Quality over quantity

How less fluoride can actually be more

Moira Crawford speaks to Prof Hill and asks how less fluoride can actually be more

Fluoride has long been seen as the 'magic bullet' in dental protection. There's no doubt that the introduction of fluoride has had a beneficial effect on the rates of decay, especially among children from deprived backgrounds, but it may be time to reassess the levels of fluoride that are given.

Too much fluoride, caused either by fluoride treatment or children ingesting toothpaste, can cause fluorosis and has led to strong anti-fluoride lobby.

In the **UK scientists are now arguing that high concentrations of fluoride alone are actually not the best strategy.**

Professor Robert Hill, research director at the Dental Institute and head of dental physical sciences at Queen Mary University of London, has been researching this area for some years, and is convinced that applying ever higher concentrations of fluoride to the teeth does not have the benefit that has previously been believed. 'Simply increasing the amount of fluoride within the toothpaste is frankly a crude solution,' he argues. 'Much of the additional soluble fluoride just goes to waste.'

The problem with fluoride toothpaste

Professor Hill's experiments have demonstrated that when conventional fluoride toothpaste containing a soluble fluoride such as sodium fluoride or sodium monofluorophosphate is used, there is an immediate 'high' of fluoride in the mouth, but that this drops rapidly as the toothpaste is washed away by salivary flow, so that after around only 100 minutes the amount of fluoride that remains is below therapeutic levels (Figure 1). **Even at high concentrations, the fluoride is rapidly washed away, so the effect is only short term.**

A further drawback is that high concentrations of fluoride form calcium fluoride (also known as fluorite) instead of fluorapatite, which is what is required for effective remineralisation. In large quantities fluorite can form a whitish crust on the tooth surface, which was previously thought to act as a reservoir of fluoride, but Professor Hill's completely insoluble, and does not release fluoride at all,' he explains.

BioMin F

Professor Hill and his team have developed a toothpaste that contains a bioactive glass that delivers a combination of calcium, phosphate and fluoride-ions to promote effective remineralisation of tooth enamel through the production of fluorapatite. Because the fluoride in BioMin F is incorporated within the structure of the glass, it is delivered gradually as the glass dissolves, and therefore a lower concentration (approx 530 ppm is required yet is more effective.

The fluoride contained within the glass structure of BioMin F is released slowly over around 12 hours and is therefore used more effectively. Prof. Hill says: 'As it dissolves, the glass structure in BioMin F provides a slow release vehicle for the fluoride, calcium and phosphate together, enabling it to form fluorapatite, which is more stable and resistant to acid conditions.'

BioMin F continues to remineralise tooth enamel for approximately 12 hours but some effects are still continuing at 24 hours after brushing.

How fluoride works in Biomin F

BioMin F has been developed to address three key problems in dental health: hypersensitivity, caries and dental erosion, caused by loss of tooth enamel or demineralisation. Under normal conditions, the hydroxyapatite mineral in tooth enamel is in dynamic equilibrium with the calcium, phosphate and hydroxyl ions in saliva, but under acidic conditions, such as following an acidic drink, this equilibrium is shifted, the pH in the mouth falls and demineralisation can occur.

As the bioactive glass in BioMin F gradually dissolves it releases phosphate, calcium and fluoride ions, these work in concert with the saliva to raise pH and restore equilibrium. Even more clever, at a lower pH the glass dissolves faster, so that the effect kicks in more rapidly.

Professor Hill summarises: 'This smart response means that if the user consumes an acidic drink, BioMin F dissolves faster to protect the teeth against acid dissolution.'

Sensitivity

In order for the glass to dissolve slowly where it's needed, the toothpaste has to stay on the teeth. The polymer used in Biomin F increases the viscosity of the toothpaste, but also chemically bonds to both the calcium in the tooth enamel and the calcium in the Biomin F, so that it sticks to the tooth surface and remains in place to release the fluoride, calcium and phosphate ions for several hours . **As the glass particle size is very small, these particles are able to enter the dentinal tubules and work to occlude these** . Fluorapatite forms preferentially on the apatite rich walls of the peritubular dentine within the tubules gradually occluding them, an effect still visible after acid challenge . Professor Hill and his research team believe that fluorapatite crystals probably favour growing on the existing apatite-rich walls of the dentinal tubules, which have a higher mineral content.

