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Differences in Saliva pH before and after Gargling Betel Leaf Mouthwash in Periodontitis with Smoking Habits

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ABSTRACT

Background: Saliva is one of the determinants of oral conditions and is easily available to diagnose and control periodontal disease. Smoking is also one of the causes of periodontitis. Periodontitis is a multifactorial chronic inflammatory disease associated with the accumulation of dental plaque (biofilm) and characterized by progressive damage to the tissues supporting the teeth, including the periodontal ligament and alveolar bone. Periodontitis can be minimized by using betel leaf (Piper betle L.) herbal mouth was, which has been proven to have many properties with minimal side effects

Objective: This study aims to determine whether there are differences in salivary pH before and after gargling with betel leaf mouthwash (Piper betle L.) in periodontitis patients with smoking habits.

Methods: The study used an experimental design with a pretest-posttest control group design. The sampling technique used was purposive sampling.

Results: The Wilcoxon test indicated that saliva pH increased after using betel leaf mouthwash for gargling (p-value=0.000).

Conclusion: Using betel leaf mouthwash (Piper betle L.), can increase salivary pH and effectively stabilize salivary pH for periodontitis patients with smoking habits.

KEYWORDS: Periodontitis, Smokers, Betel Leaf (Piper betle L.), pH Saliva

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INTRODUCTION

Currently, the use of herbal plants for improving oral hygiene and health is increasingly in demand. Many indicators influence dental and oral health; saliva is one of the indicators that functions as an important component in maintaining oral cavity homeostasis. The saliva component includes 99.5% water and 0.5% a mixture of salts, organic substances, and inorganic substances. Organic substances in saliva include proteins such as amylase, mucin, histatine, cystatin, peroxidase, lysozyme, and lactoferrin, as well as lipids, glucose, amino acids, ammonia, vitamins, and fatty acids. In addition, inorganic substances in saliva include sodium, calcium, chloride, magnesium, bicarbonate, and potassium phosphate.(1,2) Saliva helps chew and protect tissues by maintaining balance in the mouth through mechanical cleaning to minimize plaque buildup. The protective effect of saliva is in its ability to neutralize the pH of the oral cavity as well as its ability to clean food debris in the oral cavity. The normal pH value of saliva is 6.2-7.6, with 6.7 being the average value.(2) The degree of acidity of saliva is one of the biomarkers related to the pathophysiology of periodontal disease, which is characterized by acid or alkaline. In periodontal disease, which is clinically characterized by gingival inflammation and bleeding during probing (BoP), it can indirectly modify the acidity of the saliva.(3)

Periodontitis is a chronic inflammatory disease of the dental support tissue that is multifactorial and is influenced by several risk factors, as well as genetics.(4) Smoking is one of the risk factors that is quite dominant in affecting the progression of periodontitis.(5) Bergstrom et al. (1989) in their study showed the relationship between the severity of periodontal disease and smoking habits through increased pocket formation and alveolar bone damage.(6) In

smokers, periodontal conditions are generally obtained with more severe damage, such as deeper pockets, more severe bone damage, and a lot of tooth loss.(7) Nicotine, as one of the substances contained in cigarettes, is toxic and vasoactive and directly affects periodontal disease through the bloodstream and saliva, lowering the function of PMN as the body's earliest defense.(8) Gingival bleeding in smokers is slightly milder than that of non-smokers, this is because nicotine exerts a vasoconstrictive effect on the arterial blood vessels that flow to the gingiva.(9) Smokers have a 2.5-3.5x greater risk of experiencing more severe periodontal conditions.(6)

