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The Effect of the Combination of Red Betel Leaves and Basil on Changes in Plaque Status and Salivary pH of Patients with Type 2 Diabetes Mellitus in Bara-Baraya Health Centre

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ABSTRACT:

Objective: This study aims to analyse the effect of a combination of red betel leaf decoction and basil on changes in plaque status and salivary pH in patients with type 2 diabetes mellitus.
Methods: This study used quasi experiment with pretest-posttest with control group design. The research location was in the working area of Bara-Baraya health centre, Makassar. Random sampling with the criteria set with a total sample of 48 respondents consisting of 16 in the intervention group and 16 each in the comparison intervention group I and II. Data analysis used was paired sample test, one way anova, tukey test and kruskal wallis.
Results: The study showed a difference in plaque status and salivary pH before and after the intervention of gargling a combination of red betel leaf decoction and basil with a p value of 0.000.
Conclusion: The combination of red betel leaf decoction and basil has an effect on changes in plaque status and salivary pH in patients with Type II Diabetes Mellitus at Bara-Baraya Health Centre.

Keywords: diabetes mellitus, combined mouthwash, red betel leaf, basil leaf, plaque, salivary pH

1. INTRODUCTION

Diabetes is a chronic metabolic disease characterised by elevated blood glucose levels, which over time can cause serious damage to the heart, blood vessels, eyes, kidneys and nerves. The most common form is type 2 diabetes, which generally occurs in adults, where the body becomes resistant to insulin or does not produce enough insulin. Over the past three decades, the prevalence of type 2 diabetes has increased dramatically globally across all income levels [16].

Diabetes mellitus causes elevated blood sugar levels and damages blood vessels, nerves and other organs. Serious complications include heart attack and stroke as blood vessels thicken due to complex substances formed from sugar.[9]. Diabetes mellitus patients are prone to various oral complications such as inflammation like gingivitis and periodontitis, and xerostomia. Xerostomia, which occurs in 40-80% of diabetic patients, is caused by reduced salivary flow due to hyperglycaemia and dehydration. This condition can lead to tooth decay and the risk of tooth loss, affecting digestion and overall quality of life.

Research by Wayeni, Susanto and Wuryanto (2019) on Oral Hygiene Behaviour, Plaque Score, and Gingival Score in Diabetes Mellitus Patients (Study at Tugurejo Semarang Hospital) found that the plaque index in a sample of diabetes mellitus patients showed that 16.7% had poor oral conditions and 66.7% were moderate, indicating a significant risk of periodontal disease or caries due to the lack of awareness of respondents[15] .

Mouthwash is a convenient way to maintain oral health by maintaining salivary pH and controlling dental plaque. However, many available mouthwashes contain chemicals that can disrupt oral flora in the long term. Innovation is needed to create safer and more effective mouthwashes for long-term use and public consumption.[5].

Traditional plants such as red betel leaf and basil can be used as natural mouthwash. Betel leaf contains flavonoids that stimulate salivary secretion, increase salivary pH, and has antiseptic properties due to its carvacrol content. Basil is rich in chemicals such as essential oils, alkaloids, glycosides, and flavonoids that inhibit bacterial growth. Flavonoids in basil also chemically stimulate salivary secretion. Combining these two plants is expected to be a safe and effective alternative mouthwash to maintain oral health.

2. METHODS

This research is an experimental study, namely *Quasi Experiment* with *randomised control group pretest posttest design* to determine the effect of gargling with a combination of red betel leaf decoction and basil leaves on changes in plaque status and salivary pH in the Prolanis group of type II Diabetes Mellitus patients. The location of this research is in the working area of the Bara-Baraya Health Centre, Makassar City.

The population in this study were all type II DM patients who were members of the Prolanis group in the Bara-Baraya Puskesmas working area as many as 60 people. Sample calculation using the paired analytical formula resulted in a sample size of 48 individuals in three groups, where group I was the main intervention group using a combination of red betel leaf and basil, group II was the comparison intervention group I using red betel leaf, and group III was the comparison intervention group II using basil. Samples were taken using inclusion and exclusion criteria. The sampling technique used was simple random sampling (SRS).

Data processing and analysis used Stata version 17. The effect between variables was analysed using paired t-test. To test differences among three samples to see significant differences between the samples, one-way ANOVA test was used for normally distributed data, while Kruskal-Wallis test was used for non-normally distributed data. And Tukey's post hoc test was used for further tests.

