

## **EFFECTIVENESS OF MOUTHWASHES BANANA AND PINEAPPLE PEEL EXTRACT AGAINST PLAQUE INDEX OF FIXED ORTHODONTIC PATIENT**

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### **ABSTRACT**

Orthodontic fixed patients used mouthwashes to control plaque chemically. Chemically mouthwashes have aftereffects in long-term use, which can have staining impacts to teeth and mouth mucosa, aggravations in the working of the taste feelings of food, and allergic reactions. Therefore, alternative mouthwash derived from herbs is required with the expectation that the risk of aftereffects is smaller. Banana and pineapple peel extract contain active antibacterial substances such as flavonoids, tannins, saponins, terpenoids, and bromelin. The purpose of this study is compare of the effectiveness of mouthwashes banana and pineapple peel extract in inhibiting plaque formation. This study was a *quasi-experimental with pretest and posttest control group design* involving 45 orthodontic patients as the subject of the study. The subjects were divided into three groups, namely the first group was given a mouthwashes banana peel extract of 2.5% (15 subjects), the second group was given a mouthwashes pineapple peel extract of 6.24% (15 subjects) and one control group (15 subjects) given a aquadest. The measurement of plaque index using Attin's plaque index on before and after using mouthwash. Mouthwashes banana peel extract 2.5% and pineapple peel extract 6.24% effective in lowering the plaque index of orthodontic fixed appliance patients. Mouthwashes banana peel extract is more effective in lowering plaque index. Banana peel extract mouthwashes are more effective in lowering the plaque index of fixed orthodontic patients

**Keywords:** Mouthwash, Banana peel extract, Pineapple peel extract, Plaque index.

### **1. Introduction**

Orthodontic treatment is one of the dentistry fields that specializes in treating malocclusion to obtain a good function of occlusion and aesthetics in the form of regular dental arrangement, used fixed orthodontic appliance or removable orthodontic appliance. A fixed orthodontic appliance is a device attached directly to the surface of the tooth by the orthodontist, consisting of brackets, wires, and other supporting components the patients can not removed. The complexity of the arrangement of fixed orthodontic appliances makes it difficult for patients to maintain dental

hygiene in the oral cavity. This results in plaque accumulation by bacterial activity along with food debris that cannot be cleaned thoroughly<sup>(1)</sup>.

Plaque is a biofilm layer in which microorganisms accumulate in an intercellular matrix attached to the tooth's surface.<sup>(2)</sup> Plaque accumulation is a significant factor in causing periodontal disease and dental caries.<sup>(3)</sup> Control of plaques can be done mechanically and chemically. Control of plaque mechanically is by brushing teeth adequately and appropriately, while control of plaque chemically is carried out with the use of mouthwashes that are efficacious

antibacterial. The use of mouthwashes that have antibacterial efficacy is proven to help reduce the formation of plaque meaningfully, especially in areas of the teeth that are difficult to reach by toothbrushes.<sup>(4)(5)</sup>

Chlorhexidine is currently a mouthwash has becomes the "gold standard" in controlling plaque.<sup>(6)</sup> Long-term use of chlorhexidine can provide unexpected side effects, such as discoloration of the surface of the teeth and mucosa of the mouth, impaired function of the taste senses of food, to cause allergic reactions.<sup>(7)</sup> Regular use of chemical mouthwash, when use is stopped, the condition of the oral cavity can not immediately return to normal, but it will take up to one week to normalize, which is known as the washout period.<sup>(8)</sup>

The existence of side effects of mouthwashes from these chemicals, it is necessary alternative ingredients from herbs for mouthwashes, which are expected to have fewer side effects while utilizing the potential of herbs in Indonesia. Pineapples and bananas are the fruits that are widely found in Indonesia, because their production is abundant. The peel of the fruit has not been utilized to the maximum. The results of Nofita *et al* research showed that pineapple skin extract with a concentration of 6.24% has antibacterial ability against *Staphylococcus aureus* bacteria because pineapple peel contains bioactive compounds with antibacterial properties such as *flavonoids*, *saponins*, *tannins*, and *bromelin*.<sup>(9)(10)</sup>

Research on ambon banana peel conducted by Normayunita and Anam (2015), proved that ambon banana peel contains bioactive compounds that have antibacterial potentials such as *flavonoids*, *tannins*, *saponins*, and *terpenoids*.<sup>(11)</sup> Banana peel extract that is proven to have the best activity in inhibiting the growth of *S. mutants* is at a concentration of 2.5%.<sup>(12)</sup> This bioactive compound can be used for its antibacterial properties to inhibit the accumulation of dental plaque.

