

The HOME FORUM

# Sweet chemistry

Sugar candy can be soft like fudge, chewy like caramels, sticky like taffy, hard like lollipops. What's the secret of sugar's many textures?

**T**HIS Valentine's Day, while you're tearing open the wrappers on red and pink lollipops and crunching colorful candy hearts, take a minute to think about how those sweet treats are made. It might surprise you!

Would you believe that all candy, from cotton candy to fudge to peanut brittle, starts out as a plant? But not just any plant – a plant that contains sugar, like the sugar cane or the sugar beet.

When sugar cane and sugar beets are harvested, they go to a mill, where the plants are cut into shreds and then huge rollers press out what's called "raw sugar." This is then sent to a refinery, where it's made into different types of edible sugar like granulated sugar, brown sugar, and powdered sugar.

"Although there are many different types of sugar that you can use for baking," says Lisa Futterman, "plain old granulated sugar works best for most types of candy." Ms. Futterman is director of the Chopping Block Cooking School in Chicago.

## Water and heat are the key to candy

But turning those tiny sugar granules into a creamy, chewy, or crunchy candy isn't as easy as it may seem. In fact, Futterman says it can be tricky. Even dangerous. "Cooking sugar to make candy requires an intense amount of heat," she says. Most recipes require temperatures of between 240 and 310 degrees F. To give you an idea of how hot that is, consider this: Water boils at 212 degrees F.

But let's back up. Making candy is tricky because you can't just cook sugar by putting it in a pot on the stove, says Darrin Aoyama. "Hot sugar is very difficult to control because it gets hot really fast," says the pastry chef at the River Oaks Country Club in Houston. He's also on the United States' 2004 Culinary Olympics Team that competes this October in Germany. To control the heating process, chefs mix the sugar with water. Water helps slow down the temperature changes in the sugar.

That's because water never gets hotter than 212 degrees F. At that temperature, it starts to boil and then to evaporate. When you heat sugar and water to 212 degrees, the water in the solution will cause it to boil. As the water boils away, the sugar and water solution gets hotter. In fact, the temperature of the solution tells you what percentage of water is left.

Different types of candy require different concentrations of sugar. This is called "saturation." When a solution is "saturated," it holds as much sugar as it can at a certain temperature – no more sugar will

dissolve in it. In fact, to make many types of candy, there must be so much sugar in the water that it isn't just saturated, it's "supersaturated."

Here's where you have to be extra careful when cooking: The more concentrated the sugar solution, the less stable are the sugar molecules. Adding just a speck of dust, or changing the temperature ever so slightly can cause the solution to crystallize early. At lightning speed, your smooth syrup will turn into a grainy glop.

## The cold water candy test

It is also important that you carefully watch to see how hot this solution gets. That's because how hot it gets determines what kind of candy you make. "The temperature of sugar solutions jumps quickly," Futterman says, "so you have to watch it very closely." It's critical to use a candy thermometer as your guide, but "it's also cool

to do the 'cold water candy test'."

Here's how it works: Say you are making fudge. Most fudge recipes direct you to heat your sugar solution to about 235 degrees F on a candy thermometer. (Make sure that when you're reading the thermometer it's not touching the bottom of the pot, Futterman says, or you could get an inaccurate reading.)

To check this temperature with the cold water candy test, carefully skim a spoonful of the solution from the pot and pour it into a glass of cold water. Watch closely: If it is the right temperature, you will see the solution form a ball in the water. This is the "soft ball stage." That means that, once it's cooled for a few minutes, you can take the ball out of the water and it will feel soft. In fact, you can even smooch it between your fingers – just like fudge.

If the solution gets hotter, between 245 and 250 degrees F, you've reached the "firm ball stage," which is perfect for making caramels. To test it, you do the same

thing with the solution and the cold water. This time, though, the solution should form a ball that is, as it sounds, a bit firmer than the soft ball. You will still be able to squash it, but it won't be as easy.

The "hard ball stage" happens when the solution is 250 to 265 degrees F. At this point, the solution is about 92 percent sugar and only 8 percent water. When you put a bit of the solution in cold water now, it will form a ball that feels firm, like a gummy bear. This is the temperature for making divinity and nougat candies.

## 99 percent sugar is 'lollipop time'

When the solution gets even hotter – 270 to 290 degrees F – it is at the "soft crack stage." This is perfect for saltwater

taffy and butterscotch. When you drop some of the solution into cold water, you'll see threads forming, rather than a ball. If you take the threads out of the water, they can bend a bit before they break.

At 300 to 310 degrees F, the solution is 99 percent sugar and is as hot as it can be without burning. This is the "hard crack stage," and it's the temperature range for making lollipops and peanut brittle. When a bit of this super hot solution is added to cold water, it forms threads that break if you try to bend them.

You can tell your solution is getting hotter as you cook it because, as it continues to boil, the bubbles won't be as rapid. "It will go from a rapid boil to a boil that looks more like lava," Mr. Aoyama says. If your solution gets too hot – hotter than 310 degrees F – it will start to turn brown. Candy made with this brown solution will have a bitter taste, like strong caramel. The taste will overpower any flavorings you add. If your solution gets any hotter than that, it will start to burn. You'll know if this happens because it will start to smoke and will smell really bad.

