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Karamunting Fruit Gel as a Natural Dental Plaque Disclosing Solution

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ABSTRACT

Introduction: Dental and oral health issues remain a global challenge, with rising dental caries cases, particularly in regions like Sub-Saharan Africa and Indonesia, where 57.6% of the population is affected. Among Indonesian children aged 3-9, caries and toothache are prevalent, highlighting the need for early plaque detection and targeted interventions. This study aims to evaluate the effectiveness of disclosing solution gel formulated from Karamunting fruit (*Melastoma malabathricum L.*) as a dental plaque identifier in children attending the Special Education School under the Surabaya Foundation for Children with Disabilities.
Methods: This study utilized a quasi-experimental design using a post-test with a control group framework. A total of 24 respondents were selected through random sampling and divided into four groups. The first three groups were given Karamunting fruit gel at concentrations of 7.5%, 10%, and 12.5% respectively, while the fourth group received a chemically-based disclosing solution as the control. This design allowed for a comparative analysis of the effectiveness of the natural and chemical formulations in detecting dental plaque.
Results: The result of the analysis, conducted by using Kruskal-Wallis revealed a p-value of 0.004 (<0.05) indicating a statistically significant effectiveness among Karamunting gel concentrations of 7.5%, 10%, and 12.5% when compared to chemically-based disclosing solution. These findings demonstrate that Karamunting gel is effective in identifying dental plaque, with its efficacy varying significantly according to the concentration used.
Conclusion: The disclosing solution gel derived from Karamunting fruit (*Melastoma malabathricum L.*) showed a potential as an effective alternative for dental plaque notification.

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INTRODUCTION

Dental and oral health problems continue to be significant global public health concerns, with dental caries being a primary issue (1-10). Based on the Global Burden of Disease Study in 2019, there's a steady increase of caries cases due to demographic and epidemiological factors. The epidemiology of caries varies across countries and is classified based on age-standardised prevalence rates in 2019, and the average annual percentage change since 1990. While the overall prevalence of caries in permanent and primary teeth has decreased by 3.6%, the population growth especially in Sub-Saharan Africa has driven an increase in the total number of cases (10,11).

In developed countries, the prevalence of caries in permanent teeth is generally lower than in developing countries. However, primary tooth caries is more widespread in developed countries, except among high sociodemographic groups, which experience the lowest 90 prevalence. In 2019, there were 64.6 million cases of permanent tooth caries and 62.9 million cases of primary tooth caries worldwide, representing a global proportion of 3.2% and 12.1% respectively. These figures underscore the persistent challenge caries to public health and emphasize the necessity to enhance the prevention strategies (10,11).

In Indonesia, dental and oral health issues are widespread, with a prevalence of 57.6% recorded in 2019 (12). Data from East Java, collected through the Basic Health Research (Riskesdas) in 2018) revealed that caries affects 37.61% of children aged 3-4 years and 49.88% of children aged 5-9 years (13). Children with disabilities are particularly vulnerable, a study conducted at Special Education School under the Surabaya Foundation for Children with Disabilities reported an average Debris Index (DI) score of 2.05, indicating poor oral hygiene. This is nearly twice as severe as the oral health status of non-disabled individuals (14,15).

The primary issue of dental caries is the cause of poor oral hygiene, which fosters the growth of Streptococcus mutans, a bacterium which responsible for plaque formation. Plaque is a soft biofilm composed of microorganisms, that accumulate on inadequately cleaned tooth surfaces, accelerating the demineralization process, ultimately leading to tooth (16,17,18). Early detection of plaque is essential for preventing caries progression. Chemical disclosing solutions are commonly used to detect plaque, but prolonged use of these agents such as erythrosine, poses health risks, including carcinogenic potential and allergic reactions. Consequently, researchers are exploring herbal alternatives, one of which is the fruit of Karamunting (*Melastoma malabathricum L.*) that known for its potential as a natural disclosing solution.

Several prior studies have demonstrated the effectiveness of natural substances as alternatives to chemical disclosing solutions to detect dental plaque. Fatmasari et al. (19) found that beetroot extract exhibited superior efficacy in plaque detection compared to chemical solution. Natural alternatives, such as beetroot and mulberry, have also been explored. Laela et al. (20) highlighted the potential of mulberry (*Morus alba L.*) juice as a natural disclosing agent, while Said et al. (21) demonstrated the effectiveness of gels derived from super red dragon fruit (*Hylocereus costaricensis*) and purple sweet potato. Additionally, karamunting fruit has been found to contain bioactive compounds like anthocyanins and flavonoids (22,23). These findings contribute to the development of alternative natural disclosing solutions for dental plaque detection, offering a different mechanism from previously studied options like beetroot, mulberry, and purple sweet potato extracts. This study aims to investigate the efficacy of Karamunting (*Melastoma malabathricum L.*) fruit gel as a disclosing solution for plaque detection.

