

The effect of toothpaste containing gambier (*Uncaria gambir* Roxb.) 10% extract on decreasing dental plaque index: an experimental study

Aquila Haya Tuzzahra^{1*} 
Siti Rusdiana Puspa Dewi² 
Rina Meiliyanawaty³ 

¹Master's Program in Public Health,
Universitas Sriwijaya, Indonesia

²Department of Biomedical
Sciences, Faculty of Medicine,
Division of Dentistry and Oral
Medicine, Universitas Sriwijaya,
Indonesia

³Department of Periodontology
Faculty of Medicine, Division of
Dentistry and Oral Medicine,
Universitas Sriwijaya, Indonesia

*Correspondence

Email | zahrakuila@gmail.com

Submitted | 18 February 2026

Revised | 25 March 2026

Accepted | 14 April 2026

Published | 30 April 2026

DOI: [10.24198/ikg.v38i1.63633](https://doi.org/10.24198/ikg.v38i1.63633)

p-ISSN 0854-6002

e-ISSN 2549-6514

Citation | Tuzzahra AH, Dewi SRP, Meiliyanawaty R. The effect of toothpaste containing gambier (*Uncaria gambir* Roxb.) 10% extract on decreasing dental plaque index: an experimental study. J. Kedokt. Gigi Univ. 2026;38(1):94-101.

DOI: [10.24198/ikg.v38i1.63633](https://doi.org/10.24198/ikg.v38i1.63633)



Submitted to Jurnal Kedokteran Gigi Universitas Padjadjaran for possible open access publication under the terms and conditions of the Creative Commons Attribution (CC BY-NC 4.0) license (<https://creativecommons.org/licenses/by-nc/4.0/>)

ABSTRACT

Introduction: Dental plaque is a major etiological factor in various oral diseases, including dental caries and periodontitis, which are highly prevalent in Indonesia. Toothbrushing can reduce dental plaque accumulation through mechanical and chemical mechanisms. Gambier (*Uncaria gambir* Roxb.) has potential as an antibacterial agent in toothpaste because it contains catechins and tannins, which exhibit bacteriolytic and bacteriostatic activities. This study aimed to determine the effect of toothpaste containing 10% gambier (*Uncaria gambir* Roxb.) extract on the dental plaque index. **Methods:** This experimental study employed a pretest-posttest control group design and was conducted from January to March 2023. Sixty dental students from Sriwijaya University participated. The subjects were divided into two groups: a gambier toothpaste group and a fluoride toothpaste control group, with 30 subjects in each group. The subjects underwent a 21-day toothbrushing adaptation period using the Bass technique, after which the pretest plaque index was measured. Subjects then brushed their teeth for 2 minutes with either gambier toothpaste or fluoride toothpaste and fasted for 4 hours before the posttest plaque index was measured. The plaque index was assessed using the Turesky modification of the Quigley-Hein Plaque Index. We analyzed the data using paired and independent t-tests. **Result:** Both groups showed a significant reduction in the dental plaque index ($p < 0.05$). The mean difference between the pretest and posttest plaque indices was 0.677 in the 10% gambier extract toothpaste group and 0.270 in the fluoride toothpaste control group. The reduction in the dental plaque index was significantly greater in the gambier toothpaste group than in the fluoride toothpaste control group ($p < 0.05$). **Conclusion:** Toothpaste containing 10% gambier (*Uncaria gambir* Roxb.) extract significantly reduced the dental plaque index and demonstrated greater plaque-reducing effectiveness than the fluoride toothpaste used as the control.

