Newsfeature

Here comes the science bit

Robert Hill explains to Sophie Bracken the technology behind Biomin F, the innovative new toothpaste that claims to remineralise tooth enamel over 12 hours thanks to slow-release bioactive glass technology

Biomin Technologies, a spinout company from Queen Mary University, has launched what is being referred to as a breakthrough in toothpaste technology.

Biomin F toothpaste contains bioactive glass that slowly releases calcium, phosphate and fluoride ions over an eight- to 12-hour timeframe to form fluorapatite mineral, which rebuilds, strengthens and protects tooth structure. The slow release of fluoride has been identified to be particularly beneficial in the prevention of tooth decay.

Dentistry spoke to Professor Robert Hill, co-founder of Biomin Technologies and leader of the team that developed Biomin F, to find out more about the technology behind this innovative product.

Sophie Bracken (SB): Bioactive glass is very different to what most people know of glass. Could you describe the properties and its application in dentistry?

Robert Hill (RH): Most people regard glass as chemically inert and insoluble – it's what we use in the lab to put strong acids in. But bioactive glass is quite different. These are glasses that actually dissolve. They dissolve in the mouth and release calcium and phosphate. In the case of our composition, it also releases fluoride.

Historically, bioactive glasses were developed as a bone substitute material and they're regarded as a bioactive material. Thirty-plus years ago, medical device developers opted for chemically inert materials to make implants from, which produce very stable implants. Larry Hench, who invented bioactive glasses, started to think about materials that would stimulate a favourable biological response and materials that weren't chemically inert, and in this case dissolved. That changed perspectives in the field.

The glass that's used for bone grafts and bone substitutes was never originally designed as an additive for toothpastes. Despite that, it works surprisingly well and it's quite easy to develop a glass that's specifically designed and optimised for toothpastes.

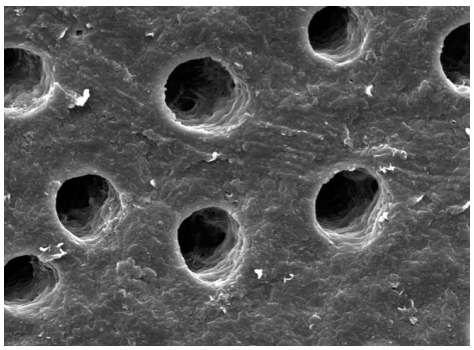

Figure 1: Tubule occlusion before brushing

Figure 2: Tubule occlusion after brushing with Biomin F

SB: How did you and your team come to develop Biomin F?

RH: I've been working in the area for 30 years. We did a lot of fundamental work at Imperial College London, where we were particularly interested in structural property relationships, and fundamental understanding of this glass structure and how it dissolves. That core know-how enabled us to develop the glass that's in the Biomin F toothpaste.

SB: What are the main benefits of including fluoride within the glass, rather than soluble fluorides that are present in most toothpastes?

RH: When you take a normal fluoride toothpaste with a soluble fluoride such as sodium fluoride or sodium monofluorophosphate, studies show that because the user is continually producing saliva and swallowing it throughout the day, the fluoride is being diluted in the mouth with time. After about 100 minutes, depending on people's salivary volumes and salivary flow rates, the fluoride concentration has dropped below a therapeutic value. We put the fluoride into the glass particles, which are designed to stick to the teeth.

The glass particles dissolve over around 12 hours, so you get a slow release of fluoride, and that's what you want. You don't want high concentrations of fluoride at any point, because then you tend to form calcium fluoride, rather than the fluoridated apatite.

So the glass is a slow release vehicle for fluoride, making much more effective use of it. In the Biomin F toothpaste we've got about a third of the fluoride content of a conventional toothpaste, but in terms of promoting remineralisation it works far more effectively, even though we've got a lower concentration of fluoride.

In order to remineralise and form apatite you need a source of calcium phosphate. In some cases where you have patients with a good salivary flow and there's a plentiful supply of calcium and phosphate, that's not an issue. But in a lot of patients with caries or dry mouth conditions, the saliva is not good quality and tends to be low in calcium and phosphates. So actually delivering calcium and phosphate with the fluoride is much more effective.

SB: What are Biomin's benefits over Novamin, the active ingredient in Sensodyne Repair & Protect toothpaste?

RH: The Novamin active ingredient is conventional glass. That has a relatively low phosphate content. Biomin F has an increased phosphate content, which increases the amount of apatite (tooth mineral) formed, and the speed at which it is formed.

The fluoride also speeds up the process, and rather than forming hydroxycarbonate apatite, it forms fluorapatite, which is much more durable in the mouth. The fluorapatite dissolves at about a pH unit less than hydroxyapatite, and probably about 1.5 pH better than the hydroxycarbonate apatite.

There are a few other advantages: the glass particle size is smaller in our Biomin F toothpaste than in Novamin, so it's got a less gritty texture and it's less abrasive towards the enamel. The glass is also slightly softer, which again is less abrasive towards the enamel. We've got a higher fraction of particles that can go into the dentine tubules, so it makes it more effective in tubular occlusion.

SB: Is Biomin technology patent protected anywhere in the world?

RH: It's covered by two patents – one that was filed by Imperial College and the other filed here at Queen Mary University of London.There's a third patent on fluoride glasses that we're developing, mostly for the American market.

SB: Besides toothpaste, are there any other dental products incorporating Biomin technology that dental care professionals can expect to see in the future?

RH: We're developing adhesives for orthodontic applications with the same technology, so the glass is similar to Biomin F but it's got a lower sodium content. We've also got about five companies that are evaluating the Biomin patents for various dental products.

We've also got a composite resin with a bioactive glass in the pipeline, which releases as much fluoride as conventional glass ionomers cements. We've still got quite a bit of work to do on it, but it's looking very promising. D

Professor Hill is a leading authority on bioactive glass. He is research director at the Dental Institute and head of Dental Physical Sciences at Queen Mary University of London. He has published over 250 papers and filed over 20 patents. Professor Hill led the group that won the Armourers and Brasiers' Venture in 2013 based on the Biomin F proposal, and developed and patented with Dr David Gillam and Periproducts, a commercially available nanohydroxyapatite toothpaste and oral rinse, now sold in Boots and other stores. He is also the inventor of Serencem, a specialised glass ionomer cement for ENT surgery.

BIOMIN F TOOTHPASTE is available priced £4.99 for a 75ml tube at dental practices who can obtain the product via dental wholesalers (call Trycare on **01274 881 044** or Serve-ice on **01483 751 789**) or contact Biomin Technologies via its website, **www.biomin.co.uk.**