This study was approved by the Health Research Ethics Committee of Hasanuddin University with a recommendation for ethical approval number 524/UN4.14.1/TP.01.02/2024 dated 22 February 2024.

3. RESULTS

This study was conducted in the working area of Bara-Baraya Health Centre, Makassar City, South Sulawesi Province. Before the intervention was carried out, the intervention materials were first tested in the laboratory to determine the phytochemical content and bacterial inhibition. Phytochemical testing was carried out at the Makassar City Health Laboratory Centre with the number: 24004635-24004637/LHU/BBLK-MKS/II/2024. With the following results.

Table 1**.** Phytochemical Testing Results

No.	Tested Materials	Phytochemical Compounds	Unit	Results
1.	Combined decoction of red betel leaf and basil	Alkaloids	µg/g	14,29
		Tannins	µg/g	35,04
		Flavonoids	µg/g	3,31
2.	Red Betel Leaf Decoction	Alkaloids	µg/g	6,78
		Tannins	µg/g	21,44
		Flavonoids	µg/g	4,09
3.	Basil Leaf Decoction	Alkaloids	µg/g	15,89
		Tannins	µg/g	62
		Flavonoids	µg/g	4,08

Source: Primary Data, 2024

Table 1 shows that in the combined decoction of red betel leaf and basil, red betel leaf decoction, and basil leaf decoction contains several active compounds including alkaloids, tannins, and flavonoids. The combined decoction of red betel leaf and basil contains alkaloids of 14.29 µg/g, tannins of 35.04 µg/g, and flavonoids of 3.31 µg/g. The red betel leaf decoction contains alkaloids of 6.78 µg/g, tannins of 21.44 µg/g, and flavonoids of 4.09 µg/g. While the basil leaf decoction contains alkaloids of 15.89 µg/g, tannins of 62 µg/g, and flavonoids of 4.08 µg/g.

Bacterial inhibition testing was carried out at the Molecular Microbiology Laboratory, Faculty of Medicine, Hasanuddin University with no: 014/LBMI/FKUH/TU/V/2024. The results of the inhibition test against *Streptococcus mutans* bacteria are listed in the table below:

Table 2: Bacterial Inhibition Test Results

No.	Tested Materials	Concentration	Area of Zone of Inhibition (mm)	Category
1.	Red Betel Leaf and Basil Combination Decoction	10 %	20.7	Very Strong

2.	Red Betel Leaf Decoction	10 %	10.5	Medium
3.	Basil Leaf Decoction	10 %	11.7	Strong

Source: Primary Data, 2024

Table 2 above shows that the combined decoction of red betel leaves and basil, red betel leaf decoction, and basil leaf decoction can inhibit the growth of *Streptococcus mutans* bacteria. In the combined decoction of red betel leaf and basil, it is known to have an inhibition zone area of 20.7 mm with a very strong category, red betel leaf decoction has an inhibition zone area of 10.5 mm with a moderate category, then basil leaf decoction has an inhibition zone of 11.7 mm with a strong inhibition category.

The study was conducted on 48 respondents by providing intervention materials to be used as a mouth rinse solution for 3 consecutive days after brushing teeth to evaluate the effect of natural mouth rinse solution on changes in plaque status and salivary pH.

Table 3 shows the characteristics of the respondents. For gender characteristics, female respondents had a higher proportion compared to males in all three groups, with the highest proportion found in the comparison intervention group II consisting of 15 respondents (93.75%). The age range of respondents in this study was mostly in the age range of 19-59 years, with the highest proportion in the main intervention group consisting of 11 respondents (68.75%). In terms of education, in the main intervention group and comparison intervention I, respondents were mostly high school graduates, with a total of 6 respondents (37.50%), while in the comparison intervention II group, respondents had mostly completed junior high school, also with a total of 6 respondents (37.50%). In terms of occupation, most of the respondents in all three groups worked as housewives, with the highest proportion in the main intervention and comparison intervention II groups of 10 respondents each (62.50%). Regarding the disease status of Diabetes Mellitus among the three groups, most of the respondents had suffered from diabetes mellitus for more than 3 years, with a total of 11 respondents in the main intervention group and comparison intervention II (68.75%), and almost all of them were taking anti-diabetic drugs orally without injections. Regarding the frequency of tooth brushing, almost all respondents brushed their teeth 1-2 times a day.