Keywords

Gambier, plaque index, toothpaste

Efek penggunaan pasta gigi ekstrak Gambir (*Uncaria gambir* Roxb.) 10% terhadap penurunan indeks plak gigi: studi eksperimental

ABSTRAK

Pendahuluan: Plak gigi merupakan penyebab utama berbagai penyakit rongga mulut, seperti karies dan periodontitis, yang merupakan penyakit rongga mulut dengan prevalensi tertinggi di Indonesia. Menyikat gigi dengan pasta gigi dapat mengurangi akumulasi plak gigi melalui metode mekanis dan kimiawi. Gambir (*Uncaria gambir* Roxb.) berpotensi sebagai antibakteri pada pasta gigi karena memiliki kandungan utama katekin dan tanin, yang bersifat bakteriolisis dan bakteriostatik. Penelitian ini bertujuan untuk menganalisis efek penggunaan pasta gigi ekstrak gambir (*Uncaria gambir* Roxb.) 10% terhadap penurunan indeks plak gigi. **Metode:** Penelitian eksperimental dengan desain pretest-posttest with control group, dilaksanakan bulan Januari – Maret 2023, dengan subjek sebanyak 60 orang mahasiswa Kedokteran Gigi Universitas Sriwijaya. Subjek dibagi menjadi 2 kelompok, yaitu kelompok pasta gigi gambir dan kelompok kontrol fluoride, dengan subjek sebanyak 30 orang untuk tiap kelompok. Subjek melakukan adaptasi cara menyikat gigi menggunakan teknik Bass selama 21 hari, lalu dilakukan pengukuran skor indeks plak pretest. Subjek menyikat gigi selama 2 menit menggunakan pasta gigi ekstrak gambir 10% atau fluoride, lalu berpuasa selama 4 jam sebelum dilakukan pengukuran skor indeks plak posttest. Skor indeks plak diukur menggunakan indeks plak Turesky-Glimore-Glickman modifikasi Quigley-Hein, dengan analisis data menggunakan uji t-test berpasangan & tidak berpasangan. **Hasil:** Terdapat penurunan indeks plak gigi ($p < 0,05$) pada kedua kelompok, dengan rerata penurunan 0,677 untuk kelompok pasta gigi gambir, dan 0,27 untuk kelompok pasta gigi kontrol fluoride. Penurunan indeks plak gigi pada kelompok pasta gigi gambir lebih besar dibandingkan dengan kelompok kontrol fluoride. **Simpulan:** Pasta gigi ekstrak gambir (*Uncaria gambir* Roxb.) 10% dapat menurunkan indeks plak gigi.

Kata kunci

Gambir, indeks plak, pasta gigi

INTRODUCTION

Dental plaque is an accumulation of various microorganisms that adhere to the tooth surface.¹ Plaque accumulation can hinder the neutralization of the oral cavity by saliva, resulting in an acidic pH.^{1,2} Under acidic oral conditions, plaque bacteria can colonize more readily, resulting in tooth demineralization, which is an indicator of dental caries. In addition to causing dental caries, plaque accumulation can also contribute to halitosis, or bad breath. This occurs because plaque bacteria produce volatile sulfur compounds (VSCs), which emit an unpleasant odor even at low concentrations.³ Plaque bacteria, such as *Porphyromonas gingivalis*, *Prevotella intermedia*, and *Fusobacterium nucleatum*, also produce metabolites that trigger inflammation, leading to gingivitis. If left untreated, gingivitis can progress to periodontitis.⁴

The 2018 Basic Health Research (RISKESDAS) reported that the prevalence of dental caries and periodontitis in Indonesia remained high, at 88.8% and 74.1%, respectively.⁵ Preventive measures are therefore necessary to reduce this prevalence by limiting plaque formation, which is a primary etiological factor in these diseases. One effective way to prevent plaque accumulation is toothbrushing with toothpaste, as toothpaste contains antibacterial agents that can inhibit the growth of plaque-associated bacteria.

