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## The Use of Red Dragon Fruit Gel as A Disclosing Agent for Plaque Measurement

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### ABSTRACT

Assessing oral hygiene through plaque index assessment is essential to identify areas that require attention, as poor hygiene can lead to problems such as caries, gingivitis, periodontitis and systemic health issues. In response to challenges such as limited access to natural tooth colouring materials and the side effects of chemical alternatives, red dragon fruit has emerged as a safe and natural option. This experimental study aimed to develop a red dragon fruit disclosing gel with concentrations of 35%, 50%, and 75% and to compare the staining effectiveness of these three concentrations. The study employed an experimental research design categorized as an "experimental study" using the Posttest Only Design. In this design, interventions (X) are carried out, followed by posttest measurements (O2). Since there is no control group, the results of O2 cannot be compared with other groups. This approach is also referred to as the "One-Shot Study." The observations (O2) provide descriptive data, with parameters measured including color intensity and plaque index scores. The study was conducted on university students as the sample population. The results revealed that a 35% concentration of red dragon fruit gel was effective in disclosing dental plaque by staining it. However, the highest color absorption and most intense staining were observed at the 75% concentration. The study concluded that a 35% concentration of red dragon fruit gel is sufficient for use as a disclosing agent, while the 75% concentration provides the best and most intense staining. Future research is recommended to stabilize the anthocyanin content in red dragon fruit extract by incorporating acetic acid or other stabilizing agents.

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### INTRODUCTION

The prevalence of dental and oral health issues in Indonesia has shown a significant increase in recent years. According to the 2018 Basic Health Research (Riskesdas), the

prevalence of dental and oral health problems rose from 25.9% in 2013 to 57.6% in 2018. This increase is largely attributed to poor oral hygiene, emphasizing the need for preventive interventions by dentists, dental therapists, and patients themselves (Kementerian Kesehatan Republik Indonesia, 2018).

One of the main contributors to dental and oral health problems is plaque accumulation, a soft deposit that adheres to the surface of teeth and forms from uncleaned food debris (Lestari, Syamsurizal, & Trisna, 2021; Ifitri, et al., 2024; Bachtiar, et al., 2024). The bacterial fermentation of sugars within plaque produces acid, leading to a drop in oral pH, which triggers demineralization and the formation of dental caries (Kleinberg, 2002; Marsh, Head, & Devine, 2015). Uncontrolled plaque buildup can result in various complications, including tooth decay, halitosis, gingivitis, and severe oral infections such as abscesses, cysts, or even oral cancer.

Effective plaque control is a crucial step in maintaining dental and oral health (Jakubovics, et al., 2021; Ruiz Núñez, et al., 2022). One method to monitor oral hygiene is by measuring plaque indices using a staining solution or disclosing solution, which highlights plaque areas that are otherwise invisible to the naked eye. Disclosing solutions are commonly employed in oral hygiene assessments, such as the Personal Hygiene Performance (PHP) index, by staining plaque on tooth surfaces for better visualization.

However, market surveys have revealed the unavailability of conventional disclosing solutions in certain regions, including Lampung Province. This scarcity poses a challenge for dental and oral health care, especially considering the limitations of chemical-based disclosing solutions, such as potential side effects, toxicity, high production costs, and adverse environmental impacts (Varsha, Kumar, & Rathi, 2022). To date, research on natural alternatives to chemical-based disclosing solutions remains limited, particularly in the development of safe, effective, and environmentally friendly formulations. While natural materials have gained increasing attention, most studies have yet to focus on testing the effectiveness of plaque staining using readily available local resources with high potential.

This study introduces a novel approach by utilizing red dragon fruit extract as a natural material for disclosing solutions. Red dragon fruit was selected due to its beta-carotene content, a natural pigment that produces a vivid contrast and adheres to plaque, making it easily visible. Additionally, red dragon fruit is widely available in Indonesia, offering a sustainable and affordable local solution. This research aims to develop a disclosing gel based on red dragon fruit extract at concentrations of 35%, 50%, and 75%, and to evaluate its effectiveness in staining dental plaque.

## METHOD

This study is an experimental clinical research with a Posttest Only Design (The One Shot Study) approach. In this design, the intervention or treatment (X) is administered first, followed by measurement (observation) or posttest (O2). The study population consists of 36 respondents, with a total sampling technique applied, resulting in a sample size of 36 participants.

The materials and tools used in this study include: red dragon fruit, 96% ethanol, sterile aquades, filter paper, aluminum foil, plastic wrap, baking paper, glass jars, and sample containers. The preparation of the red dragon fruit disclosing gel with concentrations of 35%, 50%, and 75% involves several steps:

1. Preparation of Red Dragon Fruit Simplisia
2. Maceration and Filtration Process
3. Extraction or Evaporation Process
4. Dilution of Red Dragon Fruit Extract: The dilution process involves mixing 10 ml of 100% red dragon fruit extract with 3 ml of sterile aquades to achieve the desired concentrations of 35%, 50%, and 75%.

The dilution formula used for the red dragon fruit extract is as follows:

$$A\% = \frac{m1}{m1+m2}$$

Where:

A% = Percentage of concentration

m1 = Mass of the solute (red dragon fruit extract, measured as 18 ml)

m2 = Mass of the solvent (sterile aquades used to dilute the red dragon fruit extract).

