Sugar Rush

Why is fudge gooey and why are boiled sweets hard?

Stock items	Consumables
Bin bags	Fudge
Plastic cups	Hard boiled sweets
Plastic tubs with lids	Granulated sugar
Glucose molecular model	
Fructose molecular model	
Sucrose molecular model	

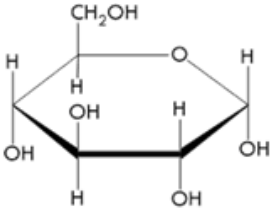
Presenting ideas

Fill a plastic cup with a small amount of granulated sugar. Put the two different sweets into two separate plastic tubs. Try and buy similar numbers of each. Show your *edible explorer* both types of sweets.

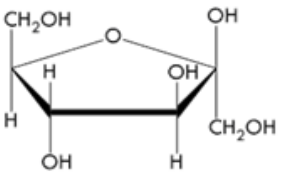
- How would you describe the texture of each?
- What are the similarities and differences between the two?
- What's the link between the sugar in the cup and the sweets?
- Do you think they're made the same way?
- Why is one harder than the other?
- Why is the boiled sweet clear?

What's the chemistry?

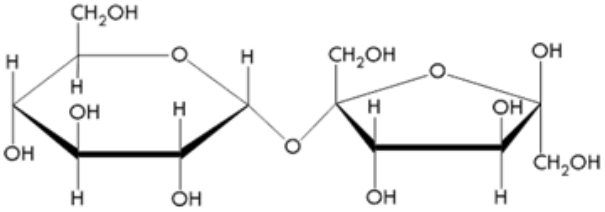
The sugar you're familiar with is a white crystalline substance called sucrose. Each sucrose molecule is a disaccharide (double sugar), consisting of monosaccharide (single sugar) molecules bonded together; one glucose and one fructose.



Glucose



Fructose



Sucrose

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All sweets are made using the same principle. When mixed with water and heated, sucrose crystals dissolve and form sugar syrup. As the temperature of the syrup increases and the water evaporates, the concentration of the sugar increases and this affects the way the molecules behave when the syrup is eventually cooled. Confectioners use these temperatures to make different types of sweets.

Sweets can be characterised as either crystalline or non-crystalline. Crystalline sweets include fudge, marshmallows, nougat and soft caramels. Non-crystalline sweets are hard, such as toffee and lollipops.

Sugar stage	Temp (°C)	Sugar concentration	Sweet examples
Thread	110-112	80%	Sugar syrup and fruit liqueur
Soft ball	112-116	85%	Fudge and praline
Firm ball	118-120	87%	Caramel
Hard ball	121-130	90%	Nougat and toffee
Soft crack	132-143	95%	Chews and butterscotch
Hard crack	146-154	99%	Lollipop and boiled sweet
Clear liquid	160	100%	
Brown liquid	170	100%	Liquid caramel
Burnt sugar	177	100%	Oops. Go and buy a new pan!

At high temperatures, the sugar is so concentrated it becomes supersaturated; it contains more sugar than could be dissolved in water under normal circumstances. This is unstable and any knock or bump will trigger crystallisation. And at these temperatures, if the sugar does crystallise, you'll end up sweets with strange consistencies. No one wants a grainy lollipop, do they?

Sweets made at these higher temperatures are more difficult to produce as the sugar concentration is higher and they naturally want to crystallise.

But there are techniques which can prevent crystallisation. Corn syrup, which contains starch, may be added to the mix. When heated, the starch breaks apart into glucose. These glucose molecules are smaller than sucrose and interfere with crystal formation, making the sugar crystals harder to form. In lollipops, a 50:50 ratio of sugar to corn syrup is often used.

Creating a non-crystalline sweet can also be done by adding lemon juice (citric acid) which causes sucrose to split into monosaccharides and just as before, these smaller sugars hinder crystal formation.

Jo's Top Tips

I find it easier to buy fudge and hard boiled sweets individually wrapped, so you don't touch them directly when you put them into the plastic tubs.

Always make sure you know the allergy advice on the sweets you're using. I make them visible by writing allergens on chalk boards but you could print them out. If your *edible explorers* don't wish to eat the sweets, they can still handle the wrapped sweets to feel the texture.

You could buy a sugar thermometer and heat up your own sugar syrup, taking aliquots of the mixture at each sugar stage. They'll all be different consistencies and colours so you could invite your *edible explorers* to match them up with the sweets in the table.

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