

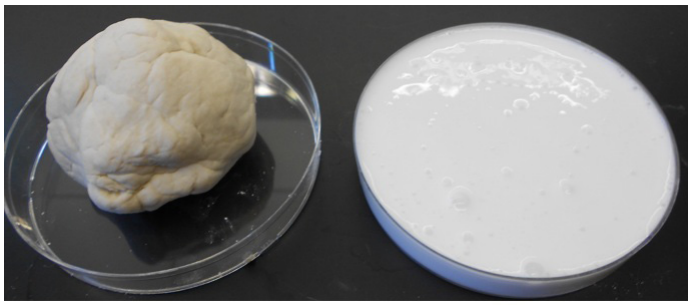

Figure 1. Tapioca flour made with (left) and without (right) gluten.

then measure the diameter of the dough balls. During this time if gluten is present, the dough balls will increase in size. The average percent increase in diameter reflects the ability of the dough to retain gas. Properties of dough made from several flours are described in Table 2.

Table 2. Properties of representative dough made with wheat and non-wheat flours.

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

Students report their data to the class so that the qualities of the various flours can be compared. They should come to the following 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.

Literature Cited

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