The STEM in Bagels

By [*Becky Stewart*](http://nstacommunities.org/blog/author/rstewart/) | Published: June 3, 2015

[](http://nstacommunities.org/blog/wp-content/uploads/2015/06/STEMClassroom-1.png)

On a recent trip to visit friends in Lewes, Delaware, I had a bagel from [Surf Bagels](http://www.surfbagel.com/surfbagelmenu.htm#.VVjf30Zy5ik) for the first time. This delicious and perfectly constructed bagel got me thinking about how they are produced. It turns out there are a number of STEM topics in bagel baking and production.

Bagels have [a long history](http://www.theatlantic.com/health/archive/2009/03/the-secret-history-of-bagels/6928/) in Middle Eastern and European baking. They are a close [relative of soft pretzels](http://tasteconnections.com/index.php/recipes/74-bagels-and-pretzels). Despite their long history, these delicious and almost ubiquitous breakfast breads were not well known in the United States, outside of the greater New York City metropolitan area, before the 1950s. [Murray Lender](http://www.slate.com/articles/business/moneybox/2012/03/murray_lender_and_frozen_bagels_the_man_who_made_america_better_by_making_bagels_worse_.html) came up with the idea of freezing bagels to improve his production schedule. Demand for bagels was very high on the weekends but very low the rest of the week. This meant his bakers worked highly irregular hours. Lender decided that freezing the bagels would let him spread out production across the week and would be more efficient. This also allowed bagels to spread across the country, because they would keep much longer in frozen form than they would if shipped fresh. The other big technological innovation in mass production was the [bagel-shaping machine](http://www.bagelproducts.com/bagel_formers/history.htm), perfected at about the same time by Daniel Thompson. Murray Lender leased the first production-scale machine from Thompson.

Bagel making is traditionally a two-step process. Hand-made bagels are boiled before they are baked, and this sets a crust on the outside of the bagel. The water does not soak into the bagel because the [starch in the dough forms a gel](http://www.thekitchn.com/food-science-why-bagels-are-bo-86711) in the hot water, which seals the surface of the bagel. The crust prevents the bagels from rising while they bake, and this makes bagels dense and chewy. There’s more to it than that, though, because the boiling water is made alkaline on purpose, to [intensify the Maillard reaction](https://thekoshergastronome.wordpress.com/2011/08/07/bagels-chemistry-101/) and make the bagels brown quickly when they are baked.

If you’re teaching acids and bases in chemistry, you could try making bagel dough in your classroom and talking about why alkaline water has this [effect on the Maillard reaction](http://articles.latimes.com/2011/oct/20/food/la-fo-pretzels-20111020). If you boil half of them [in a dilute solution of lye](http://www.thefreshloaf.com/node/10877/lye-bagels) and half of them in water to which you’ve added [baked baking soda](http://www.nytimes.com/2010/09/15/dining/15curious.html?_r=0), you could compare them to see what differences there are in the finished product.

**Does the Water Make the Bagel?**

The water used to boil the bagels may have other effects, too. There is some debate about where the best bagels in the United States can be found, but the general consensus is that New York City produces the best bagels. Most people think the reason for that is in the municipal water supply. New York City’s water comes from reservoirs in the Catskill Mountains, and the [watersheds of those reservoirs are protected](http://www.nyc.gov/html/dep/html/watershed_protection/index.shtmlhttp%3A//). The city’s water treatment plants are [not required to filter the water](http://www.nytimes.com/2007/02/18/nyregion/thecity/18feat.html?_r=1&oref=slogin) because it is so pure, and this leaves more minerals in the water than in many other places. Specifically, [the ratio of calcium to magnesium](http://qz.com/263351/the-secret-of-new-york-citys-mythic-bagel-baking-water/) in the city’s water may affect the gluten in the dough. The question of how much influence the city’s water has on the bagels boiled in it is [a source of debate](http://www.pbs.org/newshour/rundown/chemistry-secret-to-nyc-bagels-water/).

New York City’s water system is the largest in the country, and it delivers 1.2 billion gallons of water per day. The water comes into the city in a system of aqueducts and tunnels. The largest tunnel was [begun in 1970 and is not expected to be finished until 2021](http://www.nytimes.com/2013/10/17/nyregion/new-water-tunnel-can-provide-water-for-all-of-manhattan.html). The water comes from [two sources](http://www.nyc.gov/html/dep/html/drinking_water/index.shtml), the Croton Watershed and the Catskill/Delaware Watershed. The Croton Watershed supplies 10% of the city’s water and [has a filtration system](http://blogs.ei.columbia.edu/2011/07/29/maintaining-the-superiority-of-nyc%E2%80%99s-drinking-water/). There is a debate about whether the city’s water can [continue to be unfiltered](http://pulitzercenter.org/education/student-reporting/new-york-city-water-infrastructure). Upstream development in the Catskill/Delaware Watershed is having an effect.

**Why Mass-Produced Bagels Just Aren’t the Same**

[Mass-produced bagels](http://www.abreadaday.com/bagels/) are usually steamed instead of boiled. Boiling the bagels before baking them is a process that [does not lend itself to mass production](http://www.theguardian.com/lifeandstyle/wordofmouth/2014/aug/07/how-to-make-perfect-bagels). It is time consuming, and equipment large enough to boil a lot of bagels is expensive. Mass-produced bagels may also contain additives that keep the dough from sticking to the machines. It is possible to make bagels the traditional way [on a large scale](https://www.youtube.com/watch?v=oFsA_5KstMYhttp://) but it is not that common yet. There are too many people who think that bagels should be [pale doughy toroids](http://columbiaspectator.com/2010/09/09/how-eat-real-bagel).

**Bagel Math**

Luckily for all of us, however, bagels are not that difficult to [make at home](http://www.seriouseats.com/2011/03/how-to-shape-and-make-bagels-at-home-recipe.html). The formed bagels do have to be refrigerated overnight, so you need a cold place to keep them on their trays. Other than the obvious mathematical wonder of how many bagels one teenage boy can eat, there is useful math that can be done in the name of bagels. You could amaze some math teachers with this method for [cutting bagels into a Möbius strip](http://www.dailydot.com/geek/mathematics-of-bagel-cutting/), thereby maximizing the surface area for spreading with cream cheese. If you’re really into math (and bagels) you could try [slicing a bagel into 13 pieces](http://makezine.com/2012/01/09/math-monday-slice-a-bagel-into-13-pieces-with-3-cuts/) with just three cuts. For a more interactive kind of entertainment, try [Bagels Pico Fermi](http://inspiringmath.blogspot.com/2007/09/bagels-pico-fermi-mastermind-with.html) (a variant of the old board game [Mastermind](http://www.archimedes-lab.org/mastermind.html)) with your class.

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