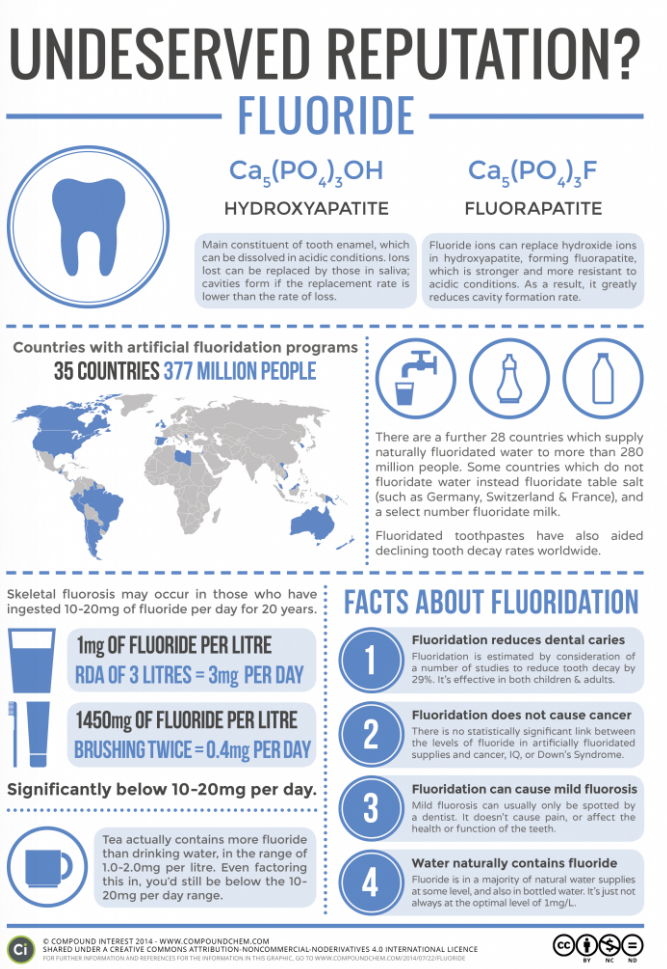
Fluoride & Water Fluoridation – An Undeserved Reputation?



Click to enlarge

This graphic is the first in a series I'm hoping to make on chemicals with potentially undeserved reputations. In it, I'll look at the evidence and research on each, and try to come to some kind of rational conclusion as to whether or not their bad reputation amongst the general public is deserved. I thought I'd kick things off with one of the most controversial topics, particularly over in the USA: the fluoridation of water supplies.

The reason for wanting a fluoridated water supply in the first place is the first thing we should consider, and it's based on the chemical structure

POPULAR

LATEST

TODAY

WEEK

MONTH

ALL


The Chemistry Behind Your Home's Water Supply


Chemical Warfare: Poison Gases in World War 1

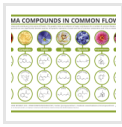

A Brief Guide to the Twenty Common Amino Acids


This Week in Chemistry –

of your teeth. The enamel that coats your teeth is made up primarily of the compound hydroxyapatite. This ionic compound consists of calcium ions, phosphate ions and hydroxide ions, and is also a major component of your bones. Enamel is well known for being pretty strong, but it can be slowly broken down and lose ions from its structure under acidic conditions. This is known as demineralisation. Our body has a built-in countermeasure for this, and can replace the ions lost with ions from our saliva, in a process known as remineralisation. However, sometimes the rate at which this replacement occurs is below that at which the ions are being lost. When this happens the pores in the tooth can become enlarged, and cavities and tooth decay can result.

