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Sodium Bicarbonate Physically Removes Plaque by Disrupting its Mechanical Stability

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Objectives Dental biofilms, including dental plaque, constitute intricate microbial communities attached to various surfaces of the oral cavity. These biofilms generate a matrix of polysaccharides, eDNA and lipoteichoic acid, providing mechanical stability and protection from antimicrobials. Plaque bacteria are known to be the primary causative drivers of oral diseases, such as caries and periodontal disease. Prevention and treatment of dental biofilms involves a multifaceted approach, including mechanical removal through brushing and flossing combined with the use of toothpaste and mouthwash, and professional cleaning by dentists. Dentifrices with sodium bicarbonate (NaHCO3) concentrations of up to 67% have been shown clinically to remove and reduce dental plaque biofilm to a greater extent than non-bicarbonate containing pastes, even in hard-to-reach areas of the mouth. This study aimed to investigate the underpinning mechanism of action of NaHCO3 treatment on the mechanical properties of oral biofilms.
Methods Particle tracking microrheology was used to quantify the viscoelastic properties of *Streptococcus mutans* biofilms grown under shear conditions pre- and post-treatment with 67%w/w NaHCO3 in water. This was combined with confocal imaging to visualize the structural changes in biofilms.
Results Under shear conditions, *S. mutans* developed a robust biofilm, exhibiting viscoelastic properties with heterogeneity in stiffness throughout its different layers. The layers closest to the substratum were found to be firmer than the upper layers, with the elastic modulus ranging from about 70Pa at the bottom to about 1Pa at the top surfaces. Treatment with 67%w/w NaHCO3 effectively removed the softer upper layers, resulting in a 40% decrease in biovolume, leaving behind the stiffer bottom layer with an average stiffness of ~70Pa. However, subsequent repeat treatment softened the remnant biofilm and further reduced the biovolume by 80%.
Conclusions This suggests that 67%w/w sodium bicarbonate removes *S. mutans* biofilms by softening the matrix and disrupting the mechanical stability and structural integrity of biofilms.