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Effectiveness of Gargling with Lemon Juice (Citrus lemon) and Betel Leaf Decoction on Debris Index and Saliva pH of Elementary School Students in Aceh Besar District

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Abstract

This study aims to evaluate the effectiveness of gargling with lemon juice (Citrus lemon) and betel leaf decoction (Piper betle) on the Debris Index and saliva pH among elementary school students in Aceh Besar District. The background of this research is rooted in the high prevalence of dental caries and other oral health issues in Indonesia, particularly among children. The methodology employed is a quasi-experimental design with two treatment groups, where one group gargles with lemon juice and the other with betel leaf decoction. The results of the study indicate that gargling with betel leaf decoction significantly increases saliva pH (an increase of 1.34) and reduces oral acidity, which is crucial for preventing enamel demineralization and lowering the risk of cavities. Conversely, lemon juice demonstrates a significant reduction in the Debris Index (a decrease of 1.3), highlighting its effectiveness in cleaning plaque and food residues from teeth in the short term. While lemon juice is effective for quick cleaning, its use must be approached with caution due to its strong acidic nature, which can damage tooth enamel if used excessively. In conclusion, this study asserts that betel leaf decoction is superior for long-term use in maintaining oral health, while lemon juice is more effective for quick cleaning but should be used judiciously. These findings emphasize the importance of selecting appropriate oral care methods, particularly in populations at higher risk for dental issues.

Keywords: lemon, betel leaf, saliva pH, Debris Index, oral health

Introduction

Dental issues among children are a significant global health concern, with approximately 60-90% of children worldwide suffering from dental caries, one of the most common dental diseases. In Indonesia, the situation is quite serious, with around 90% of children experiencing

dental caries, making it one of the most prevalent health problems (Bagramian et al., n.d.; Petersen, 2008; Petersen et al., 2005). Additionally, about 30% of children suffer from gum disease, which can adversely affect overall oral health. Many children, especially those in rural and low-income areas, lack adequate access to dental care, exacerbating these health issues. The level of awareness and knowledge about dental hygiene remains low, with many children not brushing their teeth regularly. As a result, dental problems can lead to pain, difficulty in eating, developmental disturbances, and a negative impact on the overall quality of life (Bratthall, 2000; Gadiyar et al., 2018).

The 2018 Basic Health Research report indicated that the national prevalence of dental problems in Indonesia reached 57.6%. This data reflects the concerning state of dental health across various demographics, particularly among children. In an initial survey conducted on 10 children at SDN Mesjid Lheu in Aceh Besar Regency, researchers found that 3.2% of the children had poor debris index criteria, with scores ranging from 1.9 to 3.0. Furthermore, the average saliva pH of these children was below the normal range, specifically between 5.8 and 5.9. This indicates significant oral hygiene issues that could contribute to the high prevalence of caries. Given the high prevalence of caries in Indonesia, it is crucial to prevent the formation of dental plaque and the reduction of saliva pH, which are primary causes of caries. Removing dental plaque and neutralizing saliva pH on the tooth surface can be achieved not only through brushing but also by rinsing the mouth (Kleinberg & Jenkins, 1964; Sano et al., 2003a, 2003b).

However, despite the claimed benefits of rinsing with lemon water and betel leaf extract for oral health, their effectiveness has not been scientifically proven. Therefore, this study aims to evaluate the effectiveness of rinsing with lemon water and boiled betel leaf extract on the debris index and saliva pH. This research is expected to provide valuable information about the benefits of using these natural ingredients for maintaining oral health, offering a safer and more natural alternative for the community in their efforts to maintain oral hygiene. Conducting this research is essential to provide a scientific basis for the practice of rinsing with natural ingredients as part of a more comprehensive dental care routine.

Literature Review

This method can be an effective addition to maintaining oral and dental health. Rinsing with natural ingredients, such as lemon water and boiled betel leaf extract, is one method that can help clean the teeth and mouth from food debris and bacteria (Mallikarjun & Professor, 2016; S & Kumar, n.d.; Trinawati et al., 2023). Lemon water contains citric acid, which is known to help clean dental plaque and maintain saliva pH within the optimal range. On the other hand, boiled betel leaf extract contains catechins, compounds with antibacterial properties that can help prevent plaque formation (Bhadauria et al., 2024; Levine & Stillman-Lowe, 2019).

