

Kerinci Cinnamon Leaf (*Cinnamomum burmanii*) and Tangkit Pineapple Core (*Ananas comosus*) Extracts in Mouthwash Formulation: Potential for Preventing Dental Plaque Growth in Special Needs Children

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ABSTRACT

Dental plaque is a significant factor in developing oral diseases, particularly in children with special needs who may face challenges maintaining oral hygiene. This study explores the potential of a mouthwash formulation incorporating Kerinci cinnamon leaf (*Cinnamomum burmanii*) and Tangkit pineapple core (*Ananas comosus*) extracts in preventing dental plaque growth. Both extracts were chosen due to their known antibacterial properties and natural origin, making them suitable for children with sensitivities to synthetic chemicals. The formulation was tested in varying ratios to determine the most effective combination for inhibiting the growth of *Streptococcus mutans*, a primary bacterium responsible for dental plaque. The results indicated that a 50:50 ratio of cinnamon leaf and pineapple core extracts exhibited the highest antibacterial activity (*p*-value 0,034), outperforming other ratios such as 75:25 and 25:75. This suggests a synergistic interaction between the two extracts, enhancing their combined efficacy. Further research is recommended to optimize the formulation and evaluate its long-term effectiveness and safety in clinical settings.

Keyword: pineapple core; cinnamon leaves; *Streptococcus mutans*

Introduction

Children with special needs are a vulnerable group at higher risk of developing oral health problems, such as caries and periodontal disease, compared to other children. [1], [2] The primary etiology of both diseases is bacteria within dental plaque.[3], [4] Preventive efforts, such as mechanically removing plaque through tooth brushing with toothpaste and chemically with mouthwash, can be taken to prevent these diseases.[5]

Dental plaque, which is the primary cause of caries and periodontal diseases, forms a thin layer on the tooth surface where bacteria grow. These bacteria metabolize carbohydrates, producing acids that contribute to tooth decay.[6] The bacteria in

plaque can also affect gingival tissues, and both the bacteria and the toxins they produce can trigger a series of immunological responses in periodontal tissues, leading to inflammation and tissue damage.[7]

Research indicates that approximately 10% of children with developmental disorders experience rumination, characterized by regurgitation where food returns from the stomach to the esophagus or mouth, followed by chewing and swallowing again, thus increasing the acidity in the oral cavity. This condition can stimulate bacterial growth in plaque and expedite tooth decay.[8]

In addition, studies examining the oral flora of children with mental disabilities or Autism Spectrum Disorder (ASD) have shown that

imbalances in gastrointestinal microbiota in these groups also affect the oral flora within the mouth.[9], [10] Previous clinical studies have demonstrated that tooth brushing alone cannot effectively prevent the reformation of dental plaque or inhibit its growth in the oral cavity. [11] One approach to managing plaque formation is using mouthwash containing antibacterial agents. [12] Safe antibacterial agents can be derived from various natural sources, including pineapple and cinnamon, widely available in the Jambi region.

Pineapple (*Ananas comosus* L. Merr), commonly found in tropical regions such as Brazil, Bolivia, Paraguay, and Southeast Asia, belongs to the *Bromeliaceae* family. It is rich in nutrients like vitamins A and B, proteins, enzymes (such as bromelain), sugars, and certain organic acids, including citric acid and malic acid, giving it a sweet and slightly acidic taste. [13], [14]

Previous studies have shown that rinsing with pineapple core juice can significantly increase salivary pH. [15] The antibacterial effect of pineapple has proven effective in killing *Streptococcus mutans*, a predominant bacterium in the pathogenesis of dental caries.[16]

Bromelain, a proteolytic enzyme, has also been clinically proven effective in modulating tumor cell growth, acting as an anti-inflammatory, and possessing antibiotic properties.[13], [17] Bromelain is abundant in the core and flesh of the pineapple but can also be found in smaller amounts in its peel, leaves, and stem.[18]

Cinnamon bark is widely used in cooking and herbal remedies. However, when harvesting cinnamon bark, the leaves are often discarded due to a lack of knowledge about their benefits. Previous research has found that cinnamon leaves also have substantial antibacterial properties. In studies conducted by the authors, the inhibition zone produced by cinnamon leaf extract was found to be significantly comparable to chlorhexidine mouthwash, which is the gold standard in prophylactic therapy in the oral cavity and as an adjunct treatment to aid in periodontal disease healing.[19]

Several previous studies have indicated that both bromelain and cinnamon leaves possess significant antibacterial potential. However, no studies have tested the efficacy of combining the two as an antibacterial agent for oral health applications, specifically as a mouthwash. The use of chlorhexidine as a standard for prophylactic therapy in the oral cavity has limitations, such as side effects including tooth discoloration and tissue

irritation with prolonged use, making the development of natural-based mouthwash an alternative worth investigating. Additionally, cinnamon leaves, often discarded during the cinnamon harvesting process, also hold untapped potential for pharmaceutical applications.