The use of mouthwash as one of the additional procedures in maintaining the health of the oral cavity chemically is often recommended by clinicians, especially for individuals who have difficulty maintaining the cleanliness of their oral cavity, even though it has been mechanically cleaned. Mouthwash *chlorhexidine* It is a gold standard antimicrobial agent used to maintain oral hygiene, reduce the formation of subgingival plaques, and treat oral diseases.(10) However, long-term use of chlorhexidine has various side effects, such as staining on the teeth, burning sensation, swelling of the parotid, and changes in taste.(11,12) Currently, the use of herbal plants in improving oral hygiene and health is increasingly in demand. Betel leaves (*Piper betle L.*) is an edible plant from the Piperaceae Family that has long been used as the main active ingredient in various traditional Asian medicines. Extract *Piper betle L.* is known to have several pharmacological effects, including anti-inflammatory, anti-allergic, wound-healing, antiplatelet, and antioxidant, antibacterial, and antifungal activities.(13) Betel leaf extract as one of the herbal ingredients can be used as an alternative to mouthwash due to its antiseptic and antimicrobial properties, which help reduce inflammation in the gums and surroundings.(13) Volatile oil which is an essential oil is the main ingredient of betel leaves, hydroxycavicol has a bacterial effect by affecting Streptococcus mutans by inhibiting the reproductive activity of these bacteria, thus allowing betel leaves to be used in toothpaste and mouthwash.(14) Betel leaves (*Piper betle L.*) has a distinct and sharp aroma, because it contains chavicol and bethelphenol. The sharp aroma and distinct taste possessed by betel leaves stimulate the sense of smell and taste system, thereby increasing saliva excretion, increasing the buffer capacity of saliva, thereby increasing the degree of acidity of saliva.(15) Several studies explain the relationship between the use of betel leaf extract and changes in saliva pH(16), but there are still very few studies that explain the use of mouthwash on pH changes in people with periodontitis accompanied by smoking habits.

RESEARCH METHODS

Research Design

This research is a type of experimental research with a *pre-test post-test design* with *a purposive sampling* technique, conducted at the Faculty of Dentistry, Universitas Prof. Dr. Moestopo (B) and has received approval from the Research Ethics Committee of Faculty of Dentistry, Universitas Prof. Dr. Moestopo(B), No: 97/KEPK/FKGUPDMB/VI/2024, and has also obtained a work permit from Dental Hospital, Universitas Prof. Dr. Moestopo(B).

Inclusion Criteria

The sample consisted of 32 patients diagnosed with periodontitis who would be divided into two groups: those who gargled with betel leaf mouthwash and gargled with chlorhexidine as a positive control. The criteria for periodontitis are based on age and have previously been diagnosed with periodontitis based on the patient's medical record (e-RM) of Dental Hospital, Universitas Prof. Dr. Moestopo(B) data have met the inclusion criteria, namely being a patient at Dental Hospital, diagnosed with periodontitis and having a smoking habit. The subjects were explained the objectives, objectives, and flow of the research and were asked to agree to their participation through *informed consent*.

Exclusion Criteria

Research subjects who are willing to fill in informed consent but do not complete the stages of the research conducted, and or have systemic abnormalities.

Saliva pH Analysis

Subjects were instructed to collect 5 ml of saliva into a saliva container, then an initial saliva pH measurement was carried out using a pH meter. The study subjects in the treatment group were instructed to gargle with betel leaf mouthwash with a dose of 10 ml for 30 seconds. The study subjects in the control group were instructed to gargle with *chlorhexidine* 0.2% mouthwash at a dose of 10 ml for 30 seconds. Furthermore, the two groups of subjects waited for 5 minutes, then the saliva was collected back into the saliva container to be measured after the treatment, using a pH meter.

Statistical Analysis

This research data will be compiled in Excel form, to be further processed using SPSS for Mac version 16.78 (2019). The data obtained will be analyzed qualitatively in descriptive form and paired T-Test analysis to see changes in saliva pH before and after gargling.

RESEARCH RESULTS

All subjects (32 subjects) were divided into two groups, namely the treatment group and the control group. The treatment group of 16 people gargled with betel leaf mouthwash, and the control group of 16 people gargled with *chlorhexidine* 0.2% mouthwash. The distribution of subjects in these groups is as follows:

Table 1. Frequency Distribution of Subjects by Gender

Gender	Frequency	Percentage (%)
Man	27	84,4%
Woman	5	15,6%
Total	32	100%

Table 1 shows that subjects with male gender are more dominant, namely 27 people with a percentage of 84.4%, compared to subjects with female gender, namely five people with a percentage of 15.6%.