Based on the above, research is needed

to find out the effectiveness of herbal-based mouthwashes from pineapple and banana peel extract, which of the two are more effective at inhibiting the formation of plaque in fixed orthodontic patients, as an alternative chemical mouthwash.

## 2. Method

This type of research is a double-blind *quasi-experimental* study with pretest - posttest with control group design. The number of subject amounted to 45, divided into 3 treatment groups, consisting of 30 samples using mouthwashes extract banana peel (ambon) and pineapple peel (15 samples in groups 1 and 2 respectively) and 15 samples as a control group (group 3) using gargle aquadest. The method of brushing teeth is controlled by Charter method, the toothbrush used is an orthodontic toothbrush, and the sample has been treated with a fixed orthodontic appliance for at least 7 months. The measurement of plaque index used is Attin's plaque index, measured after the sample is likened to how to brush its teeth (Charter method) for 7 days, the measurement results as preliminary data. The sample was then given 2.5% banana peel extract and 6.24% pineapple peel extract of 150 ml each for use 2 times a day (morning after breakfast and night before bed, for 30 seconds, as much as 10 ml of mouthwashes) for 7 days, and on the 7th day measured plaque index. The measurement results are recorded as final data (after using mouthwashes banana and pineapple peel extract).

### Formulation of banana and pineapple peel extracts

For preparation to make extracts from banana peels and pineapple peels, Ambon banana peels (*Musa paradisiaca* var. *sapientum*) and pineapple peels (*Ananas comosus* (L) Merr.) were selected as raw materials. Ripe Ambon bananas are characterized by large size with a curved shape with tapered ends,  $\pm$  16-20 cm fruit length, and yellowish-green skin color.

Fig.1 Ripe ambon bananas<sup>(13)</sup>

The selected pineapple is at maturity stage 2-4 (as shown in the figure circled in blue), with the characteristics of 20-90% yellow fruit eyes, and is 15-18 months old.<sup>(14)</sup>

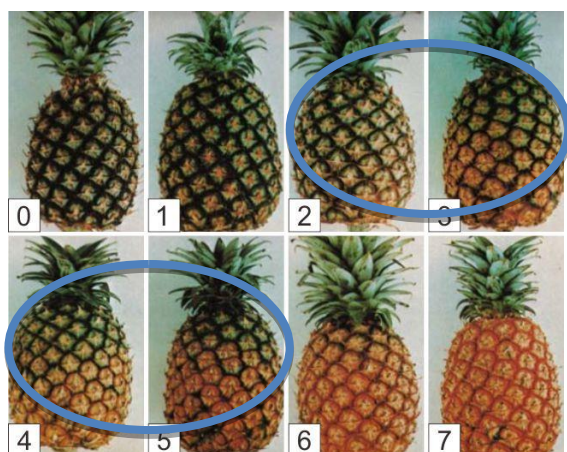


Fig.2. Selection of ripeness level of pineapple (circled in blue)

The extract is prepared using the maceration method or also called cold extraction because the equipment procedure is simple and allows many compounds to be extracted.<sup>(15)</sup>

First, banana and pineapple peels were cut into pieces and dried in an oven at 45° C for 48 hours. After drying the fruit skin in a blender (Philips®), then put it in an Erlenmeyer tube (Pirex Iwaki Glass®) and add a 96% ethanol solution, then shake in a water bath shaker (Buchi®) for 1 hour to make it homogeneous at 120 rpm.<sup>(16)</sup> The solution was left for 24 hours at room temperature, then filtered with a filter, and the residue was repeated maceration 2 times.

The results of filtration 1-3 were mixed and concentrated with a Rotary Vaccum Evaporator (Heidolph®) at 50°C

until a thick extract with a concentration of 100% pineapple was obtained. The results of the extraction of banana peels and pineapple peels were made into mouthwash preparations with concentrations: for mouthwash banana peel 2.5%<sup>(12)</sup>, for mouthwash pineapple peel 6.24%<sup>(17)</sup>

Table 1. Banana peel extract mouthwash formula

Ingredient	Formula	Function
Banana peel extract	1,25	The main ingredient
Tween 80	3,75	Emulgator
Gliserin	1,25	Wetting agent
Natriumbenzoat	0,2	Preservative
Natrium saccharin	1	Sweetener
Aquades ad	50	Solvent

\*Made for 50 mL

Table 2. Pineapple peel extract mouthwash formula

Ingredient	Formula	Function
Pineapple peel extract	3,12	The main ingredient
Tween 80	3,75	Emulgator
Gliserin	1,25	Wetting agent
Natriumbenzoat	0,2	Preservative
Natrium saccharin	1	Sweetener
Aquades ad	50	Solvent

\*Made for 50 mL

The prepared ingredients are mixed and stirred until dissolved, then filtered and put in two plastic bottles as a mouthwash banana peel extract and pineapple peel extract.<sup>(17)</sup>

### Data analysis

The research data obtained was conducted a normality test first using the *Shapiro-Wilk* method. As a result, the data were not distributed normally, then continued *Wilcoxon test* was to find out if there is an influence of mouthwash use on the amount of plaque index before and after treatment.