These antibacterial agents can come from herbal or non-herbal sources. Several studies report that non-herbal agents, such as triclosan, may cause adverse effects, including oral cavity irritation, altered taste perception, and reduced salivary flow rates.^{6–10} According to Wulandari et al., herbal toothpaste provides an alternative approach for reducing plaque accumulation and is considered safe because it contains natural ingredients.¹¹ One herbal ingredient with antibacterial properties is gambier.^{12,13}

Various studies have demonstrated gambier's antibacterial effects.^{1,6,14,15} Research by Achmad et al. indicated that gambier effectively inhibited several microorganisms, including *Streptococcus mutans*, *Staphylococcus aureus*, *Escherichia coli*, and *Candida albicans*.¹ In their study, Dewi et al. reported that gambier extracts at concentrations of 10%, 15%, and 20% were effective in reducing bacterial colony counts in gingival wounds of Wistar rats.¹⁶

A study by Apriliati et al. reported that toothpaste containing gambier extract reduced dental plaque in a sample of 33 individuals undergoing fixed orthodontic treatment.¹⁷ Consistent with these findings, Nurhayati et al. reported that toothpaste supplemented with 5% gambier catechins reduced the dental plaque index in a study involving 44 participants.¹⁸

Although gambier's antibacterial potential has been widely reported, most studies have focused on in vitro testing. Meanwhile, clinical studies remain limited in both number and population scope. Some studies have involved specific populations, such as patients undergoing fixed orthodontic treatment, so their findings cannot yet be fully generalized to the broader population.

Furthermore, research on the effectiveness of toothpaste containing 10% gambier extract in reducing the dental plaque index remains very limited. Therefore, this study aimed to provide clinical evidence on the effectiveness of toothpaste containing 10% gambier (*Uncaria gambir* Roxb.) extract in reducing the dental plaque index. The study also aimed to provide additional clinical evidence supporting gambier's potential as a safe and effective herbal antibacterial agent for preventing dental plaque accumulation.

Based on this background, the present study provides a novel contribution by clinically evaluating the effectiveness of toothpaste containing 10% gambier (*Uncaria gambir* Roxb.) extract in reducing the dental plaque index in a general population, thereby providing a scientific basis for the potential use of gambier as herbal antibacterial agent for dental plaque prevention.

METHOD

This study used an experimental pretest–posttest design with a control group. It was conducted from late January to March 2023. The study sample consisted of 60 dentistry students from Sriwijaya University. The sample size was determined based on statistical considerations, with a minimum of 30 participants per group considered adequate to obtain stable estimates and approximate a normal distribution.

Participants were selected based on the following inclusion criteria: third- or fourth-year dentistry students at Sriwijaya University; aged 20–23 years; willing to participate; physically and mentally healthy; having a Turesky plaque index ranging from moderate to poor; and being caries-free or having caries limited to the enamel. Exclusion criteria included undergoing orthodontic treatment; smoking or consuming alcohol; being uncooperative; having an allergy to herbal products; consuming food or beverages within 4 hours before posttest data collection; fasting; or having severe dental crowding, as determined through questionnaires and clinical examinations.

Participants who met the eligibility criteria signed an informed consent form. They were then randomly assigned to one of two groups: a treatment group that brushed with gambir (pale catechu) toothpaste and a control group that brushed with fluoride toothpaste. We assigned groups using simple randomization and a single-masked method.

Before the intervention, participants received instruction on the Bass toothbrushing technique and practiced it for 21 days. We selected these 21 days to allow participants to adapt to the correct toothbrushing technique. The operator taught the Bass technique through direct instruction and by showing the same instructional video to all participants. Subsequently, each participant was required to demonstrate the technique until their performance was considered consistent with the established procedure. Over the 21 days, the researcher monitored participant compliance through periodic reminders.

The researcher prepared the gambir toothpaste after preparing the gambir extract. The Soxhlet method was used for extraction. A total of 60 g of gambir powder, which had been sieved through a 40–60 mesh sieve, was placed into the Soxhlet extraction chamber. The apparatus was filled with 300 mL of 96% ethanol and heated for 7 hours until the solvent became clear. The resulting solution was subsequently evaporated to obtain a 100% gambir extract, which was then diluted to obtain a 10% gambir extract.

