Methods and compositions of chitosan-amorphous calcium phosphate based multifunctional biomaterial

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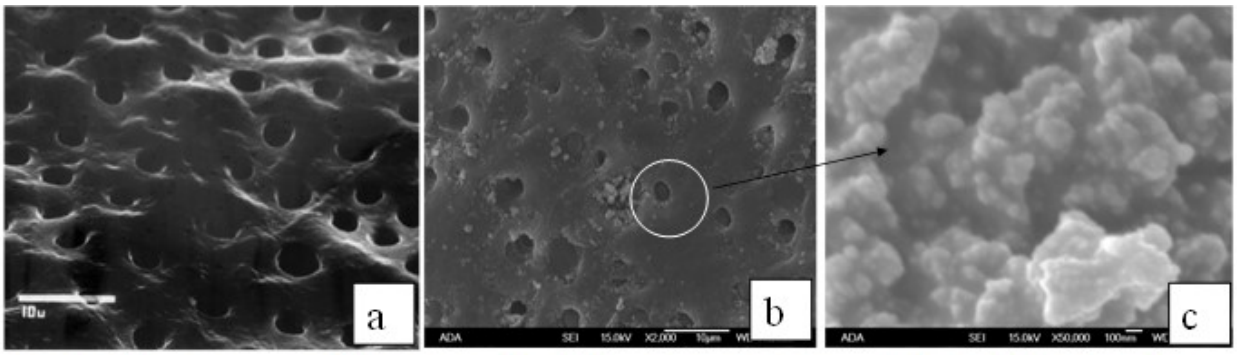
Technology description

The Problem

Dental caries is a prevalent chronic disease affecting 60% to 90% of school-aged children in industrialized countries and the vast majority of adults. In the United States, dental caries is the single, most common chronic disease of childhood. Over the past 40 years, fluoride has been the cornerstone for caries prevention, but conventional fluoride toothpaste has a significant caries-preventive effect only at concentrations of 1,000 parts per million or higher. This concentration of toothpaste is associated with an increased risk of fluorosis when used by young children under the age of 6 and particularly before the age of 2. Non-fluoride topical remineralizing agents containing calcium and/or phosphate have been investigated and show potential as an alternative to fluoride or as an adjunct to enhance its effectiveness at lower concentrations. Casein phosphoprotein-amorphous calcium phosphate (CPP-ACP) is currently most commonly used in clinic, but a significant problem with CPP-ACP is its low solubility in the acidic microenvironment where tooth demineralization occurs. The problem of stabilizing calcium and phosphate ions so that bioavailable Ca-P can be delivered when needed is a major challenge that impedes a large scale, population-based utilization of Ca-P-based products for caries prevention and control.

The Technology Solution

Researchers at the University of Tennessee are developing a composition for improved delivery of calcium and phosphate to the teeth using the natural polymer chitosan. Chitosan is a polysaccharide that can function as a delivery carrier as well as work as an antimicrobial agent and acid neutralizer with polyamino groups. Calcium and phosphate salts are encapsulated separately in different kinds of chitosan microspheres with a spray-drying method to generate chitosan-ACP microspheres. The ions can then be quickly released from these microspheres during use and form ACP in situ on tooth surfaces, which will increase the bioavailability of calcium and phosphate while further improving the efficiency by increasing the retention time of ACP.



The dentin surfaces under the scanning electron microscope. a: untreated etched surface showing the opening of dentine tubules; b: surface after the treatment of ACP paste showing the size decrease of dentin tubules with precipitates; c: high magnification of the precipitate showing nanoaggregates.

Studies showed that a high molecular weight chitosan (10KD) was able to reduce the viability of the bacteria S. mutans by 80% compared to control, whereas 200 KD chitosan can lead to 2.7 log reductions in killing S. mutans. Since calcium and phosphate ions are separated by encapsulation in different chitosan microspheres, this delivery system only forms ACP when activated by toothbrushing and, as a result, also prevents the premature conversion of ACP to hydroxyapatite during storage, leading to a significantly improved product shelf-life. Studies are ongoing to test the efficacy of this toothpaste formulation.

Advantages

•More efficient delivery of calcium and phosphate to teeth
• Natural antimicrobial and acid neutralizer
• Safe for use in pediatric oral care products
• Eliminates the problem of fluorosis in young children
Patents

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