Research Method

This research uses an analytical method with a quasi-experimental design, where all sample groups receive treatment without a control group, employing a Pre-Test and Post-Test

Only Group Design. The samples are divided into two treatment groups: the first group gargles with lemon juice, while the second group gargles with betel leaf decoction. The research process begins with preparation, including obtaining permission from the Head of the Education Office of aceh besar regency and the Head of SDN Mesjid Lhee, as well as preparing necessary tools and materials such as oral diagnostic instruments, gargling glasses, and other required materials. The study takes place from April to November 2024 at SDN Mesjid Lhee, with a total sample of 60 students randomly divided into two intervention groups, each consisting of 30 students, based on predetermined inclusion and exclusion criteria. A 10% lemon juice solution is prepared by squeezing lemons to yield 100 ml of juice, which is then diluted to a total volume of 1000 ml, while the betel leaf decoction is made by boiling five leaves of betel in 250 ml of water until 40 ml remains.

After the preparation phase, sampling is conducted at SDN Mesjid Lhee, chosen because no previous research on dental health has been conducted there. The samples are divided into two intervention groups, with Group 1 gargling with lemon juice and Group 2 gargling with betel leaf decoction. Initial observations are made by measuring debris index and saliva pH in both groups, where saliva pH is measured after subjects spit into a sputum pot. The intervention is given with Group 1 gargling 40 ml of 10% lemon juice and Group 2 gargling 40 ml of betel leaf decoction, both for 30 seconds. Final observations are conducted to re-measure plaque index and saliva pH. Data analysis in this study is conducted bivariately to test the proposed hypotheses. If the data shows a normal distribution, the analysis is performed using a Paired Sample T-Test to compare two related data sets and an Independent Sample T-Test to compare two unrelated groups. However, if the data does not follow a normal distribution, non-parametric statistical methods will be used, specifically the Wilcoxon Sign-Rank Test for paired data and the Mann Whitney Test for unpaired data. This approach ensures that data analysis is performed appropriately according to the characteristics of the obtained data distribution.

Result

Subject Characteristics

The characteristics of students in the treatment group (gargling with boiled betel leaf water) and the control group (gargling with lemon juice) can be described as follows:

Table 1. Frequency Distribution of Children's Characteristics in the Treatment and Control Groups

Children's Characteristics	Treatment Group	Control Group
	n	%
Age		
11 years	12	40.0
12 years	18	60.0
Gender		
Male	15	50.0
Female	15	50.0

Table 1 shows that the majority of children in the treatment group (class VA) are 12 years old (60.0%), and similarly, the majority in the control group (class VB) are also 12 years old (63.3%). Regarding gender, both the treatment group (class VA) and the control group (class VB) have an equal distribution of males (50.0%) and females (50.0%).

Prerequisite Analysis Testing (Normality Test)

The data analysis in this study uses parametric statistics, employing the paired sample t-test and independent t-test techniques. The use of these t-tests requires that the data distribution be normal.

Intervention Group I (Gargling with Lemon Juice)

The normality test for the data in this study was conducted using the Shapiro-Wilk test. The test was performed using the Statistical Program for Social Science (SPSS) software, version 16, and the summary of the normality test results is presented in the following table.

Table 2. Summary of Normality Test Results in Intervention Group I

Data Distribution	Variable	Shapiro-Wilk	Conclusion
		p (sig.)	
Pretest	Debris Index	0.061	Normal
	Saliva pH	0.088	Normal
Post Test	Debris Index	0.065	Normal
	Saliva pH	0.295	Normal

Table 2 shows that the normality test results for the intervention group using the Shapiro-Wilk test indicate that the Debris Index and saliva pH in both the pretest and posttest have significance values greater than α ($p > 0.05$), meaning the data are normally distributed.

