

NATURE'S LABORATORY

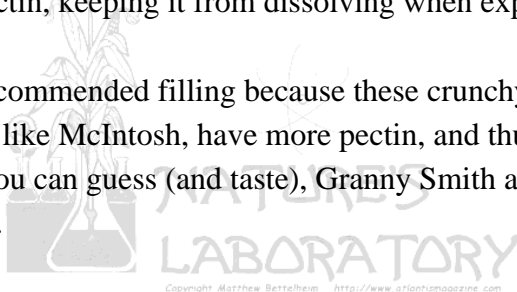
"Cookery is become an art, a noble science."

-- Robert Burton

Whether you're kneading bread dough or simmering sauces, baking cookies or whipping cream, dabbling in the kitchen is like tinkering in the laboratory with the singular exception that in the kitchen, the final product is most often edible. Step into the kitchen, and the beakers and test tubes become pots and pans. Cooking and baking are a science, literally.

The apples in apple pies are a prime example of the chemistry behind the kitchen cauldron. If you think one apple is as good as the next, think again. The apple makes the pie! The walls of the cells that make up the fruit are made of cellulose $[(C_6H_{10}O_5)_x]$ and held together with a substance called pectin. When heated, pectin melts and the cells break down, while cellulose is more resilient. The acidity of an apple is another factor; acid helps strengthen pectin, keeping it from dissolving when exposed to heat.

Granny Smith are the recommended filling because these crunchy apples contain more cellulose. Other apples, like McIntosh, have more pectin, and thus turn to mush when they're baked. And as you can guess (and taste), Granny Smith apples are indeed a tart fruit. Why? - more acid.



Meat is not only a common entree, it's also another example of chemistry in action. Meat is a general term describing the muscle of domestic animals such as cattle, pigs, sheep and goats (game animals, like deer and bear, are simply called "game"), but meat includes the flesh of any animal, such as fish and poultry.

The muscle fibers of raw meat are made of protein and water. When the meat is exposed to heat, the muscle fibers shrink and expel the moisture. The fat that runs through the muscle, also known as marbling, prevents the muscle fibers from shrinking and drying out too quickly. As the fat is heated, it melts, ensuring a juicy dinner.

For a dessert as seemingly simple as angel food cake, the chemistry is surprisingly complex. Cream of tartar, once the secret ingredient of angel food cake, is the solid salt of tartaric acid. When beaten with egg whites, cream of tartar stabilizes the mixture, making for a higher, lighter cake. Cream of tartar's acidity also helps bleach the cake it's angelic white color.

The eggs themselves are another phenomenon; when beaten, the albumen (protein) in eggs produce a liquid lattice-work of foam which trap pockets of air. When the batter is finally popped into the oven, the air bubbles expand, causing the cake to rise.

Dough also relies on proteins and trapped gasses to put bread on your table. Flours are composed the of the proteins glutenin and gliadin, which together form gluten. When the proteins are combined with a liquid like water and then kneaded, the gluten develops throughout the dough. Yeast, a key ingredient to most breads, produces gas bubbles which become trapped in the dough and expand in the oven. The interaction of the gluten and gas bubbles give rise to bread.

When gluten first forms, though, it does so in a random and disorganized manner. Kneading rearranges the scattered bonds into strong, structured sheets. To take advantage of gluten's formative properties, some bakers employ a technique known as autolyse wherein after the dough mixture is first assembled, it is allowed to rest. Resting the dough allows natural enzymes to eat away at the jumbled bonds so that when it's kneaded later, the gluten can more easily be restructured to form stronger bonds.

Kitchen chemistry isn't just restricted to meals; there is a chemistry behind tea, for instance. Essential oils in tea leaves are responsible for the myriad flavors of teas. Green teas stem from leaves that are rolled, twisted, and lightly broken, then "fired" or heated. If the leaves are exposed to air for a time, they darken, and the leaves instead develop astringent flavors instead. The English counter the astringency of the acidic tannins by adding milk.

Hands On: The best way to bring home the concept that cooks and bakers are chemists in aprons is to become one. Grab a cookbook - any one - and flip through the recipes. Each recipe spells out like a text book the steps that will turn X, Y and Z into a quiche or a pot roast. Some ingredients are essential for the recipe to "work", while others are integral to it's flavor.

To investigate a recipe's intricacies, try exploring how the recipe works. Pick a bread recipe and make three different batches. For the first batch try bread flour, for the second batch try all-purpose unbleached flour, and for the last batch try all-purpose bleached flour. With the exception of the flours, treat each bread recipe the same, kneading and resting each loaf for the prescribed time.

After the last load has been baked, taste the different breads, noting their consistency, texture and flavor. How do the different flours effect the finished bread? Was the flour the recipe called for the best choice?

Next, try making a simple apple cobbler with a variety of apples. Visit a grocer or farmer's market and buy several varieties of apples (make sure to label the apples). As before, treat each recipe the same, exchanging only the apple variety. How do different varieties of apples stand up to a Granny Smith or a McIntosh?

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