The easiest way to ensure delicious candy every time, Futterman says, is to follow the recipe exactly – and have fun.

Jenny B. Davis

■ For more on the science of sugar, go to: [www.exploratorium.edu/cooking/candy](http://www.exploratorium.edu/cooking/candy)



ILLUSTRATIONS BY JULIA GRAN



## Now... You Know FACTOIDS AND CURIOSITIES

**SUGAR ONCE HAD A STARRING ROLE IN HOLLYWOOD MOVIES.** In old-time Westerns, bad guys being thrown through the windows of saloons were actually being tossed through panes of sugar. Sugar was dissolved in boiling water to make a syrup, which was then poured into large flat pans to cool. The resulting sheets of "candy glass" would shatter realistically into jagged pieces, but the sugar shards posed little threat to actors or stuntmen. Today, the "glass" that breaks onscreen is made of special thin plastics and paraffin wax. (The sound of breaking glass is added later.)

Source: Carnegie Magazine Online, Nov.-Dec. 1997

## Make your own Valentine's Day lollipops

You will definitely need an adult's help for this, as the sugar syrup is very hot. Yield: about 10 lollipops.

### INGREDIENTS:

1 cup sugar  
1/3 cup corn syrup  
1/2 cup water  
1/4 teaspoon cream of tartar  
1/4 teaspoon cinnamon or cherry-flavored extract  
Red food coloring

### YOU WILL NEED:

An adult to help you  
Nonstick or enameled saucepan  
Wooden spoon  
Candy thermometer  
Pastry brush  
Cooking oil spray  
Cookie sheet  
Wax paper or parchment paper  
Lollipop sticks (wash and air-dry some nonsplintery craft sticks)  
Glass of very cold (*not* ice) water  
Sandwich bags or cellophane  
Red, pink, or white yarn or ribbon  
(Optional: lollipop molds)

Turn your cookie sheet upside down, cover it with wax or parchment paper, and spray the paper with cooking oil. If you are using a lollipop mold, place the lollipop sticks into their grooves, spray the entire mold with cooking oil, and put the mold on top of the cookie sheet.

Put the sugar, corn syrup, water, and cream of tartar in the saucepan and stir over medium heat. Use a wooden spoon, as it won't get hot the way a metal one will. (Note: While the solution is heating, avoid sudden temperature changes or introducing foreign particles. These can cause the solution to crystallize early and become grainy.)

Keep stirring until all of the sugar crystals dissolve. If you see sugar crys-

tals on the sides of the pan, dampen a pastry brush with hot water and brush the crystals down into the solution. Doing both these things will help prevent crystallization. And be careful: The solution will get very hot.

As soon as the solution starts to boil, stop stirring.

Ask an adult to heat the candy thermometer under hot water and then attach it to the side of the pan. Don't let the tip of the thermometer touch the sides or bottom of the pan. This could affect its accuracy – or even break the thermometer.

Keep an eye on the temperature. When it hits 300 degrees F., an adult must remove the pan from the heat immediately.

Now have an adult help you do the cold-water candy test to confirm that the solution has reached the hard-crack stage. While you watch the solution turn to brittle threads in your water glass, let the solution cool to 275 degrees F. Add flavor and a few drops of food coloring.

Have an adult prepare the actual lollipops. If you aren't using a mold, the adult should carefully pour a little of the candy solution onto the papered cookie sheet, enough to make a two-inch puddle of syrup. Now you can put in the lollipop stick. Give the stick a little twist to make sure it's coated with the candy solution. Repeat nine more times. (Note: lollipops made without a mold won't be perfectly round.)

If you have a mold, have an adult pour the solution into the prepared mold.

The lollipops now have to cool – a perfect time to start cleaning up!

After about 10 to 15 minutes, your lollipops will be ready to wrap. Cover each with a sandwich bag or a piece of cellophane and tie it closed with a piece of ribbon or yarn.

J.B.D.

## Clean-up tips to keep you and your parents happy

MAKING CANDY is a delicious project, but it can also be pretty messy. Here are some tips to sweeten your cleanup:

- Before you start making candy, cover your entire working surface (even the floor) with waxed paper, parchment paper, or newspaper. That way, sticky drips will fall on disposable coverings and not on surfaces that need cleaning.

- After you've poured out your candy solution, let the saucepan cool off on an unused stove burner. Putting a hot pan on the countertop may scorch the countertop, making cleanup tougher.

- Never pour hot leftover candy solution down the drain, as it may cool and harden in the pipes, clogging them. Instead, pour the solution into a used soup can or other container. When it has cooled, put the can in the trash.

- When your pot has cooled, you can clean off the sticky residue inside it much more easily if you redissolve it. To do this, have a grownup fill the dirty pot two-thirds full of water and bring it to a boil.

J.B.D.

