The Heat Is On

Why are chillies and mustard hot, but taste different?

Stock items	Consumables
Bin bags	Chilli sauce (as hot as you dare!)
Plastic spoons	English mustard
Plastic cups	Milk
Water	
Capsaicin molymod	
Allyl isothiocyanate molymod	

Presenting ideas

Invite your *edible explorer* to eat a pea-sized amount of chilli sauce, which you've put on a clean spoon. If you're using hot chilli sauce, reduce this amount

Invite them to taste a tiny amount of English mustard which you've put on a clean spoon.

- Do they both feel hot?
- Is there any difference in their heat?
- Can you feel one in your nose more than the other?
- Does the heat of one seem to linger more than the other?
- Have you ever noticed your nose runs when you have a hot curry? Why do you think this is?
- What's the best drink to have when you've eaten something hot?

Have glasses of water and milk to hand, if they want to see which takes the heat away more effectively.

What's the chemistry?

The chemical responsible for the heat in chillies and mustard arises from two totally different chemicals. In chillies, the heat comes from capsaicin; the more it contains, the hotter it will be. Chillies are measured on the Scoville scale, ranging from 0 for bell peppers to 16 million for pure capsaicin. Jalapenos are a mere 2500 and the super-hot Scotch Bonnet only rates at about 200,000 heat units. The hottest chilli pepper is currently the Carolina Reaper, which tops out at a whopping 2 million heat units.

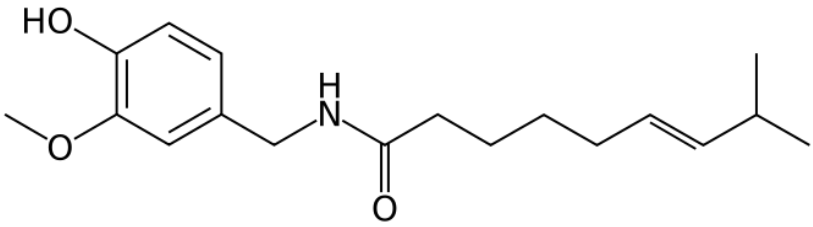
There's a good reason why foods like this feel hot. Our survival depends on our cells receiving and processing information. They do this by sensing their surroundings via proteins in their membranes called ion channels. Ions permeate through pores in the lipid (fatty) membranes of all cells and open and close in response to stimuli. These receptors convert

chemical or mechanical messages into electrical signals, which your brain interprets as different sensations.

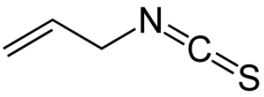
On your tongue and in the inside of your mouth, you have receptors which detect high temperatures, ensuring that you don't burn your mouth on piping-hot food. Some of these receptors are triggered by temperatures over 43 °C, and are called Transient Vanilloid Receptor Subtype 1 (TRPV1). At high temperatures, this protein springs into life and allows the flow of calcium ions from one cell to the next.

The clue's in the name, because it's not only heat that stimulates the Transient Vanilloid Receptor Subtype 1. It's vanilloids too; a class of compounds found in nature. Capsaicin is the heaviest vanilloid found in nature and when you eat chillies, you get the same response as the same nerve cells are being triggered. An electron poor area on the capsaicin molecule is attracted to an electron rich area on this receptor protein. This fires a signal to your brain that you have something very hot in your mouth. Other vanilloids stimulate this too, such as vanillin in vanilla, eugenol in cloves and zingerone in ginger.

Mustard (along with wasabi, horseradish and other members of the brassica family) get their heat from allyl isothiocynate. Allyl isothiocynate also triggers the TRPR1 receptor but coupled with that, it's also a much smaller molecule than capsaicin. This makes it more volatile, meaning it turns into a gas more readily. It is therefore more likely for the gas to enter your nose and irritate the smell receptors. You might notice strong mustard really burns the inside of your nose.



Capsaicin



Allyl isothiocynate

So both chillies and mustard feel hot, but they feel different due to the different molecules involved. The heat from chillies lingers in the mouth more as capsaicin is an oil and almost completely insoluble in saliva. But you can calm the burn by drinking milk. The protein casein in the milk helps break the bonds capsaicin forms on your nerve receptors. Allyl isothiocynate is slightly water-soluble and can be more readily washed away by your saliva, so the heat doesn't hang around as long.

Both chemicals irritate the mucous membranes in your nose, causing inflammation. Your body's natural defences produce extra mucous to keep the irritation to a minimum, causing a runny nose when eating these molecules. The compounds also irritate the membranes in your eyes, causing tear ducts to kick into action, trying to wash the irritant away. Some of these tears drain into your sinuses too.

Jo's Top Tips

As a safety precaution, I wouldn't recommend delivering this to younger students. Older students and adults are generally familiar with how hot chillies can be. But do warn people in advance.

I usually have a couple of different chilli sauces – sweet chilli and something much hotter. Bravado may sway some of your audience to try the hot stuff.

Some people can't handle the heat so always taste the amount of chilli sauce and mustard you're planning on administering.

Always wash your hands if you get any chilli sauce on them. And it goes without saying, don't rub your eyes!

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