To find out the best type of mouthwashes in reducing attin plaque index, first performed a normality test using the *Shapiro-Wilk* method on each difference in plaque index before (*pre-test*) and after treatment (*post-test*) in banana peel extract group and pineapple peel extract. Continue the *One Way Anova test* to find out the best type of mouthwashes in reducing plaque index.

### 3. Result

Attin plaque index value data from all study subjects were recorded and then analyzed using SPSS (*SPSS Inc., Chicago II USA*). Normality test is performed using the *Saphiro-Wilk test* to see data distribution.

Table 3. Test normality with *Shapiro-Wilk* before using mouthwash (*pre-test*) and after using mouthwash (*post-test*) in the treatment and control group

Group		<i>Shapiro-wilk</i>		
		Statistics	Df	Sig.
Banana Skin Extract	<i>Pre-test</i>	0,107	15	0,038
	<i>Post-test</i>	0,117	15	0,028
Pineapple Skin Extract	<i>Pre-test</i>	0,164	15	0,028
	<i>Post-test</i>	0,212	15	0,045
Aquadest	<i>Pre-test</i>	0,187	15	0,015
	<i>Post-test</i>	0,172	15	0,011

From table 3, it is known that data is not normally distributed ( $p$  value  $<0.05$ ), then it is followed by the Wilcoxon test to find out whether there is an effect of using mouthwash on the number of Attin plaque indexes before and after treatment. *Wilcoxon test* results can be seen in table.4.

Table 4. Average Value of Attin Plaque Index Before (*Pre-Test*) and After (*Post-Test*) in Treatment and Control Group

Attin Plaque Index Value		Mean $\pm$ SD	<i>P Value</i>	N
Banana Skin Extract	<i>Pre-test</i>	43.58 $\pm$ 11.58	0,001*	15
	<i>Post-test</i>	22.14 $\pm$ 11.30		
Pineapple Skin Extract	<i>Pre-test</i>	21.52 $\pm$ 10.85	0,001*	15
	<i>Post-test</i>	10.74 $\pm$ 6.91		
Aquadest	<i>Pre-test</i>	34.99 $\pm$ 16.80	0,004*	15
	<i>Post-test</i>	34.04 $\pm$ 17.54		

Description : \**Wilcoxon Test*, Significance =  $p < 0.05$

Based on table 4 it is known that there was a significant decrease in the average value of the plaque index in all three groups. Statistical tests showed the result of the value  $p = 0.001$ , in both groups that received treatment, while the control group obtained the value  $p = 0.004$ . this indicates that in the treatment group the results had a higher meaning value than the control group.

So gargling with aquadest is able to lower the plaque index, but not as good as using mouthwash banana peel extract and pineapple peel extract.

Then to find out the best type of mouthwash for reducing the attin plaque index, first performed a normality test on the average value of the difference in plaque index before (*pre-test*) and after (*post-test*) treatment on banana peel extract group and pineapple peel extract.

Table 5. Test normality with *Shapiro-Wilk* attin plaque difference in treatment and control group

Attin Plaque Difference (pre-test and post-test)	<i>Shapiro-wilk</i>		
	Statistics	Df	Sig.
Banana Skin Extract	0,270	15	0,011
Pineapple Skin Extract	0,262	15	0,020

Table 5 known that data of values on the measurement of the difference in attin plaque index before and after treatment in the gargling group banana peel extract and pineapple peel extract distributed normally. Furthermore, a *One Way Anova test* was conducted to find out the best type of mouthwash in reducing attin plaque index. *One Way Anova test* results from both groups can be seen in table 6.