After the 10% gambir extract had been obtained, the toothpaste was prepared as follows: (1) Na-CMC was mixed with hot water to prepare Mass 1; (2) sodium bicarbonate, sodium benzoate, and glycerin were mixed until homogeneous to prepare Mass 2; (3) Mass 1 and Mass 2 were combined and stirred until homogeneous, followed by the addition of saccharin and distilled water; (4) SLS was added to the mixture, followed by either the 10% gambir extract or fluoride, depending on the intended toothpaste formulation; and (5) the resulting mixture was homogenized, subjected to a homogeneity test, and packaged in identical containers labeled with codes known only to the researchers to distinguish between the gambir toothpaste and fluoride toothpaste.^{11,12}

We conducted a homogeneity test by spreading the paste onto a glass slab. The paste was considered homogeneous if no coarse granules were observed during the examination. All ingredients used in the formulation of the 10% *Uncaria gambir* Roxb. extract toothpaste was of toothpaste-grade or food-grade quality.

Dental plaque index measurements were performed directly by a single examiner using the Turesky-Gilmore-Glickman modification of the Quigley-Hein plaque index. A disclosing agent was applied to the facial and lingual surfaces of all teeth, after which each surface was scored on a scale of 0 to 5 according to the specified index criteria. After scoring all tooth surfaces, the dental plaque index was calculated by summing the total scores and dividing by the number of surfaces examined. The resulting scores were

then interpreted according to the criteria of the Turesky-Gilmore-Glickman modification of the Quigley-Hein plaque index.

Data analysis included the Kolmogorov-Smirnov normality test and Levene's homogeneity test for univariate analysis, as well as paired and unpaired t-tests for bivariate analysis.

Results

We randomly assigned 60 participants who met the inclusion and exclusion criteria to two equal-sized groups using simple randomization: the 10% gambir extract toothpaste group (n=30) and the fluoride toothpaste group (n=30). Regarding age distribution, the gambir extract toothpaste group was predominantly composed of participants aged 20 years (60.0%), whereas the fluoride toothpaste group was predominantly composed of participants aged 18 years (40.0%). In addition, most participants in both groups were female.

Table 1. Distribution of the characteristics of the study subjects according to treatment

Toothpaste	Gender		Age			
	Male	Female	19	20	21	22
Gambir	3	27	3	18	9	0
Fluoride	0	30	12	10		8
Total	3	57	15	28	9	8

Kolmogorov-Smirnov normality tests showed that the pretest data ($p=0.066$), posttest data ($p=0.200$), and differences in plaque index scores ($p=0.200$) all had p -values >0.05 , indicating normally distributed data. Furthermore, Levene's test showed $p=0.067$ for the pretest data, $p=0.486$ for the posttest data, and $p=0.196$ for the differences in plaque index scores (all $p>0.05$), indicating homogeneous variances between groups. The results of these two tests are presented in Tables 1 and 2.

Table 2. Results of the Kolmogorov-Smirnov and Levene's normality and homogeneity tests for pretest, posttest, and changes in dental plaque index in the Gambir toothpaste and fluoride toothpaste groups

Toothpaste	n	Mean	SD	p-value	Asymp. Sig.
Pretest	60	1.52307	0.404509		0.066
Posttest	60	1.04925	0.324299	>0.05	0.200
Change	60	0.47382	0.362040		0.200

Table 3. Results of Levene's homogeneity test for pretest, posttest, and changes in dental plaque index in the Gambir toothpaste and fluoride toothpaste groups

Toothpaste	Mean	Median	SIG	p-value
Pretest	3.479	3.322	0.67	
Posttest	0.492	0.431	0.486	>0.05
Change	1.709	1.786	0.196	

Bivariate analysis using a paired t-test to compare mean pre-test and post-test plaque index scores yielded a p -value <0.05 for both groups, indicating a significant difference between mean pre-test and post-test plaque index scores. Table 2 presents the paired t-test results.

Table 4. Results of the paired t-test comparing pretest and posttest dental plaque index in the Gambir toothpaste and fluoride toothpaste groups

Toothpaste		n	Min-Max	Mean	SD	p-value
Gambir	Pretest	30	1.011-2.874	1.62	0.472	<0.05
	Posttest	30	0.285-1.785	0.943	0.346	
Fluoride	Pretest	30	1.003-2.234	1.425	0.299	<0.05
	Posttest	30	0.642-1.714	1.155	0.265	

DISCUSSION

Maintaining oral hygiene through regular toothbrushing with toothpaste helps prevent various oral diseases caused by dental plaque. In addition to the mechanical action of toothbrushing, plaque accumulation can also be reduced through the chemical effects of the active ingredients contained in toothpaste.