Table 3. Distribution of Respondents' characteristics at Bara-Baraya Health Centre, Makassar City, Year 2024

Respondent Characteristics	P1		P2		P3	
	n	%	n	%	n	%
Gender						
Male	3	18,75	2	12,50	1	6,25
Women	13	81,25	14	87,50	15	93,75
Age Group						
19-59 Years	11	68,75	10	62,50	10	62,50
≥60 Years	5	31,25	6	37,50	6	37,50
Education						
Finished primary school	3	18,75	3	18,75	3	18,75
Completed junior high school	5	31,25	3	18,75	6	37,50
Completed high school	6	37,50	6	37,50	4	25,00
College Graduate	2	12,50	4	25,00	3	18,75

Jobs						
Not Working	0	0,00	0	0,00	1	6,25
IRT	10	62,50	7	43,75	10	62,50
Trader/ Self-employed	3	18,75	6	37,50	5	31,25
PNS	1	6,25	1	6,25	0	0,00
Retired	1	6,25	2	12,50	0	0,00
Others: Labour	1	6,25	0	0,00	0	0,00
Marital Status						
Unmarried	0	0,00	0	0,00	2	12,50
Married	15	93,75	16	100,00	13	81,25
Widow/Widower	1	6,25	0	0,00	1	6,25
Duration of Suffering						
1-3 Years	5	31,25	6	37,50	5	31,25
> 3 Years	11	68,75	10	62,50	11	68,75
Type of Treatment						
Oral OADs	14	87,50	16	100,0	16	100,0
OAD Oral + Injection	2	12,50	0	0,00	0	0,00
Frequency of Tooth Brushing						
1-2 times	15	93,75	13	81,25	15	93,75
> 2 times	1	6,25	3	18,75	1	6,25
Total	16	100,00	16	100,00	16	100,00

Source: Primary Data, 2024

Notes: P1: Main Intervention, P2: Comparator Intervention I, P3: Comparator Intervention II

Data analysis was carried out on the three groups given the intervention to statistically determine the effect of the intervention on changes in plaque status and salivary pH then further analysis was carried out to determine which intervention was more influential. Data analysis carried out on plaque status variables using paired t test in all three groups, one way ANOVA test and Tukey post hoc test as a further test and data analysis carried out on salivary pH variables using Wilcoxon test and Kruskal Wallis test in all three groups. With the test results as follows.

Table 4. Analysis of Changes in Plaque Status Before and After Intervention in the Three Groups

Group	Variables	Mean	SD	p-Value
Main Intervention (n=16)	Pre-test	3.16	0.49	0.000
	Post-test	1.24	0.30	
Intervention Comparator I (n=16)	Pre-test	2.88	0.68	0.000
	Post-test	1.48	0.42	
Comparator II Intervention (n=16)	Pre-test	2.75	0.69	0.000
	Post-test	1.50	0.39	

Source: Primary Data, 2024

Table 5. One Way ANOVA Test

Group	n	Difference between Pre-test and Post-test scores		p-value
		Mean	SD	
Main Intervention	16	1.9	0.38	0.000
Intervention Comparator I	16	1.3	0.35	
Intervention Comparator II	16	1.2	0.41	

Source: Primary Data, 2024

Table 6. Post Hoc Test using Tukey Test

Group	Std.Error	p-Value
Combination vs Red Betel Leaf	0.13	0.001
Combination vs Basil Leaf	0.13	0.000
Red Betel Leaf vs Basil Leaf	0.13	0.515

Source: Primary Data, 2024

Table 7. Analysis of Changes in Salivary pH Before and After Intervention in the Three Groups

Group	Variables	Mean	SD	p-Value
Main Intervention (n=16)	Pre-test	6.18	0.33	0.000
	Post-test	6.97	0.17	
Intervention Comparator I (n=16)	Pre-test	6.20	0.30	0.000
	Post-test	6.91	0.07	
Comparator II Intervention (n=16)	Pre-test	6.23	0.20	0.000
	Post-test	6.87	0.09	

Source: Primary Data, 2024

Table 8. Kruskal Wallis Test

Group	n	Rank Sum	p-value
Main Intervention	16	449.50	0.000
Intervention Comparator I	16	413.50	
Intervention Comparator II	16	313.00	

Source: Primary Data, 2024

Based on the paired t test in the main intervention group, the mean plaque status before the intervention was 3.16 and the mean plaque status after the intervention was 1.24 with a value of p = 0.000. In the comparison intervention group I shows the average plaque status before the intervention of 2.88 and the average plaque status after the intervention of 1.48 with a value of p = 0.000 and in the comparison intervention group II shows the average plaque status before the intervention of 2.75 and the average plaque status after the intervention of 1.50 with a value of p = 0.000.