Table 2 shows that the distribution of the research sample based on the most age is 43 years old as many as 4 people with a percentage of 12.5% and the least age sample is 41 years, 42 years, 47 years, 48 years, 49 years, 50 years, 64 years and 67 years, each as many as 1 person with a percentage of 3.1%.

Table 2. Distribution of subjects by age

Age	Frequency	Percentage (%)
40 Years	2	6,3%
41 Years	1	3,1%
42 Years	1	3,1%
43 years	4	12,5%
44 Years	2	6,3%
45 Years	2	6,3%
46 Years	2	6,3%
47 Years	1	3,1%
48 years	1	3,1%
49 Years	**1**	3,1%
50 Years	1	3,1%
52 Years	2	6,3%
53 Years	2	6,3%
54 Years	2	6,3%
56 Years	2	6,3%
57 Years	2	6,3%
64 years	1	3,1%
67 years	1	3,1%
68 Years	2	6,3%
Total	32	100%

Table 3 shows that the average pH value of saliva before gargling using betel leaf mouthwash is 5.8944 and after gargling with betel leaf mouthwash is 7.1600, so that the average pH difference of saliva before and after gargling using betel leaf mouthwash is 1.2656. The average pH value of saliva before gargling with *chlorhexidine* 0.2% was 5.7556 and after gargling with *chlorhexidine* 0.2% was 8.0481, so the average pH difference between saliva before and after gargling with *chlorhexidine* 0.2% was 2.2925. There was an increase in saliva pH in the study subjects who gargled with betel leaf mouthwash and in the control group who gargled with mouthwash containing *chlorhexidine* 0.2%.

Table 3. Average pH of Saliva Before and After Treatment in Both Groups

Group	N	Initial pH	Final pH	Difference
First Group (Betel Leaf Mouthwash)	16	5.8944	7.1600	1.2656
Control Group (*chlorhexidine* 0.2%)	16	5.7556	8.0481	2.2925

Table 4. shows that the group that gargled with betel leaf mouthwash, the pH of saliva before gargling had a median value of 5.99 with a range of 5.12 to 6.21. After gargling with betel leaf mouthwash, the median pH of saliva increased to 7.15 with a range of 6.77 to 7.50. A p-value of < 0.001 indicates that this increase in pH is statistically significant. The normality test stated that the data was not normally distributed ($p<0.05$) so a non-parametric statistical test *of the Wilcoxon Signed Ranks Test* (tables 4 and 5) had to be carried out.

Table 4. Non-parametric statistical test *Wilcoxon Signed Ranks Test* (treatment group)

	Median (Minimum-maximum)	P value
pH of saliva before gargling betel leaf mouthwash	5.995 (5.12-6.21)	0.000
pH of saliva after gargling betel leaf mouthwash	7.15 (6.77-7.50)	

*Wilcoxon Test

Table 5. Non-parametric statistical test *Wilcoxon Signed Ranks Test* (control group)

	Median (Minimum-maximum)	P value
pH of saliva before gargling chlorhexidine mouthwash 0.2%	5.755 (5.25-6.14)	0.000
pH of saliva after gargling chlorhexidine mouthwash 0.2%	8.200 (7.01-8.75)	

*Wilcoxon Test

Table 5. shows that gargling with *chlorhexidine* 0.2%, saliva pH before gargling has a median value of 5.755 with a range of 5.25 to 6.14. After gargling with *0.2% chlorhexidine*, the median saliva pH increased more significantly to 8.2, with a range of 7.01 to 8.75. Just like in betel leaf mouthwash, a p-value of less than 0.001 indicates a

statistically significant increase in pH. Based on the Wilcoxon test in both groups (Tables 4 and 5), it was shown that all study subjects (n= 32) experienced a statistically significant increase in saliva pH (*p-value* < 0.001).