In this study, we assessed the effect of toothpaste use on the dental plaque index by comparing pretest and posttest plaque index scores. We considered toothpaste use to affect the dental plaque index when we observed a statistically significant difference ($p < 0.05$) between pretest and posttest scores.¹⁸ According to Sugiyono, studies using a pretest–posttest control group design yield more accurate results than other study designs because this design allows baseline values to be determined before the intervention, enabling comparison with post-intervention values and helping to determine whether the observed differences resulted from the intervention itself.¹⁹

The results indicated that both 10% gambir extract (*Uncaria gambir* Roxb.) toothpaste and fluoride toothpaste reduced the dental plaque index. The effect observed with gambir toothpaste was consistent with the study by Apriliati et al., which involved 33 Faculty of Dentistry students at Universitas Airlangga who wore fixed orthodontic appliances. The study reported that, after using gambir toothpaste, 63.6% of subjects had a plaque index in the "low" category.¹⁷ Similarly, in the present study, 76.6% of the subjects showed an improvement in their mean dental plaque index from the "moderate" category to the "low" category after using gambir toothpaste.

A higher proportion of subjects in the present study experienced a reduction in the dental plaque index compared with the study by Apriliati et al., possibly because the subjects in the latter study wore fixed orthodontic appliances. Fixed orthodontic appliances consist of various components, such as brackets and wires, with complex structures that can increase the risk of plaque accumulation and make plaque removal more difficult.²⁰ Gambir may reduce the dental plaque index because it contains key compounds, particularly catechins and tannins, which inhibit the growth and proliferation of plaque-associated bacteria.^{6,12,13} Catechins act as antibacterial agents by inhibiting the enzyme glucosyltransferase, thereby suppressing extracellular polysaccharide formation. Reduced glucan production inhibits bacterial adhesion to tooth surfaces, thereby preventing bacterial colonization and limiting nutrient acquisition.^{13,15,16,20} In addition, catechins can alter bacterial membrane permeability, leading to bacteriolysis.^{15,16} Another antibacterial component found in gambir is tannin. Tannins can interact with bacterial proteins and cell components, disrupting the structure and integrity of the bacterial cell membrane and ultimately causing bacteriolysis.^{16,21,22}

Paired t-test results comparing the pretest and posttest values for the fluoride toothpaste group showed a significant difference ($p < 0.05$), with a plaque index reduction of 0.27. Fluoride toothpaste can reduce the dental plaque index because fluoride exhibits antibacterial properties. It can be converted into hydrated fluoride, which penetrates bacterial cells and causes cytoplasmic acidification.²³ These findings were supported by research conducted by Anggina and Ramayati, who reported that the use of fluoride toothpaste, despite lacking herbal ingredients, could reduce the dental plaque index.²⁴

Data analysis using an unpaired t-test of plaque index reduction values in each group revealed a significant difference between the 10% gambir toothpaste and fluoride toothpaste groups in plaque index reduction. The 10% gambir toothpaste showed a greater mean difference between pretest and posttest plaque index scores than fluoride toothpaste ($p < 0.05$). This finding indicated that 10% gambir extract toothpaste was more effective than fluoride toothpaste in reducing the dental plaque index. These results were consistent with a study by Nurhayati et al., which reported that gambir toothpaste among 44 subjects reduced the dental plaque index more effectively than the control toothpaste.¹⁴

The difference between the pretest and posttest plaque index scores in the fluoride toothpaste group was smaller than that observed in the gambir toothpaste group. This may have occurred because fluoride's antibacterial activity is more effective against Gram-negative bacteria, such as *Escherichia coli*, *Actinobacillus actinomycetemcomitans*, and *Porphyromonas gingivalis*, than against Gram-positive bacteria, such as *Streptococcus mutans* and *Streptococcus salivarius*, particularly under low-pH conditions.²⁵⁻²⁸ During the initial phase of plaque formation, aerobic Gram-positive species such as *Streptococcus oralis*, *Streptococcus mutans*, and *Streptococcus salivarius* predominate. In contrast, anaerobic Gram-negative bacteria generally appear later during the bacterial co-aggregation phase or secondary colonization.²⁹