Given the antibacterial capabilities of these two natural ingredients, research is needed to combine their benefits and explore their potential as a mouthwash.

Methods

This study is an experimental investigation comparing mouthwash formulations containing active ingredients of cinnamon leaf and pineapple core extracts, assessing their effectiveness in inhibiting the growth of dental plaque bacteria. Both pineapple core and cinnamon leaf *simplicia* were prepared through maceration, starting with wet sorting and drying of the materials. The maceration process utilized 96% ethanol as a solvent. A total of 200 grams of pineapple core was placed in a macerator and mixed with 2 liters of 96% ethanol for the first 6 hours with occasional stirring, followed by an 18-hour resting period. The resulting macerate was separated using a rotary evaporator.

Phytochemical screening of the pineapple core and cinnamon leaf extracts was conducted as follows:

- a) **Flavonoid Test:** 2 ml of the extract sample was mixed with 5 ml of 30% methanol, then heated for 5 minutes. Five drops of concentrated H₂SO₄ were added to the filtrate. The presence of a red color indicates the presence of flavonoids.
- b) **Tannin Test:** 2 ml of the sample extract was mixed with 5 ml of distilled water and boiled for 5 minutes. Afterward, 5 drops of 1% FeCl₃ solution were added to the filtrate. The appearance of a dark blue or greenish-black color indicates the presence of tannins in the sample.
- c) **Saponin Test:** The sample was placed in a test tube, and hot water was added, followed by vigorous shaking. The formation of stable foam persisting for over 10 minutes indicates the presence of saponins.
- d) **Stability Test of the Formulation:** Stability was assessed by measuring various parameters, including pH, color, odor, taste, and clarity.

The basic mouthwash formulation consisted of 2.5% glycerin, 0.005% benzoic acid, 5% sorbitol, 0.5% peppermint oil, and distilled water up to 50 ml. The active ingredient consisted of a 3.125% combination of cinnamon leaf and pineapple core

extracts. The combinations were divided into three groups combination of Pineapple core (B) and Cinnamon Leaf (D) (1) 75%:25%; (2) 50%:50%; (3) 25%:75%.

All formulations were tested for their bacterial inhibitory effect using *Streptococcus mutans* ATCC 25175 PK/5, a known causative agent of dental plaque. This test involved pouring 15 mL of MHI agar media into a sterile petri dish, followed by adding 0.1 mL of bacterial suspension to the dish containing liquid agar. The media was then homogenized by shaking it in an "8" pattern

and allowed to solidify. A filter paper disk soaked in the mouthwash solution was placed on the surface of the solidified agar medium and labeled. The medium was then sealed and incubated at 37°C for 24 hours. After incubation, the inhibition zones were observed and measured using calipers. Negative control was performed with the mouthwash formulation without extracts, while positive control was conducted with 0.2% chlorhexidine mouthwash. Each formulation was tested in three replicates.

Results and Discussion

Table 1.

Phytochemical Test of Tangkit Pineapple Core Extract and Kerinci Cinnamon Leaf Extract

Test	Tangkit Pineapple Core Extract	Kerinci Cinnamon Leaf Extract
Flavonoid	+	+
Tannin	+	+
Saponin	+	+
Color	Yellow	Dark Green
Aroma	Pineapple aroma	Cinnamon Bark aroma
Rasa	Sweet, slightly acidic	Bitter
Clarity	+	-
pH	4	5

Table 2.

Mouthwash Formulation Combining Tangkit Pineapple Core Extract and Kerinci Cinnamon Leaf Extract

Test	F1 (B:D= 75%:25%)	F2 (B:D= 50%:50%)	F3 (B:D= 25%:55%)
Color			
Yellow	+++	+	
Green	+	+++	+++
Aroma	Menthol slightly pineapple aroma	Menthol	Menthol slightly cinnamon aroma
Taste	Sweet, minty slightly sour	Sweet, minty	Sweet, minty
Clarity	+	-	-
pH	4	5	5

Table 3.