METHOD

This study employs a quasi-experimental method to evaluate the effectiveness of Karamunting (*Melastoma malabathricum L.*) fruit gel as a dental plaque identifier. The experimental group was subjected to specific treatments, while the control group received no treatment. A post-test with a control group design was utilized, wherein the outcomes were measured after the intervention.

Population and Sample/Informants

The study population included all students in the Surabaya Foundation for Children with Disabilities (Sekolah Luar Biasa Yayasan Pembinaan Anak Cacat Surabaya), consisting of 64 individuals. From the population, a sample of 24 respondents was selected for dental plaque assessment. The respondents were divided into four groups. The inclusion criteria required participants to have at least two index teeth and provide informed consent, while the exclusion criteria ruled out individuals with fewer than two index teeth or allergies to the dye substances used in the treatment. The sampling technique in this study used random sampling.

Research Location

For staining of Staphylococcus aureus bacteria, this study was conducted at Laboratorium Health Polytechnic of Health Ministry Denpasar and the application on the teeth is done on children Surabaya Foundation for Children with Disabilities (Sekolah Luar Biasa Yayasan Pembinaan Anak Cacat Surabaya) Moreover, the patient's personal information was kept confidential and unidentifiable throughout the study.

Instrumentation or Tools

Dental plaque levels were measured using the Debris Index (DI), calculated based on plaque accumulation on specific index teeth representing various dental segments. The selected teeth and corresponding surfaces were as follows: 16 buccal surfaces, 11 labial surfaces, 26 buccal surfaces, 36 buccal surfaces, 31 labial surfaces, and 46 lingual surfaces. Plaque on the Debris Index score was calculated by summing the debris values on all teeth examined, then dividing by the number of teeth observed. Dental plaque categories were determined based on the Debris Index score, with criteria: good (0-0.6), moderate (0.7-1.8), and poor (1.9-3.0). The application procedure for karamunting gel was carried out after lunch. After eating, students were instructed not to rinse their mouths for five minutes. The four groups were then treated with either a chemical-based disclosing solution or a karamunting fruit gel disclosing solution at concentrations of 7.5%, 10%, and 12.5%. Plaque levels were assessed by calculating the Debris Index according to the specified categories. Finally, a comparison was made between the chemical-based disclosing solution and the karamunting gel disclosing solution at three different concentrations.

Data Collection Procedures

Quantitative data were collected through the application of disclosing materials written on the debris index assessment sheet in July 2024 at the Surabaya Foundation for Children with Disabilities (Sekolah Luar Biasa Yayasan Pembinaan Anak Cacat Surabaya).

Data Analysis

Statistical analysis to process and analysed data aimed at knowing the difference in intervention between the use of chemical-based disclosing solution and karamunting fruit gel disclosing solution with a sample of 24 respondents, was carried out using the Kruskal-Wallis test. This test is processed through a computer application program for Windows.

Ethical Approval

The study was approved by the Ethics Committee on August 09, 2024, with the number as follows No.EA/2822/KEPK-Poltekkes_Sby/V/2024; No. Protocol: 006722357821112202407010l0, from the Health Polytechnic of Health Ministry Surabaya, Indonesia and conducted in accordance with The Declaration of Helsinki.

RESULTS

Based on research that has been conducted to determine the effectiveness of *disclosing solution of Karamunting* fruit gel (*Melastoma malabathricum L.*) as an identifier of dental plaque conducted at the Special Education School under the Surabaya Foundation for Children with Disabilities in 2024, tables 1, 2 and 3 are obtained.

Table 1. Frequency distribution of index plaque staining criteria after application of the chemical-based *disclosing solution.*

Plaque Index Criteria (DI)	Application of Chemical-based Disclosing Solution	
	n	%
Good (0-0.6)	0	0%
Moderate (0.7-1.8)	1	16.67%
Poor (1.9-3.0)	5	83.33%
Total	6	100%

Table 1 shows that after the index plaque staining measurement was carried out by applying a chemical-based disclosing solution, the highest results obtained were in the poor criteria with a percentage of 83.33%.

