Tooth Furry

What causes that ‘furry’ teeth feeling when eating spinach?

Stock items	Consumables
Bin bags	Canned spinach
Plastic forks	Fresh spinach
Plastic plates	
Can opener	

Presenting ideas

Open the canned spinach. It contains lots of water, so drain it well and put it on a plastic plate (I’ll warn you, it does not look appetising!). Open the bag of fresh spinach and put some leaves onto another plate. Invite your *edible explorer* to eat some of the canned spinach, which you have put on a fork. Ask them to chew it for 10 seconds before they swallow.

- How does the inside of your mouth feel?
- Do your teeth feel any different? If so, how?
- Have you noticed the sensation before?
- Have you noticed the same thing happen when you eat other foods?

Invite them to try some fresh spinach. Make sure they chew this well before swallowing.

- Do you get the same sensation?

What’s the chemistry?

Oxalate or oxalic acid is a strong acid, constructed from two carboxylic acid groups (COOH). It’s a naturally occurring chemical and it’s indigestible, passing through the body unabsorbed.

We synthesise it. We can create it from amino acids like hydroxyproline in our liver, vitamin C can transform into oxalate and our red blood cells synthesise it from glyoxylate. We can also eat oxalic acid as it’s found in a variety of different foods including green leafy vegetables, nuts, seeds, most berries and soy products.

Spinach has very high levels of oxalic acid; it contains about 750 milligrams per 100 gram serving. The oxalic acid is usually contained within little pockets in the cell walls of the spinach but when these are ruptured by either being boiled or being chewed well, the cell walls break and oxalate crystals leach out.

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A healthy gut contains *Oxalobacter formigenes*, an anaerobic bacterium found in the large intestine that breaks down oxalates. There is a limit to how much the body can excrete, so if too much oxalate is absorbed, some will be stored. If there's an excess in our bodies, our kidneys produce urine with a higher than usual concentration of oxalates. When combined with high levels of calcium in the urine, this increases the risk of kidney stones as the urine is super-saturated with calcium oxalate salts.

There are some chemicals in urine (such as the Tamm-Horsfall protein, nephrocalcin and citrate) which inhibit these calcium oxalate crystals from forming. If the inhibitors are depleted, or they're overwhelmed by calcium oxalate and can't cope, a 'seed' is formed within the kidney tissue and this acts as a binding site onto which more calciuim oxalate is deposited. Once large enough, they can detach themselves from the kidney walls forming a kidney stone. Your urinary system is usually able to remove small kidney stones without any problem. However, larger ones get stuck and cause immense pain.

The furry mouth you experience when you chew spinach is related to this. Spinach contains calcium, as does your saliva. This combines with the oxalic acid crystals in the spinach's cell walls and deposits calcium oxalate-rich plaque on your teeth. Being insoluble, you feel this as a chalky deposit in your mouth.

The presence of oxalate decreases your ability to absorb vital minerals from foods, such as iron and calcium, as the oxalic acid binds to these metals in your digestive tract and keeps them from being absorbed. Despite containing almost the same amount of calcium by weight, you absorb five times more calcium from milk than you do from spinach because in spinach, much of the calcium forms insoluble precipitates.

Some people are more predisposed to having excess oxalic acid in their bodies than others. Genetic variations, people who don't consume enough water, those who are deficient in vitamin B6 or have an excess of glycine increase their risk of developing kidney stones.

In large amounts, oxalic acid is poisonous, but toxic levels are not found in foods that we normally eat. Simply rotating or mixing spinach with lower-level oxalate-containing foods will cut the risk of kidney stones.

If you want to avoid eating large amounts of oxalic acid, boil spinach and throw away the water – about 85 % is lost this way compared to steaming, which only reduces the oxalic acid by half that much. But it's a trade off because by doing this, you discard lots of important nutrients too.

Jo's Top Tips

If you've never tasted canned spinach before, count yourself lucky! If the texture doesn't put you off, the flavour might. The canning process seems to reduce some of the distinctive flavour and it doesn't taste of very much at all (and I should know; I'm a supertaster!). I simply use it because it demonstrates that the furry teeth effect is far greater when the cell walls have been pulverised. If you have the time, you could wilt your own spinach instead of buying it in a can, but it's more expensive that way.

Find out if anyone you're going to try this on has ever had kidney stones or has a family history. If they have, despite the fact you're only getting them to taste small quantities, use your judgement.

Rhubarb, beetroot, leeks, kale and chocolate are high in oxalic acid, although I've found spinach generates the best 'furry' teeth. Count me in for any chocolate-tasting clinical trials!

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