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Spring 5-2020

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Antibacterial Efficacy of Novel Eastern Medicine-Inspired Toothpastes Compared to Commercial Formulations

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Introduction

• Many commercial toothpastes contain numerous abrasive chemicals, the most potentially detrimental to human health being sodium fluoride, triclosan, and sodium lauryl sulfate (SLS):

• Fluoride is not only effective in disrupting the metabolic processes of bacteria, but it exhibits the same effects in odontoblasts (teeth cells), ultimately leading to cellular death (1).

• Triclosan, even in small concentrations such as within toothpastes, has been found to downregulate anticancer genes (2).

• SLS contributes to the formation and prolongation of mouth ulcers (3). Furthermore, SLS has been found to diminish the thickness of oral epithelial in vitro models by interfering with cellular adhesion (4).

• In place of these substances, it was postulated that incorporating Eastern medicine ingredients into toothpaste embodiments could be a safer and equally effective alternative (e.g. coconut oil, bamboo charcoal powder, matcha, and cinnamon oil).

Methods

• Three formulations of a novel toothpaste composed of varying amounts of coconut oil, matcha, cinnamon oil, xylitol, and sodium bicarbonate were prepared.

• To evaluate toothpaste efficacy, a minimum inhibitory concentration (MIC) assay against *Streptococcus mutans* (serotype c) was conducted using three commercial toothpastes (e.g. Sensodyne®, Colgate®, and Crest®) as positive control groups.

• To compare the safety of each toothpaste, the cell counting kit-8 (CCK-8) assay was attempted on healthy human fibroblasts derived from gingival tissue, and the same dilution scheme from the MIC assay was implemented.

Table 1. MIC Assay Findings of Duplicate Experimental Formulations

Formulation Duplicates	Dilution Scheme					
	1:1	1:2	1:4	1:8	1:16	1:32
Formulation I	+	+	+	+	+	+
Formulation I	+	+	+	+	+	+
Formulation II	+	+	+	+	+	+
Formulation II	+	+	+	+	+	+
Formulation III	-	+/-	+/-	+/-	+/-	+/-
Formulation III	-	+/-	+/-	+/-	+/-	+/-

Table 2. MIC Assay Findings of Duplicate Commercially Available Toothpastes

Commercial Toothpaste Duplicates	Dilution Scheme					
	1:16	1:32	1:64	1:128	1:256	1:512
Colgate®	-	+	-	-	+/-	-
Colgate®	-	-	-	-	-	-
Sensodyne®	-	-	-	-	-	+/-
Sensodyne®	-	-	-	-	-	+/-
Crest®	-	-	-	-	+	+
Crest®	-	-	-	-	+/-	+

Table 3. Results of Negative Control Group and Blank Corresponding to MIC Assay

Negative Control	+	+	+	+	+	+	+	+	+	+	+
Blank	-	-	-	-	-	-	-	-	-	-	-

*Based upon a preliminary assessment of the CCK-8 assay, no interpretable data was obtained due too much background noise caused by each toothpaste mixture.

Conclusion/Summary

Formulation III exhibited the greatest efficacy against *S. mutans*. These findings are attributable to the following ingredients:

• 61.2% (w/w) coconut oil; this ingredient has antimicrobial properties, increases mucous levels of epithelial tissue, and reduces acid levels in the body that perpetuate ulcers (5).

• 22.2% (w/w) bamboo charcoal powder, which has been found to have an MIC against *S. mutans* ranging from 2% (w/v) to 5% (w/v) (6)

• 5.6% (w/w) cinnamon oil; this substance has been determined to have a strong inhibitory effect against *S. mutans* {MIC value of 0.08% (v/v)} (7).

• The commercial toothpaste from Colgate® exhibited the greatest efficacy against *S. mutans* due to the synergistic combination of fluoride, triclosan, SLS, and zinc oxide (8).

Future Research

• Going forward, Formulation III can be perfected, and potentially new, natural antimicrobial reagents can be introduced to optimize the efficacy of the product.

• In order to evaluate the safety of each toothpaste, the CCK-8 assay protocol should be modified such that background noise is minimized. One feasible approach is to routinely wash each well with HBSS during the incubation period, such that most of the product is washed away.

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