In Table 5. obtained a value of p = 0.000 so it can be concluded that there is a significant difference in the difference in plaque status between the three intervention groups so that further tests can be used to analyse which intervention has the most effect on changes in plaque status. The further test used or Pos Hoc used is the Tukey Test because the results of the analysis of normal data distribution and significant anova results meet the requirements for this test. Based on the Tukey test output, it can be concluded that the intervention groups that have significant differences are between the combination with red betel leaves with a p value of 0.001 and between the combination with basil leaves with a value of p = 0.000. So it can also be concluded that the intervention that has the most effect on changes in plaque status is the combination intervention.

In Table 7. in the main intervention group, testing was carried out using the Wilcoxon test because the data was not normally distributed, showing the average salivary pH before the intervention of 6.18 and the average salivary pH after the intervention of 6.97 with a value of p = 0.000. In the comparison intervention group I, testing was carried out using the paired t test because the normally distributed data showed the average salivary pH before the intervention of 6.20 and the average salivary pH after the intervention of 6.91 with a value of p = 0.000 Then in the comparison intervention group II, testing was carried out using the Wilcoxon test because the data was not normally distributed, showing the average salivary pH before the intervention of 6.23 and the average salivary pH after the intervention of 6.87 with a value of p = 0.000.

Then in table 8. the results of the Kruskal Wallis test in the table above, obtained a value of p = 0.202 which means that there is no significant difference in the difference in salivary pH between the three intervention groups so it can be concluded that all interventions have a relatively similar effect on changes in salivary pH.

4. DISCUSSION

Phytochemical Testing

Phytochemicals are natural chemical compounds found in plants and have various health benefits. When two substances containing phytochemicals are combined, the interaction between these phytochemicals can have synergistic, additive, or even antagonistic effects. Based on the research results in Table 5, it was found that in the combined solution of red betel leaf and basil boiled at a concentration of 10%, it contains alkaloids, tannins, and flavonoids. The content of alkaloids as secondary metabolite compounds found in red betel leaves and basil leaves has a mechanism of action that inhibits the synthesis of bacterial cell walls, causing lysis of the cell wall and resulting in bacterial death.[8] Alkaloids can act as antibacterials by disrupting the peptidoglycan component in cells, thus forming incomplete cell walls that cause cell death. [12].

The tannin content in red betel leaf and basil has a mechanism of action against bacteria by adhering to the cell wall and causing disturbances in cell permeability. Disruption in cell permeability leads to disruption in cell activity, making the cell fragile and susceptible to death.[8]. The mechanism of action of tannins includes inhibiting the enzymes reverse transcriptase and DNA topoisomerase, preventing the formation of bacterial cells. The

antibacterial effect of tannins is related to their ability to inactivate microbial adhesion, enzymes, and disrupt protein transport in the inner layer of the cell [4].
Meanwhile, flavonoids have a mechanism against bacteria by inhibiting microbial growth through penetration into the cell and causing protein clumping on the cell membrane, thus damaging the protein structure. Instability and protein control of the cell wall, cytoplasmic membrane, and permeability cause disruption, resulting in destabilisation of S. mutans cells and subsequent lysis[8] . Similar findings were reported by Bujung, Homenta and Khoman (2017) in their journal, stated that the mechanism of action of flavonoids as antimicrobials can be divided into three parts: inhibiting nucleic acid synthesis, inhibiting cell membrane function, and inhibiting energy metabolism. Flavonoids cause damage to the bacterial cell wall, microsomes, and lysosomes as a result of the interaction between flavonoids and bacterial DNA.