Fluoride ions can help arrest this process. They can be incorporated into the hydroxyapatite structure, replacing the hydroxide ions and forming fluorapatite. Fluorapatite is stronger than hydroxyapatite, and is also more resistant to acidic conditions. This means it can greatly delay the onset of cavities and tooth decay, and this is the reason why there's a clamour to add it to water supplies. The World Health Organisation, based on research, have set an optimal amount of fluoride in water supplies of around 1 part per million (ppm). To give this some perspective, 1 ppm is equivalent to one minute in two years; it's 1 milligram of fluoride per litre of water. Studies have suggested

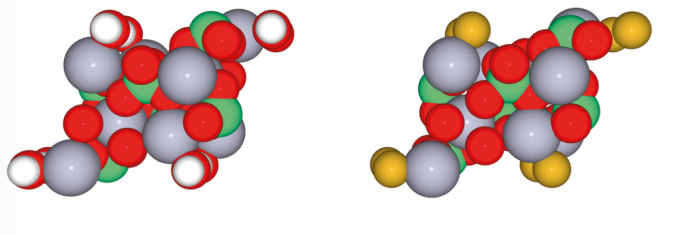
Fluorescent Frogs, and How Tardigrades Survive Dehydration



The Chemical Compounds Behind the Smell of Flowers

The chemical structures in Compound Interest's graphics are created using PerkinElmer's ChemDraw® Professional v15 desktop software. Includes PerkinElmer copyright

that this level of fluoridation could reduce tooth decay by as much as 29%. It's been hailed as 'the most cost effective and practical way to provide protection from tooth decay'.



Hydroxyapatite (left) and fluorapatite (right) (created using Atomsmith Apps for chemistry education (http://www.bitwixt.com/jsite/atomsmith-molecule-lab))

Artificial fluoridation of water is carried out in around 35 countries worldwide, including the USA, Australia, Spain, several countries in South America, and parts of the UK and Ireland (not including Northern Ireland). This artificial fluoridation is usually achieved by adding small amounts of fluorosilicic acid to the water, but sodium fluoride and sodium fluorosilicate can also be used. Fluoride also occurs naturally in the majority of natural water supplies; often, this is at a lower concentration than that recommended, but in a select few places it can be much higher. For example, in some lakes in Ethiopa, levels of over 260mg/L have been recorded.

So, if fluoride is so beneficial for the health of our teeth, why the controversy? This stems in part from legitimate studies on the effects of higher fluoride concentrations. An oft-quoted study by the National Research Council in 2006 found that

fluoride can have a range of harmful effects – but they were discussing concentrations several times higher than those used in artificially fluoridated supplies. Another frequently mentioned study is one carried out in China and published in 2012, which found that high levels of fluoride in childhood were associated with a reduction in IQ. In this case, the authors of a review including the study noted that their findings weren't applicable to artificially fluoridated supplies, as the concentrations they were examining were many times higher. They also commented on the poor design of the study. A recent New Zealand study, published this year, found no link between fluoride exposure and IQ or neurotoxicity over a 38 year period at more normal levels of fluoride consumption. Reviews on studies linking fluoride at the levels found in drinking water to cancer and other conditions such as Downs Syndrome have commonly found them to be poorly designed, and those studies that were well designed showed no statistically significant link.

Despite these misinterpretations, it's not the case that fluoride is completely benign. An accepted adverse effect of fluoridation is dental fluorosis. This can cause streaks or specks in tooth enamel, and discolouration and brown markings in its most severe form. However, it's estimated that, in the majority of cases, only mild dental fluorosis will be observed in 1 out of

6 people living in artificially fluoridated areas. Mild fluorosis doesn't cause pain, or affect the health or function of the teeth, and can usually only be spotted by a dentist. Fluorosis of 'aesthetic concern' can affect 1 in 22; this is still considered by dentists to be purely aesthetic in its impact, but may be marginally more noticeable.

Generally, the risk of dental fluorosis is a concern for children, especially because at a young age they can have a tendency to swallow toothpaste. This is one reason why child toothpaste with lower fluoride levels are sold. Additionally, if using infant formula instead of breast-feeding, it's recommended that distilled water is used rather than fluoridated tap water, to ensure that the child isn't exposed to too much fluoride.