According to SNI 8861-2020, toothpaste is considered compliant with the Indonesian National Standard (SNI) if it meets specific requirements for pH, heavy metal contamination, microbial contamination, free fluoride, free formaldehyde, homogeneity, organoleptic properties, and sucrose content.³⁰ In this study, testing was limited to homogeneity, organoleptic properties, and pH because the equipment and materials required for the other tests were not available at the research site.

One observation regarding the use of 10% gambir (pale catechu) toothpaste was that some subjects reported a slightly bitter taste, which made it somewhat uncomfortable to use. This bitterness may have resulted from the gambir content, particularly catechu tannate, which can impart a bitter taste when heated or combined with alkaline compounds. Because this study did not incorporate additional flavoring or sweetening agents, the catechu tannate's bitterness remained pronounced, causing discomfort for some participants.

Using 10% gambir toothpaste reduced the dental plaque index, as shown by the difference between pretest and posttest scores. These findings indicate that 10% gambir toothpaste has potential as an herbal-based alternative to conventional toothpaste. A limitation of this study was that the toothpaste had not yet been fully evaluated according to the Indonesian National Standard (SNI) quality requirements. Therefore, further testing in accordance with SNI 8861-2020 is needed to ensure product quality and support the development of a more effective, user-friendly formulation. This study may serve as a basis for future research to develop and optimize gambir toothpaste further.

CONCLUSION

Both 10% *Uncaria gambir* Roxb. (gambir) toothpaste and fluoride toothpaste were effective in reducing the dental plaque index ($p < 0.05$). However, 10% *Uncaria gambir* Roxb. toothpaste demonstrated a greater reduction in the plaque index than fluoride toothpaste, indicating greater effectiveness in reducing dental plaque. These findings suggest that gambir has potential as an herbal antibacterial agent for use in toothpaste. Further development is needed to ensure compliance with the SNI 8861-2020 quality standards and to improve the formulation's organoleptic properties, thereby producing a more effective and user-friendly toothpaste.

Acknowledgement: None

Author Contributions: Conceptualization, AH and SR; methodology, AH; software, AH; validation, SR and R; formal analysis, AH; investigation, SR and R; resources, AH; data curation, AH; writing-original draft preparation, AH; writing-review and editing, AH; visualization, AH; supervision, SR and R; project administration, SR; funding acquisition, AH. All authors have read and approved the published version of the manuscript.

Funding: This research did not receive any external funding or grants.

Ethical Approval: This study was conducted in accordance with the Declaration of Helsinki and was approved by the Ethics Committee of the Faculty of Medicine, Universitas Sriwijaya (No. 011-2023, dated January 17, 2023).

Institutional Review Board Statement: Not applicable

Informed Consent Statement: Informed consent was obtained from all subjects involved in this study.

Data Availability Statement: The complete supporting data for the findings of this study are available at <https://repository.unsri.ac.id/105555/>

Conflict of Interest: The authors declare no conflict of interest.