Table 6. Comparison of Attin's Plaque Index Value in The Mouthwash Group of Banana Peel Extract and Pineapple Peel Extract

Group	Mean ± SD	Median (Min-Max)	P Value	N
Banana Skin Extract	21.45 ± 2.42	22,22 (15-25)	0,000*	15
Pineapple Skin Extract	10.77 ± 5.84	8,33 (4,17-24,07)		15

Description : \**One Way Anova*, Significance =  $p < 0.05$

Based on table 6, it was seen that the average difference in the value of *Attin's plaque index post-test and pre-test* in the group who used mouthwashes banana peel extract was much greater than the group who used pineapple peel extract mouthwashes. This means using mouthwashes banana peel extract is much more effective in reducing plaque than using pineapple peel extract mouthwashes. From the statistical test known value  $p = 0.000$  means there is a significant difference in the value of attin plaque index in the use of mouthwashes banana peel extract and pineapple peel extract.

Based on table 4 it is known that there was a significant decrease in the average value of the plaque index in all three groups. Statistical tests showed the result of the value  $p = 0.001$ , in both groups that received treatment, while the control group obtained the value  $p = 0.004$ . this indicates that in the treatment group the results had a higher meaning value than the control group. So gargling with aquadest is able to lower the plaque index, but not as good as using mouthwash banana peel extract and pineapple peel extract.

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Table 6. Comparison of Attin's Plaque Index Value in The Mouthwash Group of Banana Peel Extract and Pineapple Peel Extract

Group		Mean $\pm$ SD	Median (Min-Max)	P Value	N
Banana Extract	Skin	21.45 $\pm$ 2.42	22,22 (15-25)	0,000*	15
Pineapple Extract	Skin	10.77 $\pm$ 5.84	8,33 (4,17-24,07)		15

Description : \**One Way Anova*, Significance =  $p < 0.05$

Based on table 6, it was seen that the average difference in the value of *Attin's plaque index post-test and pre-test* in the group who used mouthwashes banana peel extract was much greater than the group who used pineapple peel extract mouthwashes. This means using mouthwashes banana peel extract is much more effective in reducing plaque than using pineapple peel extract mouthwashes. From the statistical test known value  $p = 0.000$  means there is a significant difference in the value of attin plaque index in the use of mouthwashes banana peel extract and pineapple peel extract.

#### 4. Discussion

Patients with fixed orthodontic appliance treatments have difficulty cleaning dental plaque using only a toothbrush, this is due to the complex arrangement of the fixed orthodontic appliance so that the toothbrush cannot clean the plaque formed in hard-to-reach areas of the toothbrush, such as the interdental area and on the edge area around the *bracket*. Plaque begins to form when bacteria are attached to the surface of the tooth by intercession pellicle derived from saliva. One by one bacteria will gather, so that early bacterial colonies begin to form. Colonies of bacteria attached to the surface of the teeth are mostly *Streptococcus* types, followed by other bacteria such as obligate aerobic bacteria and facultative anaerobic bacteria. An example of obligate aerobic bacteria are *Haemophilus spp.*, *Neisser*

*ia spp.*, while facultative anaerobic bacteria are *Actinomyces spp.* and *Veillonella spp.*

The early bacterial colonies eventually became the primary bacterial colonies, where they would form receptors used for the attachment of other bacteria so that plaques became mature with many variations of bacteria in them.<sup>(18)</sup> Accumulation of plaques containing many of these bacteria can cause caries and periodontal diseases that can lead to failure in the treatment of orthodontics. Plaques that accumulate should be prevented by mechanically controlling plaque (using toothbrushes and dental floss) and chemically (by using mouthwashes).<sup>(19)</sup>

Mouthwashes in the form of liquid preparations that have an antibacterial agent and can reach plaque on the tooth area that is difficult to clean with bristles toothbrush and dental floss. Mouthwashes inhibit the formation of plaques by bacterial control mechanisms.<sup>(20)</sup> Gargling using aquadest is proven to significantly reduce the remnants of debris in the oral cavity by dissolving some of the debris, which can ultimately reduce bacterial activity and cause reduced plaque accumulation.<sup>(21)</sup> In this study gargling with aquadest also proved statistically significant in lowering the plaque index of patients who used fixed orthodontic appliance, but using banana peel extract mouthwashes 2.5% and pineapple peel extract 6.24% proved much more meaningful in lowering the plaque index of patients who used fixed orthodontic appliance.

