

GROWTH INHIBITION OF *Streptococcus mutans* USING NANOCERIA

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ABSTRACT

A leading cause of tooth decay stems from the build-up of microbes and the formation of biofilms on the surfaces of teeth. Oral health is impacted by this proliferation of bacteria, which often produce harmful acids as by-products of metabolism. In particular, the oral bacteria *Streptococcus mutans* metabolizes sugars into lactic acid and plays a prevalent role in tooth decay. Research regarding the nanoparticle cerium oxide (nanoceria, CeO_2) shows nanoceria as a potential antimicrobial agent and biofilm disruptor through the lysis of bacterial cell walls. We propose that synthesized nanoceria can be utilized as an inhibitor of *S. mutans*; by reducing growth and lactic acid production, tooth decay may be reduced. We first studied the growth pattern of *S. mutans* through optical density (OD) and colony-forming unit (CFU) measurements. Next, we examined the effect of nanoceria on lactic acid production through pH tests conducted at varying sucrose concentrations. After initial measurements were taken, the antimicrobial effect of nanoceria on pH and OD was studied. Preliminary tests showed nanoceria inhibiting lactic acid production and decreasing the log phase of the bacteria, and future trials will further examine these associations. In the future, these findings could support using nanoceria in dental applications as an antibacterial agent.

Keywords: *Streptococcus mutans*, biofilms, dental plaque, oral health, nanoceria, nanoparticle, lactic acid production, tooth decay, antibacterial agent, pH test

INTRODUCTION

Dental cavity formation is the most common oral disease. It is caused by biofilm formation on teeth [1]. If not removed, biofilms harden and form tartar. The most prevalent bacteria in the mouth is *Streptococcus mutans*. Like many bacteria, it metabolizes sugars into lactic acid. Low pH. can lead to premature tooth decay [2].

Cerium oxide nanoparticles called nanoceria possess antimicrobial properties [3] and can be applied in medicine [4]. Nanoceria specifically kills bacteria by inducing oxidative stress. It permeates the cell wall and catalyzes Reactive Oxygen Species (ROS) formation at the low pH of the cytoplasm. ROS damages bacterial proteome and genome, resulting in death [5]. The effectiveness of nanoceria in breaking down biofilms was extensively described. Nanoceria can also break down the biofilm of gram-positive bacteria S. aureus [7]. This experiment tested whether nanoceria can be integrated into many fields where control of microorganisms is necessary, such as dentistry and medicine.

We propose that nanoceria could inhibit the growth of pathogenic oral bacteria. We will assess whether nanoceria can decrease bacterial growth. Through nanoceria inhibiting the growth of *S. mutans*, we hypothesize it will also reduce lactic acid production in the biofilms. To monitor nanoceria's potential for interfering with *S. mutans* growth, biofilms were grown in cultures containing sucrose and nutrients to mimic the oral environment.