Bacterial Inhibition Testing

Inhibition testing is the ability of a substance to inhibit the growth of plants or microorganisms.[23]. In the combination of red betel leaf and basil, the diameter of the bacterial inhibition zone reached 20.7 mm, categorising it as very strong in inhibiting bacteria. Meanwhile, the inhibition zone diameters for red betel leaf and basil separately were 10.5 mm, categorised as medium, and 11.7 mm, categorised as strong, respectively. The large zone of inhibition in this combination indicates a synergistic effect between red betel leaf and basil.
The synergy between red betel leaf and basil in this study is consistent with research conducted by Kurniati, et al (2018) which stated that the combination of ethanol extracts from basil leaves and red betel leaves has shown greater mucolytic activity compared to the use of each individually. Ethanol extracts of 0.5% basil leaves and 0.5% red betel leaves in combination form showed better mucolytic activity compared to the mucolytic activity of each individual preparation. The study also showed the presence of synergistic effect in the combination of these two test plants, thereby enhancing the mucolytic activity.
Combination research was also conducted by Pramiastuti and Joharoh (2020) related to the antibacterial activity of a combination of red ginger and betel leaf extracts, which stated that the combination of Red Ginger Extract (Zingiber officinale var. Rubrum) and Betel Leaf (Piper betel L.) in 96% ethanol solvent showed strong antibacterial activity at a concentration of 80% against Staphylococcus aureus and 100% against Escherichia coli.[7][10].

Changes in Plaque Status and Salivary pH Before and After Intervention

Plaque is a soft film that adheres firmly to the surface of teeth and gums, with a high potential to cause disease in the hard tissues of the teeth. Bacteria in plaque process food debris that is cariogenic. Left unchecked, plaque can cause demineralisation and can lead to tooth decay. Dental plaque originates from colonies of bacteria that multiply in the matrix, especially when oral hygiene is neglected.[3].
People with diabetes mellitus are prone to dental health problems for several reasons related to high blood sugar levels and changes in body function. Firstly, high blood sugar levels can weaken the immune system, making patients more susceptible to infections, including gum infections such as periodontitis. Untreated periodontitis can lead to damage to the bone supporting the teeth and even tooth loss.[I6].
Plaque control is an effective way to treat and prevent gum inflammation and is an essential part of all periodontal disease treatment and prevention procedures. Good biofilm control has been shown to influence biofilm growth and composition, thus favouring the establishment of healthier normal flora. Plaque control can be achieved chemically using mouthwash. Some chemicals in mouthwash have antiseptic or antibacterial properties that are useful for inhibiting

plaque formation. Currently, research on herbal mouthwashes has shown promising results in plaque control.[1].

In this study, three groups were pre-tested to measure plaque status and salivary ph before the intervention then the post-test was carried out after three consecutive days of gargling with the intervention material given twice a day after brushing teeth. The model used in this measurement is 3-days plaque accumulation which is a model that is often used to study the formation and development of dental plaque and is often used in clinical and experimental research to evaluate the effectiveness of oral care such as toothpaste and mouthwash.

The results of this study showed the effect of natural ingredients from red betel leaf and basil on changes in plaque status, both in mouthwash formulations that combine red betel leaf and basil and in mouthwash formulations that use each of these natural ingredients separately. This is because both natural ingredients contain several active compounds with antibacterial properties such as alkaloids, flavonoids, tannins, and saponins. These compounds can inhibit the growth of bacteria in the mouth, which is the main cause of dental plaque formation. Bacteria such as Streptococcus mutans, which play a role in plaque formation and tooth decay, can be suppressed by the antibacterial activity of red betel leaf extract and basil leaf extract.

Red betel leaf cooking water contains carvacrol, which functions as a disinfectant and antifungal agent, making it suitable for use as an antiseptic to maintain oral health. Betel leaf (Piper crocatum), which contains flavonoids, alkaloids, tannins, and essential oils with antibacterial properties, can inhibit plaque growth. [5]. Meanwhile, basil leaves (Ocimum basilicum) contain chemical compounds such as essential oils, alkaloids, glycosides, saponins, flavonoids, triterpenoids, steroids, and tannins. Some of these chemical compounds can inhibit bacterial growth. One of the active ingredients in basil leaves with antibacterial properties is compounds from essential oils such as 1,8-sineol, ß-bisabolene, and methyl eugenol. These three substances are soluble in ethanol and can cause damage to bacterial cell membranes. This theory is consistent with research conducted by [17]. This study showed a difference in plaque index before and after treatment, where the plaque index improved after treatment (mouth rinse with red betel leaf infusion). The paired t test results showed that the p value = 0.000 ($p < 0.05$), indicating a significant difference between plaque scores before and after gargling with red betel leaf infusion. Similar research was also conducted by Marlindayanti et al. (2017), which revealed that the higher the concentration of basil leaf extract, the lower the plaque accumulation; a concentration of 20% basil leaf extract can already be compared with the positive control in reducing plaque accumulation (PHP). Basil leaf extract can reduce plaque accumulation.