DISCUSSION

This study aims to determine the difference in saliva pH before and after the use of betel leaf mouthwash (*Piper betle L.*) and *chlorhexidine* 0.2% in 32 research subjects who were patients at the Dental and Oral Hospital of Prof. Dr. Moestopo University. The results of the study showed 27 more male respondents (84.4%), this is in line with RISKESDAS data which revealed that 62.9% of men in Indonesia are smokers.(17) 43-year-old individuals dominated with four people (12.5%), who generally had a longer smoking history.(18)

According to Amerogen research (1991), saliva pH is influenced by several factors, including time. When a person wakes up at night, the pH of the saliva is generally high or alkaline, which will then decrease immediately within a few minutes. A similar condition also occurs during the eating process, where the pH of the saliva will increase due to mechanical stimulation, and then in the next 30 minutes, the acidity of the saliva will decrease.(15) Based on the fluctuating conditions of saliva, all research subjects were asked to come in the afternoon towards the afternoon (15 hours), this condition is by a study conducted by Ekstrom et al. (2019) which stated that the peak time of saliva secretion is 15 hours.(19) Selected study subjects were instructed not to eat or drink (except water) for 1 hour before saliva collection was performed. This study showed that the average pH value of saliva before gargling with betel leaves was 5.8944, and after gargling, it became 7.1600, with a pH difference of 1.2656, indicating a normal pH (6.7-7.4). Meanwhile, the average pH value of saliva before gargling with *chlorhexidine* 0.2% is 5.7556, and after gargling it becomes 8.0481, with a pH difference of 2.2925, indicating the pH value of the saliva, which is alkaline. According to Baliga S et al (2013), a high saliva pH in periodontitis patients indicates the presence of alkalinity, where excessive alkalinity will result in anaerobic conditions, thus causing biofilms to take a mixture of calcium in the oral cavity to be used as their protection when the saliva condition is in an acidic state. A high pH value (above 7.6) will stimulate the formation of biofilm crystals that allow the development of periodontal disease.(20) Betel leaves are effective in increasing the pH of saliva to normal due to the phenol compounds and flavonoids it contains; this is following previous research such as Ariyanti *et al.* (2014) and Wilis *et al.* (2017), which supports the effectiveness of betel leaves in maintaining saliva pH.(21,22) The increase in pH value in research subjects who gargle with betel leaf mouthwash may be caused by the presence of hydroxychavicol content isolated from betel leaves (*Piper betle L.*) which has been proven to increase the bactericidal effect on the group of bacteria that cause periodontitis, such as *Aggregatibacter actinomycetemcomitans*, *Prevotella intermedia*, *Fusobacterium nucleatum,* and *P. gingivalis*.(23) Gargling with betel leaf mouthwash is highly recommended for individuals with smoking habits or who have unfresh breath, this is due to the characteristics of betel leaves, which have a sharp taste and aroma so that they can help disguise bad breath.(14) This research is also in line with the research conducted by Mozafari *et al.* (2019), which states *chlorhexidine* 0.2% increases pH but can disrupt the balance of the oral microbiome if used over a long period due to its capacity to buffer high pH.(24) This study shows that there is almost the same antimicrobial ability between gargling and betel leaf mouthwash and *chlorhexidine* 0.2%, this is in line with research conducted by Sundaram *et al* (2021).(25) The weakness of this study is that it is carried out in a small sample and a small population, in the future, to get better results, research like this should be carried out on a wider population, which involves a larger and varied sample number.

CONCLUSIONS AND SUGGESTIONS

The use of mouthwash is one of the additional treatments in maintaining oral health. So far, the main choice is mouthwash that contains *0.2%* chlorhexidine, because it has been proven to be effective and bactericidal, but the use of herbal mouthwashes such as mouthwashes with betel leaf content (*Piper betle L.*) turns out to provide almost similar effectiveness to *chlorhexidine* 0.2%, which has almost similar antimicrobial activity, so it can be an alternative mouthwash in maintaining oral health, especially for individuals who are undergoing periodontal treatment.

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CONFLICTS OF INTEREST

The author states that there is no conflict of interest between fellow authors concerning the publication of this article.

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