Intervention Group II (Gargling with Betel Leaf Boiled Water)

Table 3. Summary of Normality Test Results in Intervention Group II

Data Distribution	Variable	Shapiro-Wilk	Conclusion
		p (sig.)	
Pretest	1. Debris Index	0.072	Normal
	2. Saliva pH	0.113	Normal
Post Test	1. Debris Index	0.073	Normal
	2. Saliva pH	0.082	Normal

Table 3 shows that the normality test results for the intervention group, using the Shapiro-Wilk test, indicate that the Debris Index and saliva pH in both the pretest and posttest have significance values greater than α ($p > 0.05$). Therefore, the data are normally distributed.

Univariate Analysis

The univariate analysis in this study includes the Debris Index and saliva pH in both intervention group I (gargling with lemon juice) and intervention group II (gargling with betel leaf boiled water), both before the intervention (pre-test) and after the intervention (post-test). The results of the univariate analysis are presented in the following sections.

Debris Index and Saliva pH in the Treatment Group (Gargling with Lemon Juice in Class VA)

Table 4 Distribution of Debris Index and Saliva pH Before and After Gargling with Lemon Juice

Variable	Category	Before	After
		n	%
Saliva pH	Acidic	30	100
	Normal	0	0
	Alkaline	0	0
Debris Index	Good	0	0
	Moderate	0	0
	Poor	30	100

Figure 4 shows that the distribution of saliva pH before the treatment (pre-test) in the treatment group (gargling with lemon juice) was 100% in the acidic category, and after the treatment (post-test), it remained 100% in the acidic category. The distribution of the Debris Index before the treatment was 100% in the poor category, and after the treatment, 76.7% of the students were in the poor category, while 23.3% were in the moderate category.

Debris Index and Saliva pH Levels in Intervention Group II (Rinsing with Boiled Betel Leaf Water)

Table 5: Distribution of Debris Index and Saliva pH Levels Before and After Rinsing with Boiled Betel Leaf Water.

Variable	Category	Before	%	After	%
Saliva pH	Acidic	30	100	0	0
	Normal	0	0	30	100
	Basic	0	0	0	0
Debris Index	Good	0	0	0	0
	Moderate	0	0	29	96.7
	Poor	30	100	1	3.3

Figure 5 shows that the distribution of saliva pH before the treatment (pre-test) in the intervention group (rinsing with boiled betel leaf water) was 100% acidic, and after the treatment (post-test), 100% of the saliva pH levels fell into the normal category. The distribution of the Debris Index before the treatment (pre-test) in the control group (rinsing with plain water) was 100% in the poor category, and after the treatment (post-test), 96.7% were in the moderate category, with 3.3% remaining in the poor category.

Bivariate Analysis

Bivariate analysis aims to test the hypotheses in this study. The hypotheses are tested using the paired sample t-test to determine the differences in the decrease of the Debris Index and saliva pH within the treatment group and the control group from pre-test to post-test. Additionally, an independent t-test is used to examine the differences in the decrease of the Debris Index and saliva pH between the treatment and control groups. The results of these statistical analyses are presented below.

Analysis of Differences

Debris Index and Saliva pH in Intervention Group I (Rinsing with Lemon Juice)

The mean differences in the Debris Index and saliva pH for Intervention Group I (rinsing with lemon juice) are shown in the following table:

Table 6: Mean Differences and Standard Deviations of Debris Index and Saliva pH in Intervention Group I (Rinsing with Lemon Juice)

Variable	Median (Min-Max)	Mean ± SD	p-value
Debris Index	Pre-test: 2.6 (2.0-3.0)	Pre-test: 2.5 ± 0.29	0.069*
	Post-test: 2.2 (1.5-2.8)	Post-test: 2.4 ± 0.39	
Saliva pH	Pre-test: 5.8 (5.2-6.5)	Pre-test: 5.5 ± 0.32	0.010*
	Post-test: 6.0 (5.4-6.5)	Post-test: 6.0 ± 0.29	

*Note: * = significant

Table 7: Mean Differences and Standard Deviations of Debris Index and Saliva pH in Intervention Group II (Rinsing with Boiled Betel Leaf Water)

