



## Bitter Orange

### Why does orange juice taste horrible after brushing your teeth?

Stock items	Consumables
Bin bags	Orange juice
Plastic spoons	Toothpaste
Plastic shot glasses	
Sodium lauryl sulfate molecular model	

### Presenting ideas

Invite your *edible explorer* to take a sip of the orange juice - about half the amount you've poured into a shot glass.

- How does it taste? How would you describe the taste?

Then ask them to chew some toothpaste, which you have put on a spoon. Use a very small amount (half the size of a pea), as they will swallow it. Ask them to swill it around inside their mouths for 20 seconds before swallowing. Ask them to drink the remaining portion of the orange juice.

- How does it taste now?
- What are the different types of taste?
- Which one do you think this is?
- Why do you think the toothpaste has altered the taste of the orange juice?

### What's the chemistry?

The bumps on your tongue contain about 10,000 taste buds, each comprised of up to 100 taste receptor cells. Your taste buds are programmed to identify five different taste types - receptors identify sweet, bitter and umami (savory) and ion channels identify salty and sour. You can think of different taste molecules as being different shapes. Each taste receptor is designed to recognise certain shapes and ignore others. This molecular sorting system is usually very accurate but you can alter the way it works.

Toothpaste is made up of four primary ingredients; water, abrasives, fluoride and detergents. Water simply bulks out the paste. Abrasives remove the plaque from the surface of your teeth and gums. Fluoride helps fight against cavities and the detergents help to create a foam, evenly distributing the toothpaste in your mouth.

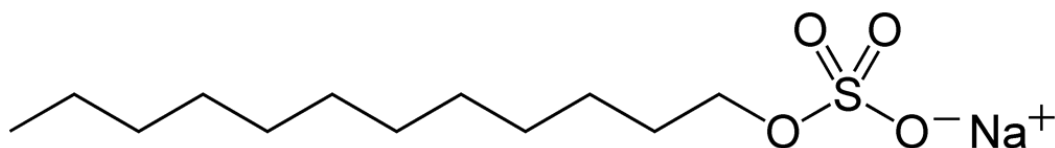
A commonly used detergent is sodium lauryl sulfate (SLS) and it's used in many other household products where producing a foam is necessary, such as soaps,



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shaving gels and washing up liquids. It's great at producing a foam, but it fools around with our sense of taste. SLS is a surfactant – the molecule attaches itself to oil and suspends it in water, allowing it to be easily removed.

You can use the SLS molecular model to explain how it behaves as a surfactant. The word surfactant is a combination of SURFace ACTIVE AgeNT.



SLS has a water-loving (hydrophilic) 'head' and a water-hating (hydrophobic) 'tail'. The tail is key to how surfactants work because although it hates water, it loves oil (lipophilic). If you start adding a surfactant to water, the surfactant molecules will start to aggregate on the surface with their hydrophilic heads sticking into the water. Once you add more, the surface becomes saturated and any additional surfactant molecules are forced below the surface and huddle their hydrophobic tails together, creating little pockets of water-free environments. This is known as a micelle. Any oil in the water migrates to this oil-friendly environment inside the micelles and is removed when the water is drained away.

SLS in toothpaste attaches to sweet receptors on the tongue, which inhibits the ability to taste sweet flavours. SLS also destroys phospholipids in our mouths, which inhibit the bitterness receptors. By suppressing sweet receptors and destroying a compound which impedes bitterness, SLS creates a double-whammy of bitterness. It's no wonder orange juice tastes so horrible after brushing your teeth!

Your sense of taste can be fooled in other ways. If you eat an artichoke then drink water, you might notice the water tastes slightly sweet. This is because a molecule present in the artichoke called cynarin silently attaches itself to your sweet receptors without activating them. When you wash the molecule away with a glass of water, the sweet receptors are activated.

Then there's the miracle fruit - West African berries which turn sour into sweet. The molecule miraculin contained in the berries lurks quietly in your mouth until something acidic arrives. The drop in pH changes the shape of the miraculin so it now interacts with your sweet receptors and means acidic, sour foods taste incredibly sweet. Chewing a lemon actually tastes like you're eating sweets.

## Jo's Top Tips



Buy children's toothpaste, as it's low in sodium. Toothpaste comes in a range of flavours, not just mint, so why not buy a selection and experiment? Many people think the minty flavour of toothpaste is what makes orange juice taste horrible... so you can prove them wrong.

I buy shot glasses from my local pound shop; a tiny amount of orange juice is all that's needed and you can wash and reuse.

Orange juice from concentrate works just as well as non-concentrate. It's generally cheaper and has longer shelf life too.

You can buy tablets containing miraculin. The 'effect' wears off after about an hour!



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