

### **Mechanism of action of fluoride on teeth.**

Empirically, community water fluoridation, (CWF), and fluoride toothpastes reduce dental decay at the population and individual level<sup>1,2</sup>. Research and debate continues about the exact modes of action and relative importance of these two mechanisms for delivery. Readers may find it helpful to understand current ideas about the pathological process and value of fluoride in repair of dental caries.

Enamel in teeth comprises crystals of hydroxyapatite,  $\text{Ca}_{10}(\text{PO}_4)_6(\text{OH})_2$ , in a matrix of proteins. The process of dental caries (dental decay) involves acids formed in the mouth, largely from breakdown of carbohydrates by bacteria in the biofilm on teeth (dental plaque). These acids dissolve the surface hydroxyapatite, causing an initial “white spot” – a visible partly demineralised area that may progress onwards to a cavity. However, minerals in the biofilm can diffuse back into the matrix and recrystallise. This process promotes remineralization of early caries. If fluoride ions are present at time of enamel formation or after eruption they will substitute for varying proportions of the hydroxyl ions to form fluorapatite crystals,  $\text{Ca}_{10}(\text{PO}_4)_6\text{F}_2$ . These crystals are more symmetric, pack better and are more resistant to decay. It is also thought that  $\text{F}^-$  inhibits bacterial enzyme activity, and hence reduces acid formation.

Fluoride has both a systemic and topical effect on tooth enamel. When ingested, fluoride circulates in body fluids and is incorporated into the enamel of developing teeth, from mid-pregnancy up until complete enamel formation of the 3<sup>rd</sup> molars (wisdom teeth), around 15 years of age. Such incorporation makes enamel more resistant to demineralization and decay. Excess ingestion of fluoride, which might come from water supplies containing above 1.5 ppm of fluoride or from swallowing excess fluoride-containing toothpaste, may cause slight white mottling in some teeth. This is called fluorosis (though there are also other causes of white mottling, which makes assessment and attribution difficult). Teeth with mild fluorosis are more resistant to decay. Teeth with severe fluorosis (which is visible as brown staining) are brittle and can break, but severe fluorosis only occurs at concentrations over 4 ppm, or extreme ingestion. The enamel on the anterior teeth is formed by about 8 years, so any fluorosis that occurs before that age will be visible on these exposed teeth.

When applied topically, fluoride is incorporated into the enamel of people at all ages. Water fluoridation provides this benefit to the whole population. Fluoride toothpaste in Canada contains 850 to 1150ppm in the container<sup>3</sup> but dilutes as it is used in the mouth. Regular use provides transient local high concentrations, providing substantial protection and reduces cavities by up to 40%. Professional fluoride applications at higher concentrations also reduce cavities. Extra value comes through continuous exposure from low concentrations of fluoride in water, and hence in saliva.

Ideally, the effect of fluoride is greatest when it is present in the plaque and saliva during or shortly after fermentable sugar exposure. This emphasises the value of brushing shortly after eating, especially where the water is not fluoridated. However, meticulous dental hygiene after every time food is consumed is difficult, especially for parents of active children.

That CWF offers both systemic and topical benefits is valuable for those who have difficulty maintaining their oral hygiene or accessing routine dental care. Many lower income Canadians cannot afford oral health care, even irregularly, while in rural areas it is largely unavailable. CWF is particularly valuable for those who are unaware of the need to, or unable to, brush their teeth regularly. These include people with structural or behavioural challenges that make toothbrushing difficult, and many with low incomes, whose children are then further disadvantaged.

1. Yeung, C. A systematic review of the efficacy and safety of fluoridation. *Evid Based Dent* 9, 39–43 (2008). <https://doi.org/10.1038/sj.ebd.6400578>
2. Gluckman P, Skegg D *Health effects of water fluoridation: A review of the scientific evidence*. 2014 Royal Society of New Zealand, Wellington. ISBN- 978-1-877317-08-8
3. *Oral Health Products Monograph*  
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