Variable	Median (Min-Max)	Mean ± SD	p-value
Debris Index	Pre-test: 2.6 (2.0-3.0)	Pre-test: 2.56 ± 0.29	0.015
	Post-test: 1.3 (0.6-1.9)	Post-test: 1.26 ± 0.38	
Saliva pH	Pre-test: 5.7 (5.0-6.5)	Pre-test: 5.63 ± 0.34	0.007
	Post-test: 7.0 (6.7-7.2)	Post-test: 6.97 ± 0.11	

*Note: * = significant

Table 7 illustrates that in Intervention Group II (rinsing with boiled betel leaf water), the Debris Index before the intervention had a mean value of 2.56, which decreased to a mean value of 1.26 after the intervention, representing a reduction of 1.3. This decrease is statistically significant ($p<0.05$), indicating a notable improvement in the Debris Index. Similarly, the saliva pH before the intervention had a mean value of 5.63, which increased to a mean of 6.97 after the intervention, reflecting an increase of 1.34. This change is also statistically significant ($p<0.05$), showing a significant improvement in the saliva pH. Overall, these results suggest that rinsing with boiled betel leaf water effectively reduces the Debris Index and significantly increases the saliva pH, contributing positively to oral health.

Debris Index

The analysis of the Debris Index between Intervention Group I (rinsing with lemon juice) and Intervention Group II (rinsing with boiled betel leaf water) is as follows:

Table 8: Mean and Standard Deviation of Debris Index Between Intervention Groups

Debris Index	Group	Mean ± SD	p-value	Interpretation
Pre-test	Intervention I	2.56 ± 0.297	1.000	Not Significant
	Intervention II	2.56 ± 0.295		
Post-test	Intervention I	2.24 ± 0.391	<0.001*	Significant
	Intervention II	1.20 ± 0.384		

*Note: * = significant

Analysis of Results

Table 8 reveals that there was no significant difference in the Debris Index before the intervention (pre-test) between Intervention Group I (rinsing with lemon juice) and Intervention Group II (rinsing with boiled betel leaf water), with a p-value of 1.000, indicating no statistical significance. However, a significant difference in the Debris Index was observed after the intervention (post-test) between the two groups. Intervention Group I had a mean

Debris Index of 2.24 ± 0.391, while Intervention Group II had a significantly lower mean of 1.20 ± 0.384, with a p-value of <0.001. This result indicates that rinsing with boiled betel leaf water was significantly more effective in reducing the Debris Index compared to rinsing with lemon juice.

Degree of Acidity of Saliva (pH Saliva)

The analysis of pH Saliva between Intervention Group I (rinsing with lemon juice) and Intervention Group II (rinsing with boiled betel leaf water) is presented as follows:

Table 9: Mean and Standard Deviation of pH Saliva Between Intervention Groups

pH Saliva	Group	Mean ± SD	p-value	Significance
Pre-test	Intervention I	5.76 ± 0.325	0.138	Not Significant
	Intervention II	5.63 ± 0.343		
Post-test	Intervention I	6.01 ± 0.292	<0.001*	Significant
	Intervention II	6.97 ± 0.117		

*Note: * = significant

Table 9 indicates that there was no significant difference in pH Saliva before the intervention (pre-test) between Intervention Group I (rinsing with lemon juice) and Intervention Group II (rinsing with boiled betel leaf water). The p-value of 0.138 suggests that the difference in pre-test pH Saliva between the two groups was not statistically significant. In contrast, a significant difference was observed in pH Saliva after the intervention (post-test). The mean pH Saliva for Intervention Group I was 6.01 ± 0.292, while for Intervention Group II it was 6.97 ± 0.117. The p-value of <0.001 indicates that the increase in pH Saliva in Group II was statistically significant compared to Group I. This suggests that rinsing with boiled betel leaf water was significantly more effective in raising the pH level of saliva compared to rinsing with lemon juice.

