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How Fluoride in Dental Products Protects Your Teeth from Cavities

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Fluoride in Dentistry
Fluoride is a well-known additive which is used for dental care. Fluoride’s role includes the prevention of caries and improving oral and health. There are many different types of fluoride compounds used in toothpastes and mouthwashes in order to replace lost calcium and phosphate ions due to demineralization.

How do Teeth Decay
Oral caries and tooth decay begin when the outer surface of the tooth is attacked by acid produced by bacteria commonly known as plaque. This overall process is called mineralization.

Replacement Reaction of Fluoride in Mineralization:
$$C_4H_2PO_4(OH)_2 + 2F^- \rightarrow C_4H_2PO_4F_2 + 2OH^-$$
Fluoride replaces hydroxide in hydroxyapatite to produce enamel that is less soluble in the presence of acid, thus showing the effectiveness of fluoride for dental health.

Enamel Structure
The enamel is made of a three-dimensional molecular network of calcium ions ($Ca^{2+}$), phosphate ions ($PO_4^{3-}$) and hydroxide ions ($OH^-$). This structure is called hydroxyapatite. Further strengthening the bonds between these ions are various fibrous proteins, dispersed between the empty spaces between them. Mineralization occurs due to hydroxyapatite continually dissolving and reforming within the mouth. This occurs when bacteria quickly converts sugars consumed through food and drink into an acidic byproduct. The acid from the bacteria eats calcium and phosphate minerals in the enamel through a process called demineralization. At the same time, ions in saliva are working to neutralize the acid by recombining to deposit enamel back on the teeth. The process of saliva replenishing calcium and phosphate ions in the enamel is called remineralization. If the bacteria is left undisturbed for extended periods of time and remineralization does not occur at an equal rate as demineralization, a net loss of calcium/phosphate ions will occur, leading to the formation of pits or cavities in tooth enamel.

Eventually, bacteria will break through the enamel and further destroy the tooth structure.

Fluoride in Dental Products and Municipal Water
The British Fluoridation Society recognizes that while the relationship between fluoride and tooth decay is complex and not fully understood, fluoride in toothpastes, mouthwashes and even municipal water are known to intervene in the progression of tooth decay through at least four ways:

1. Fluoride alters the structure of the developing enamel, making it more resistant to acid attack.
2. Low levels of fluoride in the plaque and saliva both encourage remineralization and ensure that enamel is replaced with improved quality.
3. Fluoride works to reduce the ability of plaque acid to produce acid by preventing enzymes from functioning properly.
4. Fluoride ingested during childhood while the teeth are developing minimizes the depth of grooves on the surface of teeth, preventing bacteria from embedding deep in the enamel.

Save your Teeth!
Fluoride is an essential and necessary component to ensuring the health of and well-being of teeth. Using fluoridated products such as water, milk, salt, toothpaste and mouthwash is essential to preventing dental caries by protecting the strength of your enamel. In a given routine, even using mouthwash daily on top of brushing your teeth can severely lower your chances of getting tooth decay and cavities. The effects of fluoride on your teeth have been widely recognized to improve dental hygiene, harden enamel and kill harmful bacteria.

References