Another form of fluorosis is often cited when discussing fluoridated water – skeletal fluorosis. This occurs when fluoride is ingested, and passes through the body, reacting with hydroxyapatite in the bones to form calcium fluoride. This removes calcium from the bones, which results in increased density but decreased bone strength. Luckily, the levels of fluoride in artificially fluoridated areas are nowhere near high enough to cause skeletal fluorosis.

The World Health Organisation states that skeletal fluorosis can occur in those who've ingested 10-20mg of

fluoride every day for 20 years. Artificially fluoridated water supplies typically contain 1mg of fluoride per litre; considering that it's recommended you drink 3 litres of water a day, this would put you on 3mg. Toothpaste also contains fluoride, and even though you don't eat it, a small amount will still end up being ingested (estimates state around 20% of the fluoride content). This accounts for around an extra 0.4mg per day, assuming you brush your teeth twice. If we're going to cover all bases, tea and some foods also contain fluoride; in fact, black tea can contain more than any artificially fluoridated water supply, and can be up to 2mg per litre. But even if you binge on tea all day, you're unlikely to reach the lower bound of the 10-20mg per day figure. Skeletal fluorosis is a problem in some countries, but this tends to be in those where the natural water fluoride concentration is at dangerous levels, rather than as a result of any fluoride added.

It's often stated, incorrectly, that the vast majority of European countries have rejected fluoridation. Aside from those that do practise some degree of artificial fluoridation, such as Spain, the UK, and Ireland, many other countries fluoridate their salt instead. Germany, Switzerland and France all do this, whilst in some countries in Eastern Europe, milk is fluoridated instead. Some countries don't fluoridate their water supplies because the natural fluoride levels are already close to the

recommended level. Bottled water also frequently contains fluoride.

Another argument commonly put forward is that, with toothpastes commonly being fluoridated, there isn't any need for water supplies to be fluoridated too. However, a range of studies have shown that, comparing fluoridated water areas with non-fluoridated areas, there was a much lower rate of tooth decay. This was despite the fact that 94% of children living in the non-fluoridated areas were using fluoride toothpaste.

To conclude, it's not incorrect to say that fluoride can have some unpleasant consequences – at high concentrations. At the concentration at which it's introduced into water supplies, however, it's been proven by numerous studies to be both safe, and to have a beneficial effect on tooth health. Despite the allegations of links with cancer and mental health conditions, reviews of the currently available research have found no statistically significant links between these and fluoride at the concentrations commonly found in water supplies.

In summation, we can say that fluoridation of drinking water probably has the right to feel unfairly maligned. Unless we can come up with a more effective and cheaper method, it remains an inexpensive, effective, and safe way of improving our dental health, as long as the concentrations in water are carefully

controlled. If you don't want to just take my word for it, I'd encourage you to take a look at some of the links below, from which I pieced together the graphic in this article.

DOWNLOAD THIS GRAPHIC

SUBSCRIBE TO SITE UPDATES

References & Further Reading

- A Systematic Review of the Efficacy & Safety of Fluoridation – Australian National Health & Medical Research Council
- The Extent of Fluoridation – The British Fluoridation Society
- Fluoride in Drinking Water – M Tiemann
- Fluoridation Systematic Reviews – CDC
- What to Critics Say? – Campaign for Dental Health
- Fluoridated Water – Science, Scams and Society – Starts With A Bang

One blogger likes this.

Related

The Chemistry of Limescale
March 2, 2016
In "Inorganic Chemistry"

The Chemistry of Vodka – Structure, Additives, and Impurities
June 8, 2016
In "Alcohol Chemistry"

Chlorinati... & Pee in the Pool: The Chemistry of Swimming Pools
August 12, 2015
In "Miscella... Graphics"

The Chemistry of Limescale
March 2, 2016
In "Inorganic Chemistry"

The Chemistry of Vodka – Structure, Additives, and Impurities
June 8, 2016
In "Alcohol Chemistry"

Chlorinati... & Pee in the Pool: The Chemistry of Swimming Pools
August 12, 2015
In "Miscella... Graphics"

By Compound Interest | July 22nd, 2014

Share This Story, Choose Your Platform!

Related Posts