Discussion

Based on the results of the study conducted on students at SDN Mesjid Lheu, Aceh Besar District, both interventions, namely gargling with lemon juice and betel leaf decoction, showed different effects on saliva pH and Debris Index. Before the intervention, the saliva pH in the first intervention group, which gargled with lemon juice, had an average value of 2.5. After the intervention, this pH slightly decreased to 2.4, with a Debris Index reduction of 0.1. Although this decrease is noticeable, statistical analysis indicates that there is no significant difference ($p>0.05$). This suggests that the use of lemon juice in the short term may not provide substantial changes in oral hygiene among the children in this group.

In contrast, in the second intervention group, which gargled with betel leaf decoction, the saliva pH increased from 5.5 before the intervention to 6.0 after the intervention. This increase of 0.5 shows a statistically significant difference ($p<0.05$). The betel leaf decoction proved to be more effective in neutralizing saliva acidity, which is an important factor in preventing dental caries. Additionally, lemon juice, which contains citric acid, was found to be more effective in reducing the Debris Index, with a reduction of 1.3, compared to the betel leaf decoction, which only reduced the Debris Index by 0.1. This indicates that while lemon is

superior in terms of plaque cleaning, its use should be approached with caution due to the risk of enamel erosion from its acidic nature.

On the other hand, the betel leaf decoction showed a more significant increase in saliva pH of 1.34, from 5.63 to 6.97. This reflects a more stable and safe pH balancing effect for long-term use, making it a better choice for overall oral health maintenance. With a more stable pH increase, the use of betel leaf decoction can help create an oral environment that is not conducive to the growth of cavity-causing bacteria. Therefore, although both interventions have their respective benefits, the results of this study suggest that the use of betel leaf decoction should be prioritized as a safer and more effective preventive method for maintaining the dental and oral health of children. Effects of gargling with lemon juice and saline on saliva pH and oral hygiene in children. The findings indicated that lemon juice is not only effective in lowering the debris index but also raises concerns about the risk of enamel erosion due to its acidic properties(Anderson et al., 2019; Chang et al., 2023; Yu & Fang, 2024a). This finding aligns with further studies on the use of acidic substances in oral care. Additionally, a study by (Alioes et al., 2020)examined the effects of gargling with betel leaf decoction on saliva pH and dental health. This research found that using betel leaf decoction significantly increased saliva pH while reducing cavity-causing bacteria, demonstrating the potential of betel leaves as a safe and effective antibacterial agent. Research by Harahap et al., (2017)also examined the comparative effectiveness of gargling with betel leaf extract and antiseptic solutions in reducing dental plaque in adolescents. The results of this study indicate that betel leaf extract can effectively reduce dental plaque, aligning with the findings of this research that emphasizes the benefits of gargling with betel leaf decoction. Additionally, some study explored the effects of gargling with herbal solutions on saliva pH and dental health, finding that natural ingredients like betel leaves and ginger not only increase saliva pH but also reduce the risk of caries. These studies collectively support the importance of using natural ingredients in dental and oral health care, providing a strong scientific basis for further exploration of the effectiveness of different gargling methods(Yu & Fang, 2024b). With consistent results, this research contributes to a better understanding of how natural substances can be used as preventive measures in maintaining dental health, while also offering safer and more effective alternatives for the community in oral health care.

Conclusion

.Based on the research results, gargling with betel leaf decoction and lemon juice produces different effects on saliva pH and Debris Index in students at SDN Mesjid Lheu, Aceh Besar District. The betel leaf decoction is more effective in significantly increasing saliva pH (an increase of 1.34) and reducing oral acidity, which is important for preventing enamel demineralization and lowering the risk of cavities. Additionally, betel leaves possess antimicrobial properties that contribute to overall oral health. On the other hand, lemon juice shows a significant reduction in the Debris Index (a decrease of 1.3), indicating its effectiveness in cleaning plaque and food residues from teeth in the short term. However, the use of lemon should be approached with caution due to its strong acidic nature, which can damage tooth enamel if used excessively. In conclusion, betel leaf decoction is superior for long-term use in

maintaining oral health, while lemon juice is more effective for quick cleaning but should be used carefully.

Declaration of Conflicting Interest

The author declares that there is no conflict of interest in the implementation and results of this research.

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