REFERENCES

1. Achmad H, Rieuwpassa IE, Djais AI, Riyanti E, Primarti RS, Ilham AI. Gambier extract (*Uncaria gambier* Roxb.) as herbal treatment for the oral cavity: a systematic review. *J Syst Rev Pharm.* 2021;12(2):414-419. <https://doi.org/10.31838/srp.2021.2.56>
2. Newman MG, Klokkevold PR, Elangovan S, Kapila Y. Newman and Carranza's Clinical Periodontology and Implantology. 14th ed. St. Louis (MO): Elsevier; 2023.
3. Das RS, Dange PJ, Dange DG, Chendke PR. Formulation and evaluation of toothpaste with herbal ingredient. *Int J Novel Res Dev.* 2024;9(5):d844-d850.
4. Kwon D, Park J, Kim J, Lee H, Choi Y. *Fusobacterium nucleatum* and *Treponema denticola* are robust biomarkers for gingivitis and periodontitis in small dogs. *Front Vet Sci.* 2025;11:1515521. <https://doi.org/10.3389/fvets.2024.1515521>
5. Badan Penelitian dan Pengembangan Kesehatan. *Riskesdas 2018*. Jakarta: Lembaga Penerbit Badan Penelitian dan Pengembangan Kesehatan; 2018. p. 674.
6. Nilasary RS, Chintami SP. Pasta gigi ekstrak etanol daun sirih, biji pinang, gambir terhadap hambatan bakteri *Pseudomonas aeruginosa*. *J Ilmu Kedokt Gigi.* 2020;3(2):6-13. <https://doi.org/10.23917/iikg.v3i2.12349>
7. Sabri H, Khorsand A, Ebrahimi H, Nikfarjam J, Khaghani Z, Abbasi M, et al. The yin and yang of sodium lauryl sulfate use for oral and periodontal health: a literature review. *J Dent (Shiraz).* 2023;24(3):262-276. <https://doi.org/10.30476/dentjods.2022.95108.1836>
8. Wawo EB, Wowor PM, Siagian KV. Uji pengaruh penggunaan pasta gigi dengan kandungan detergen sodium lauryl sulfate terhadap kecepatan alir saliva pada masyarakat di Desa Walantakan. *Pharmacon J Ilm Farm.* 2016;5(4):46-51. <https://doi.org/10.35799/pha.5.2016.13973>
9. Setiadi R. Efek penggunaan produk perawatan gigi dan mulut yang dijual bebas (OTC) pada mukosa oral. *J Mater Kedokt Gigi.* 2016;2(5):52-61.
10. De Groot A. Contact allergy to (ingredients of) toothpastes. *Dermatitis.* 2017;28(2):95-114. <https://doi.org/10.1097/DER.0000000000000255>
11. Wulandari LGPJ, Kusumadewi S, Sudirman PL. Perbandingan efektivitas penggunaan pasta gigi herbal dan non herbal terhadap penurunan indeks plak. *Bali Dent J.* 2020;4(1):49-53. <https://doi.org/10.51559/bdj.v4i1.239>
12. Ashadi RW. Uji efektivitas antimikroba pada ekstrak daun gambir (*Uncaria gambier* Roxb.) dan daun sirih hijau (*Piper betle* Linn.) terhadap *Streptococcus mutans*, *Escherichia coli* dan *Candida albicans*. *J Agroindustri Halal.* 2017;1(1):64-72. <https://doi.org/10.30997/jah.v1i1.375>
13. Dewi SRP, Handayani P, Anastasia D, Maulina ST. Antimicrobial potency of toothpaste containing gambir (*Uncaria gambier*) extract. *Padj J Dent.* 2023;35(2):98-105. <https://doi.org/10.24198/pjd.vol35no2.47130>
14. Nurhayati N, Ilmiawati C, Bambang B. Pengaruh pasta gigi yang mengandung katekin gambir (*Uncaria gambier* Roxb.) terhadap penurunan indeks plak gigi. *Andalas Dent J.* 2020;8(2):57-63. <https://doi.org/10.25077/adj.v7i2.144>
15. Musdja Y, Hapsari A, Agusta A. Comparison of activity and inhibitory mechanism between (+)-catechin and water extract of gambier (*Uncaria gambier* Roxb.) against some bacteria. *Sci J PPI UKM.* 2017;4:55-60. <https://doi.org/10.27512/sjippi-ukm/se/a29012018>
16. Dewi SRP, Pratiwi A, Teodorus. The effect of gambier extracts (*Uncaria gambier* Roxb.) as antiseptic on gingival wound in rats. *Odonto Dent J.* 2018;5(1):80-87. <https://doi.org/10.30659/odj.5.1>
17. Apriliati E, Goenharto S, Sjamsudin J. Pasta gigi antibakteri dari tanaman gambir (*Uncaria gambier* Roxb.) sebagai penghambat pertumbuhan plak pada pemakai peranti ortodonti cekat. *Orthod Dent J.* 2017;3(2):17-22.
18. Saputra DN, Novita S, Listyaningrum, Asnah, Rokhayati T. Buku ajar metodologi penelitian. Jakarta: CV Feniks Muda Sejahtera; 2022. p. 83.
19. Sugiyono. Metode penelitian kuantitatif, kualitatif, dan R&D. 2nd ed. Jakarta: Alfabeta; 2017. p. 334.
20. Sulistyanti AD, Kamelia E, Miko H, Ambarwati T, Setiana R. Mengunyah buah apel Royal Gala terhadap pembentukan plak dan derajat keasaman saliva pada siswa kelas VI SDIT Assunnah Kota Cirebon. *J Dent Hyg Ther.* 2021;2(1):27-33. <https://doi.org/10.36082/jdht.v2i1.214>
21. Puspita PA, Lendrawati, Kustastiningtyastuti D. Perbedaan efektivitas berkumur larutan madu dan larutan teh hijau terhadap penurunan indeks plak. *Andalas Dent J.* 2020;8(2):83-88. <https://doi.org/10.25077/adj.v8i2.203>
22. Sapara TU, Waworuntu O, Juliatri. Efektivitas antibakteri ekstrak daun pacar air (*Impatiens balsamina* L.) terhadap pertumbuhan *Aggregatibacter actinomycetemcomitans*. *Pharmacon J Ilm Farm.* 2018;5(4):2019-2022. <https://doi.org/10.35799/pha.5.2016.13968>