As the fluorapatite occludes the dentinal tubules, it reduces the flow of fluid, known as hydraulic conductance, which is the cause of sensitivity. Studies at Queen Mary have shown that the fluorapatite formed by the dissolution of the glass in BioMin F is more resistant to acid challenge than hydroxy-carbonated apatite formed from soluble fluoride in conventional toothpastes, and so the tubules remain occluded more completely.

The hydraulic conductance shows a greater percentage reduction as well as faster remineralisation rates than other toothpastes tested, says Professor Hill.

Professor Hill and his research team's have shown that it is not quantity of fluoride that improves its efficacy, but quality – the way that it is delivered.

Incorporating fluoride within the structure of the bioactive glass, combining it with phosphate and calcium ions to enable quicker production of stable, acid-resistant fluorapatite, and adhering the product to the teeth so that it can dissolve slowly where it can deposit fluorapatite most effectively, is the key to its effectiveness. Biomin F is a smart toothpaste, using new technology to deliver efficient remineralisation at levels of fluoride far lower than conventional toothpastes. It seems that in this case, less fluoride really can be more!

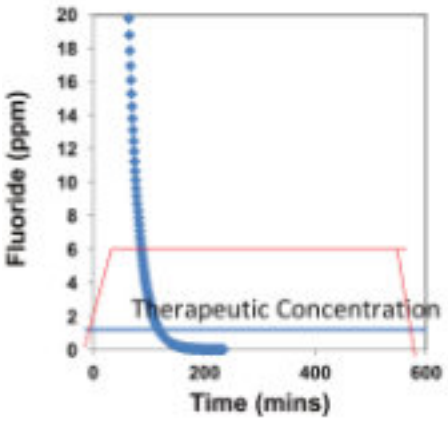

Figure 1: Soluble fluoride drops rapidly below therapeutic levels

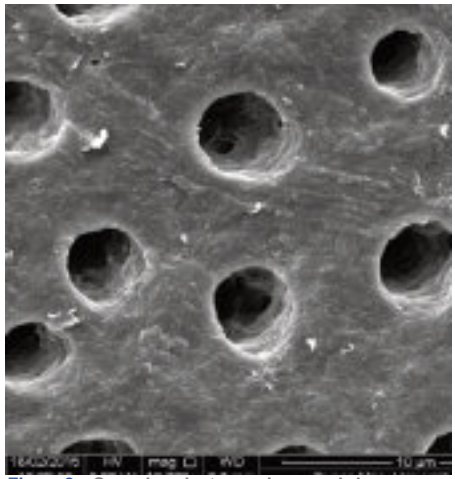

Figure 2a: Scanning electron micrograph image showing tubule occlusion before brushing with Biomin F

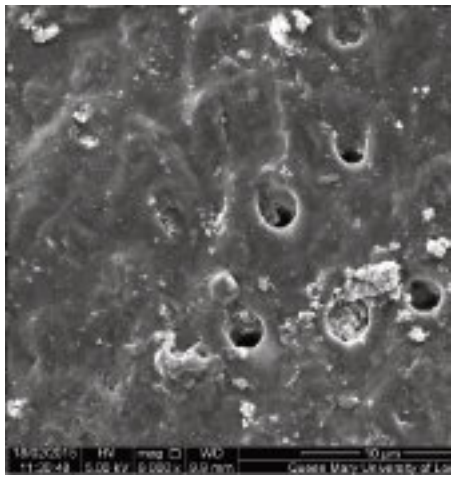

Figure 2b: Scanning electron micrograph image showing tubule occlusion after acid challenge