Gargling with mouthwashes banana peel extract 2.5% twice a day, that is, the

morning after breakfast and the night before going to bed at night. in seven days, it is proven to be effective in reducing the formation of plaque on the teeth significantly. These plaques can be controlled by bioactive substances such as *flavonoids*, *tannins*, *saponins*, and *terpenoids* contained in banana peel (*Musa paradisiaca var. sapientum*) inhibit the growth of bacteria that play a big role in the process of making plaque, resulting in reduced accumulation of dental plaque.<sup>(11)(22)(23)</sup> Similarly, the content of bioactive substances contained in mouthwashes pineapple peel extract 6.24%, such as *flavonoids*, *tannins*, *saponins*, and *bromelin*, is effective in inhibiting the growth of bacteria that play a role in the process of plaque formation.<sup>(9)(10)</sup>

*Flavonoids* have *phenol* structures that are generally produced by plants.<sup>(24)</sup> The way it works is by forming complex compounds through *hydrogen* bonds along with extracellular proteins of bacteria so that the structure of bacterial cell membrane walls consisting of *peptidoglikan* containing proteins becomes weak and bacterial cells undergo *lysis* and cell become dead.<sup>(25)</sup> *Flavonoids* can also inhibit the synthesis of *nucleic acids* in bacterial cells (as a result of inhibiting *topoisomerase*) and inhibit energy metabolism in bacteria inhibited *NADH-cytochrome c reductase* resulting in the life of disturbed bacterial cells.<sup>(26)</sup>

*Tannins* are a group of *phenolic polymeric* substances that work by inhibiting the growth and activity of bacterial cells. It worked by damaging the permeability of bacterial cell membranes, lowering the surface tension of bacterial cell walls, and inhibiting the activity of *protease* which is an enzyme for protein breakers in bacteria in the transport of proteins in bacterial cells, and making *adhesin* inactive in microbes.<sup>(27)(28)</sup> *Tannins* interfere with *peptidoglycan* syntheses resulting in the imperfect formation of bacterial cell

walls.<sup>(29)</sup> *Tannins* inhibit the multiplication and formation of bacterial cells so that bacteria cannot multiply, by disrupting the enzyme *reverse transcriptase* and *DNA topoisomerase*.<sup>(30)</sup>

*Saponins* have *hypocholesterolemic* activity (bonding with cholesterol) contained in bacterial cells, resulting in the *lysis* of bacteria. *Saponins* interfere with the permeability of bacterial cells, with fat dissolution mechanisms, resulting in reduced cell surface tension and resulting in bacterial cell death.<sup>(31)(23)</sup> *Saponins* can also damage bacterial cell walls because they have fungicidal activity, resulting in the leakage of proteins and enzymes in bacterial cells.<sup>(32)(10)</sup> *Saponins* diffuse and bind to the cytoplasmic membrane of bacterial cells so that the permeability of bacterial cells is reduced, resulting in cytoplasm exiting bacterial cells and the occurrence of bacterial cell death.<sup>(33)</sup>

*Terpenoids* as *phytochemical* compounds have antibacterial activity of the *isoprenoid* pathway produced by plants, by damaging the permeability of bacterial cell membranes and have proven to inhibit the growth of bacteria *S mutants*.<sup>(34)</sup> *Terpenoid* activity also affects *fungi*, *protozoa*, and *viruses*.<sup>(28)</sup>

*Bromelin* acts as a *proteolytic enzyme* in protein breakdown which is one of the important ingredients of bacterial cell membrane constituents.<sup>(10)(16)</sup> *Bromelin* works by denaturing proteins that build bacterial cell walls. This results in the weakening of the cell walls of bacteria so that bacteria can not develop because the growth is disturbed and over time bacterial cells will die.<sup>(10)</sup>

Mouthwashes of banana peel extract 2.5% proved more effective in inhibiting the formation of plaque in fixed orthodontic patients than the mouthwashes of pineapple peel extract 6.24%. The same antibacterial agent is contained in mouthwashes banana peel extract and pineapple peel extract, namely in *flavonoids*, *tannins*, and *saponins*, while different antibacterial agents are *terpenoids* contained in banana peel extract



mouthwashes and *bromelin* antibacterial agent contained in mouthwashes pineapple peel extract. *Terpenoids* and *bromelin* have an antibacterial mechanism with the same ultimate goal of weakening bacterial cell walls. However, there has been no research that proves which is more effective than the two in weakening bacterial cell walls. This study proved the synergism of antibacterial agents in mouthwashes of banana peel extract 2.5% better than mouthwashes of pineapple peel extract 6.24% in inhibiting the formation of plaque in fixed orthodontic patients.

## 5. Conclusion

Mouthwashes banana peel extract 2.5% and pineapple peel extract mouthwashes 6.24% effective in inhibiting the formation of plaque in fixed orthodontic patients. However, mouthwashes banana peel extract is much more effective in lowering plaque index than pineapple peel extract mouthwashes

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