Table 2. Frequency distribution of index plaque staining criteria after application of Karamunting fruit gel disclosing solution.

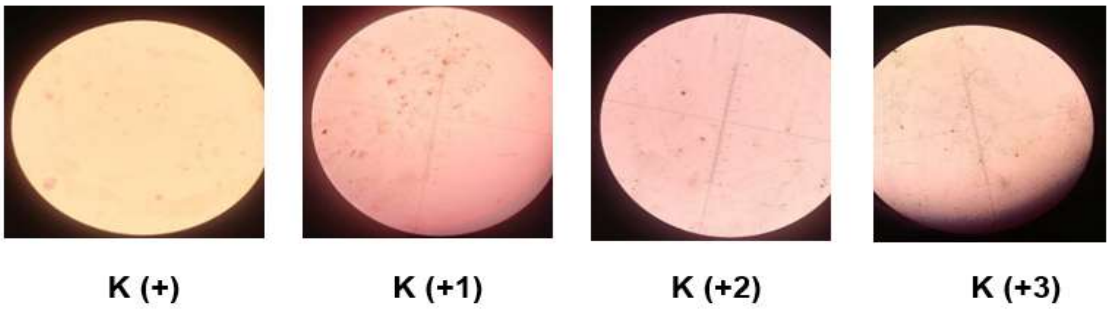
Plaque Index Criteria (DI)	**Application of 7.5% Karamunting Fruit Gel Disclosing Solution**	
	n	**%**
Good (0-0.6)	4	66.67%
Moderate (0.7-1.8)	2	33.33%
Poor (1.9-3.0)	0	0%
Total	6	100%
Plaque Index Criteria (DI)	**Application of 10% Karamunting Fruit Gel Disclosing Solution**	
	n	**%**
Good (0-0.6)	4	66.67%
Moderate (0.7-1.8)	2	33.33%
Poor (1.9-3.0)	0	0%
Good (0-0.6)	6	100%
Plaque Index Criteria (DI)	**Application of 12.5% Karamunting Fruit Gel Disclosing Solution**	
	n	**%**
Good (0-0.6)	3	50%
Moderate (0.7-1.8)	3	50%
Poor (1.9-3.0)	0	50%
Total	6	100%

Table 2 shows that after applying the disclosing solution of Karamunting fruit gel with concentrations of 7.5% and 10%, the index plaque staining results showed a good criteria category of 66.67%. Meanwhile, at a concentration of 12.5%, the results obtained showed a distribution between the good and moderate categories with 50% each.

Table 3. Mean Rank Distribution of Chemical-based Disclosing Solution and Karamunting Fruit Gel with Concentrations of 7.5%, 10%, and 12.5% based on Dental Plaque Identifiers

Variable	**n**	**Mean Rank**	**Kruskal Wallis**	**p-value**
Plaque Index (DI)				
Karamunting 7.5%	6	8.17	13.288	0.004
Karamunting 10%	6	8.25		
Karamunting 12,5%	6	12.58		
Chemical Based	6	21.00		

Table 3 illustrates that the mean rank of dental plaque increases as the plaque level rises, reflecting the effectiveness of the different concentrations of Karamunting fruit gel in plaque detection. For instance, the mean rank for the dental plaque group (DI) using 7.5% Karamunting fruit gel is 8.17, while the group with 10% Karamunting fruit gel has a mean rank of 8.25, and the group with 12.5% Karamunting fruit gel has a mean rank of 12.58. In comparison, the group using a chemical-based disclosing solution shows a mean rank of 21.00. The statistical test results, using the Kruskal-Wallis test, revealed a p-value <0.05, indicating a significant difference in the mean plaque index (DI) based on the type of dental plaque identifier used. This demonstrates that higher concentrations of Karamunting fruit gel are more effective in detecting plaque compared to the chemical-based solution.



Description: K (+) = Control, K (+1) = 7.5% Karamunting Gel, K (+2) = 10% Karamunting Gel, K (+3) = 12.5% Karamunting Gel.

Figure 1. Observation results of karamunting fruit gel staining with concentrations of 7.5%, 10% and 12.5% on *Staphylococcus aureus* bacteria

Figure 1 illustrates the culture of *Staphylococcus aureus* bacteria, which was exposed to karamunting fruit extract gel at concentrations of 7.5%, 10%, and 12.5% for 10 minutes. The bacteria appeared as cocci and displayed a pink coloration. This demonstrates that karamunting gel can stain the bacteria found in dental plaque. The figure also highlights the correlation between pink bacterial staining and plaque detection. The pink staining indicates the presence of bacterial plaque, which becomes more prominent in areas with higher plaque accumulation. As the intensity of the staining increases, it correlates with a higher level of plaque, making it easier to visually detect and assess the extent of plaque on the teeth. This provides an effective method for identifying and measuring plaque buildup, especially when compared to other disclosing agents. The clearer the pink coloration, the more pronounced the presence of plaque, offering a visual cue for plaque detection and evaluation.