Results of *Streptococcus mutans* Inhibition Test

Test	Mean	SD	<i>p</i> -value [§]	Formula	<i>p</i> -value ^{§§}
Kontrol +	16,41	±0,076		F1	0,000
				F2	0,000
				F3	0,000
F1 (B:D= 75%:25%)	6,93	±0,665	0,000	F2	0,034*
				F3	0,740
F2 (B:D= 50%:50%)	8,40	±0,721		F3	0,145
F3 (B:D= 25%:55%)	7,36	±0,321			

[§]ANOVA Statistical Test

^{§§}Post Hoc Tukey Statistical Test

The results of the flavonoid and tannin tests showed positive outcomes for the pineapple core extract, indicating the presence of flavonoids and tannins. In contrast, color changes in the cinnamon leaf extract were not clearly visible due to the dark green color of the extract.

This study is consistent with previous research, which also demonstrated positive results for the presence of flavonoids, alkaloids, saponins, tannins, steroids/triterpenoids, and phenols in cinnamon leaf extract.[20]

The extract was then formulated by incorporating both extracts into three types of combination formulas, as shown in Table 2.

Cinnamon leaves tend to produce a darker or greenish color when used in larger amounts. In contrast, pineapple core extract often has a natural yellow color due to the pigment content in its phenolic components[21].

Peppermint oil contains menthol, which provides a spicy and refreshing sensation in the mouth. At the current concentration (0.5%), menthol delivers an intense cooling effect and enhances the feeling of freshness in the mouth. This causes all formulations to have a predominantly spicy/refreshing taste.[22]

Cinnamon leaves have a distinctive spicy taste due to their eugenol and cinnamaldehyde content.[23] In formulations containing a higher concentration of cinnamon leaf extract, this spiciness becomes more pronounced. The refreshing sensation is often associated with a clean mouth and fresher breath, helping to mask bad breath and encouraging more consistent use.

Pineapple contains citric acid and malic acid, which are naturally acidic compounds. These acids contribute to the overall low pH of pineapple extracts. Even a small amount of pineapple extract can lower the pH significantly, as these acids are quite strong and persist through the extraction process.[25]

The results of the antibacterial activity test were conducted against *Streptococcus mutans* and compared with a positive control using mouthwash containing 0.2% chlorhexidine gluconate. The results are shown in Table 3.

Based on the research results, it can be concluded that the inhibitory effect of the mouthwash containing a 3.125% combination of Tangkit pineapple core extract and Kerinci cinnamon leaf extract still differs significantly from the gold standard, Chlorhexidine gluconate 0.2% (p-value 0.000). The highest inhibitory effect was observed in the combination of Tangkit pineapple

core (B) and cinnamon leaf (D) at a 50%:50% ratio, showing a significant difference from the B:D 75%:25% combination (p-value 0.034), although not significantly different from the B:D 25%:75% combination (p-value 0.145).

According to Table 3, in the 50%:50% ratio, both extracts are likely in an optimal balance, where active components from both pineapple and cinnamon leaves complement each other to maximize antibacterial inhibition. There is a possibility that these compounds work synergistically, complementing each other to produce a stronger inhibitory effect.

When one extract is overly dominant, as in the 75%:25% or 25%:75% ratios, the synergistic effect may diminish because one of the extracts may become less effective or is not present in a sufficient amount to support the desired antibacterial effects. Each extract has its optimal concentration to provide the best antimicrobial effect. The 50%:50% combination may be close to this optimal concentration, where both extracts contribute equally to the antimicrobial effect, while other ratios may reduce overall effectiveness due to an imbalance in the concentration of active ingredients.

Although chlorhexidine is the gold standard for antiplaque agents commonly used as an adjuvant in periodontal disease treatment, long-term use has side effects, such as staining on teeth, altered taste perception, and potential irritation of oral tissues. [26]

These drawbacks highlight the need for alternative mouthwash formulations that are both effective and safe for prolonged use. Natural extracts, such as those from pineapple core and cinnamon leaf, offer promising antibacterial properties with fewer side effects. The results of this study suggest that the combination of Tangkit pineapple core extract and Kerinci cinnamon leaf extract, especially in a 50%:50% ratio, can provide a significant inhibitory effect against *Streptococcus mutans*, potentially reducing plaque formation. This natural formulation could serve as an effective and safer alternative to chlorhexidine, promoting oral health without the adverse effects of synthetic agents. Further research is recommended to optimize these formulations, assess long-term safety, and explore their efficacy in clinical settings for broader application in oral health management.

Conclusion

There is a significant difference in the inhibitory effect of the mouthwash formulation

combining Tangkit pineapple core extract and Kerinci cinnamon leaf extract compared to the control. Compared to other formulations, the highest and most significant inhibitory effect was achieved with a 50%:50% concentration combination of both extracts.

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