The concentration of the mouthwash used is 10% because the researcher hopes that this concentration can form an effective antibacterial effect. Extracts with small concentrations that have great activity are called effective as antibacterials. Activity tests were carried out at concentrations of 5%, 10%, and 15%, this is based on previous research that antibacterial activity exists at concentrations above > 5%. The addition of concentrations is carried out based on the formula n (+5), the largest concentration used is 15%, with the assumption that antibacterial activity that occurs above > 15% is less effective because it uses more extracts and usage is not efficient if applied to the clinical use of simplification. [5]

The plaque status in the combination group of red betel leaf and basil decoction water was affected by the synergistic interaction of their phytochemicals. Analysis using One-Way ANOVA (table 5) showed significant differences in changes in plaque status among the intervention groups: red betel leaf combination, single red betel leaf, and single basil leaf. Tukey's follow-up test (Table 6) identified significantly different combination groups, showing their strong antibacterial effect (20.8 mm zone of inhibition) against Streptococcus mutans, a common oral plaque bacteria.

Salivary pH measurements were also taken because, based on the theory of the respondent group in this study-diabetes mellitus patients often experience problems with their salivary secretions, which leads to an acidic pH in the oral cavity. Diabetes mellitus patients generally have more acidic saliva due to several factors interrelated with this condition. This theory is consistent with research conducted by Priyanto, Andid and Zanaria, (2017) which showed that the pH level of saliva in DM patients at the Endocrine Clinic of RSUDZA tended to be acidic compared to neutral or alkaline pH, with 83.7% acidic pH and 16.3% alkaline pH, and 0% neutral pH. Similar findings were also reported by Antara and Jati (2019) in a study conducted, it was found that the majority of DM patients at Kasihan 1 Bantul Community Health Centre had an acidic salivary pH. The use of mouthwash, which plays a role in inhibiting bacterial growth, also affects the neutralisation of salivary pH. Mouthwash made from natural ingredients such as red betel leaf and basil, which have antibacterial properties, can reduce the number of acid-causing bacteria in the mouth. By reducing the bacterial population, acid production is also reduced, helping to maintain a more balanced salivary pH. [11].

The flavonoid content in betel leaf and basil causes a bitter and pungent taste in these plants, which can stimulate the secretion of salivary glands to chemically increase saliva production. The distinctive aroma of basil comes from the essential oil concentrated in its leaves, which is known to contain 71% eugenol as the main active ingredient, which also stimulates salivary production neurally through the sympathetic and parasympathetic nervous systems. Increased salivary flow can lead to an increase in salivary pH. This theory is supported by research conducted by TC.Tandelilin, (2020) Significant differences were observed after gargling with a 10% concentration of boiled red betel leaf, indicating that red betel leaf as a mouthwash ingredient can increase salivary acidity (pH).

The test to determine differences in mean salivary pH using the Kruskal-Wallis test (table 8) showed no significant difference in salivary pH changes among the three intervention groups. Although based on theory and research findings, all three groups showed an effect on salivary pH changes, no significant difference was observed among the groups. This could be due to the fact that the three intervention groups could similarly change the salivary pH from acidic to neutral, with pH values that were not significantly different from each other. [14].

5. CONCLUSIONS

There was an effect of gargling with a combination of red betel leaf and basil decoction on changes in plaque status and salivary pH, whether used together or separately. However, the combined intervention had the most significant impact with the greatest difference between the red betel leaf and basil groups separately in terms of plaque status. However, none of the interventions had a greater effect on changes in salivary pH as all three groups showed similar mean changes in salivary pH.

Advice

It is expected for people with diabetes mellitus to use a natural ingredient combination of red betel leaf and basil as an alternative mouthwash given the theoretical and practical benefits that have been proven. For further researchers to be able to develop alternative natural-based mouthwashes that are easily found in the community so that natural mouthwash innovations can vary.

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