23. Mandalas HY, Aini N, Edinata K. Perbandingan efektivitas berkumur dengan chlorhexidine dan obat kumur yang mengandung daun sirih (*Piper betle*) terhadap penurunan indeks plak pasien pengguna alat ortodontik cekat. *Sound Dent.* 2022;6(2):45-57. <https://doi.org/10.28932/sod.v6i2.3459>
24. Anggina DN, Ramayanti I. Perbandingan efektivitas berbagai jenis pasta gigi bahan herbal dan pasta gigi bahan non herbal terhadap pembentukan plak. *Syifa Med J.* 2018;9(1):1-9. <https://doi.org/10.32502/sm.v9i1.1338>
25. Pradiptama Y, Purwanta M, Notopuro H. Antibacterial effects of fluoride in *Streptococcus mutans* growth in vitro. *Biomol Health Sci J.* 2019;2(1):1-3. <https://doi.org/10.20473/bhsj.v2i1.13232>
26. Braga AS, Abdelbary MMH, Kim RR, Melo FPSR, Saldanha LL, Dokkedal AL, et al. The effect of toothpastes containing natural extracts on bacterial species of a microcosm biofilm and on enamel caries development. *Antibiotics.* 2022;11(3):1-14. <https://doi.org/10.3390/antibiotics11030414>
27. Marinho VT, dos Reis AC, da Costa Valente ML. Efficacy of antimicrobial agents in dentifrices: a systematic review. *Antibiotics (Basel).* 2022;11(10):1413. <https://doi.org/10.3390/antibiotics11101413>
28. Nelson JW, Plummer MS, Blount KF, Ames TD, Breaker RR. Small molecule fluoride toxicity agonists. *Chem Biol.* 2015;22(4):527-534. <https://doi.org/10.1016/j.chembiol.2015.03.016>
29. Kasuma N. *Plak Gigi*. Padang: Andalas University Press. 2016. h. 44.
30. Pujiastuti P, Arina YMD, Praharani D, Wahyukundari MA, Sakinah NN, Sari DS. Kajian kesesuaian cemaran logam berat dalam pasta gigi ekstrak biji kopi robusta berdasarkan Standar Nasional Indonesia 8861:2020: Studi eksperimental. *J Ked Gi.* 2025;37(3):335-342. <https://doi.org/10.24198/jkg.v37i3.61265>