DISCUSSION

This study evaluated the use of Karamunting fruit gel (*Melastoma malabathricum L.*) as a disclosing solution for dental plaque identification, with concentrations of 7.5%, 10%, and 12.5%, compared with chemical-based disclosing solutions. The study involved 24 children who were divided into four groups, each group receiving different treatments. Before applying the disclosing solution, the children were fed for 5 minutes. The application was done as follows: Group 1 used Karamunting fruit gel with 7.5% concentration, Group 2 used gel with 10% concentration, Group 3 used gel with 12.5% concentration, and Group 4 used chemical disclosing solution.

The results of the data analysis showed that Karamunting fruit gel disclosing solution and chemical-based disclosing solution were effective in helping plaque identification. Based on Table 1 and Table 2, it can be seen that applying Karamunting fruit gel produces different mean values between sample groups. Chemical disclosing solution gave the highest mean value while Karamunting fruit gel disclosing solution at a concentration of 7.5% gave the lowest mean value.

A prior study done by Fione et al. (25) shows that chemicals are more effective than natural materials in the PHP index. The average difference in smearing results can be explained by differences in concentration, where higher concentrations provide clearer coloring. Research by Diana et al. (26) also states that ethanol extract of Senduduk fruit (*Melastoma malabathricum L.*) can be used as a colorant in eye shadow cream preparations.

The Kruskal-Wallis test in Table 3 shows results with a p-value = 0.004 <0.05, which indicates a significant difference between the application of Karamunting fruit gel disclosing solution at concentrations of 7.5%, 10%, and 12.5% compared to chemical-based disclosing solutions. These results indicate that Karamunting fruit gel disclosing solution has the potential as an alternative dental plaque identifier (27). The Karamunting fruit gel works through a mechanism involving the interaction of bioactive compounds with dental plaque components. Anthocyanins act as the primary coloring agent, flavonoids enhance color adhesion, tannins help bind proteins in plaque, and the fruit's acidity influences color stability. Additionally, the antibacterial effects of the active compounds in Karamunting fruit can provide additional benefits in maintaining oral health.

In addition to its potential as a coloring agent, Karamunting fruit gel also has advantages in terms of cost and availability of materials. Karamunting fruit grows abundantly in tropical regions such as Indonesia, so the raw

materials for making this gel are easily available at affordable prices (28). The process of making this gel is relatively simple and does not require high technology, allowing local production at low cost. The easy availability of materials and low production costs make Karamunting fruit gel an economical and practical alternative for dental plaque detection, especially in areas with limited access to imported dental health products (29, 30, 31).

The limitations of this study are related to the anthocyanin, flavonoid, and tannin content in Karamunting fruit, which may vary depending on environmental conditions, ripeness stage, and extraction methods used. Additionally, the stability and shelf life of the gel may be affected by environmental factors such as temperature, humidity, and light exposure.

Recommendations for Future Research

Further research is recommended to explore additional areas, such as conducting clinical trials with a larger population or improving the formulation to enhance its effectiveness in detecting dental plaque.

CONCLUSION

It can be concluded that the disclosing solution gel derived from Karamunting (*Melastoma malabathricum L.*) fruit shows potential as an alternative dental plaque identifier. Further research is recommended to explore additional areas, such as conducting clinical trials with a larger population or improving the formulation to enhance its effectiveness in detecting dental plaque.

AUTHOR'S CONTRIBUTION STATEMENT

All authors contributed to the conception, design, supervision, materials, data collection and/or processing, analysis and/or interpretation, literature search, writing and critical review.

CONFLICTS OF INTEREST

All authors declared no conflict of interest.

DECLARATION OF GENERATIVE AI AND AI-ASSISTED TECHNOLOGIES IN THE WRITING PROCESS

In writing this manuscript, the authors uses/acknowledge the use of generative AI technology and/or AI-assisted tools such as ChatGPT to assist with language editing, spelling, and grammar correction. The authors ensures that the use of this technology is conducted ethically and transparently, and is not used to produce inauthentic or misleading content.

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