This method ensures accurate preparation of the disclosing gel at the required concentrations for the study.

## RESULTS AND DISCUSSION

**Table 1.** Plaque examination with application of Red Dragon Fruit Disclosing Gel with Concentrations of 35%, 50% and 75% With Each Total 12 Samples

Percentage Concentration	Number of Samples	Plaque Examination Score		
		Good	Medium	Bad
35%	12	1	11	0
50%	12	2	10	0
75%	12	3	7	2

Table 1 shows that the number of samples on the application of red dragon fruit disclosing gel at a concentration of 35% obtained good criteria amounted to 1, moderate criteria amounted to 11 and bad criteria amounted to 0. At a concentration of 50% obtained good criteria amounted to 0, good criteria amounted to 2, moderate criteria amounted to 10 and bad criteria amounted to 0, at a concentration of 75% good criteria amounted to 3, moderate criteria 7, and bad criteria 2.

**Table 2.** Plaque Absorbency with Anterior Tooth Smears

Initial Condition Before Disclosing Red Dragon Fruit Gel	Disclosing Red Dragon Fruit Gel 35% Concentration	Disclosing Red Dragon Fruit Gel 50% Concentration	Disclosing Red Dragon Fruit Gel 75% Concentration
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Table 2 shows that the 35% concentration can already be absorbed in the plaque, the 50% concentration shows more colour in the absorption, plaque, and at 75% concentration the absorption in the plaque looks brighter. With the above results at a

concentration of 35%, it can be used as a material for measuring the plaque index in the sample. Of the three concentrations of 35%, 50% and 75%. The application of red dragon fruit disclosing gel was carried out on all 12 samples with 3 concentrations of each 12 samples per 1 concentration, and it was found that red dragon fruit disclosing gel applied to the entire surface of the teeth can be seen plaque and there are differences in the colour of plaque absorption.

**Table 3.** Aroma Disclosing

Respondents	Concentration 35%		Concentration 50%		Concentration 75%	
	-	+	-	+	-	+
Sample 1		√		√	√	
Sample 2		√		√		√
Sample 3		√		√		√
Sample 4		√		√		√
Sample 5		√		√	√	
Sample 6		√		√		√
Sample 7		√				√
Sample 8		√		√		√
Sample 9		√		√		√
Sample 10		√		√	√	
Sample 11		√		√		√
Sample 12		√		√		√

**Description:**

(-) = Stinging aroma

(+) = Non-pungent aroma

Table 3 shows that the aroma of red dragon fruit gel at 35% and 50% concentrations did not produce a strong odor, while at 75%, 2 out of 10 respondents reported a noticeable odor. The 35% concentration is suitable for use, as it does not produce a strong smell. Thus, the red dragon fruit gel meets the requirement of not producing an unpleasant odor.

**Table 4.** Effects of Flavour on Disclosing

Respondents	Concentration 35%		Concentration 50%		Concentration 75%	
	-	+	-	+	-	+
Sample 1		√		√		√
Sample 2		√		√		√
Sample 3		√		√		√
Sample 4		√		√		√
Sample 5		√		√		√
Sample 6		√		√		√
Sample 7		√		√		√
Sample 8		√		√		√
Sample 9		√		√		√
Sample 10		√		√		√
Sample 11		√		√		√
Sample 12						

**Description:**

(-) = No flavour

(+) = There is Flavour (Sweet)

Table 4 shows the taste of red dragon fruit gel at 35%, 50%, and 75% concentrations has a sweet taste, which is appealing to children. This characteristic makes it suitable for use in children's plaque examinations, providing a pleasant experience.

**Table 5.** Allergic Reactions in The Oral Cavity

Respondents	Concentration 35%		Concentration 50%		Concentration 75%	
	-	+	-	+	-	+
Sample 1		√		√		√
Sample 2		√		√		√
Sample 3		√		√		√
Sample 4		√		√		√
Sample 5		√		√		√
Sample 6		√		√		√
Sample 7		√		√		√
Sample 8		√		√		√
Sample 9		√		√		√
Sample 10		√		√		√
Sample 11		√		√		√
Sample 12		√		√		√

**Description:**

(-) = Causes Allergic Reaction

(+) = No Allergic Reaction

Table 5 shows that no allergic reactions at any of the concentrations (35%, 50%, and 75%). This outcome is attributed to the natural and safe properties of red dragon fruit. Consequently, the red dragon fruit gel meets the requirement of being non-allergenic, making it a safe and effective alternative to conventional disclosing solutions.

**DISCUSSION**

Based on Table 2, the results indicate that a concentration of 35% is already capable of being absorbed into dental plaque. At 50%, the coloration becomes more prominent, and at 75%, the absorption produces a brighter stain on the plaque. This effect can be attributed to the presence of betacyanin and beta-carotene in red dragon fruit. Beta-carotene is known for producing a range of colors from yellow, orange, and red, to deep red. At the 75% concentration, the higher content of betacyanin and beta-carotene results in a more intense red stain on dental plaque, making it easier to identify plaque-affected areas. Accumulated plaque becomes distinctly visible after applying the red dragon fruit gel.

The red dragon fruit extract in gel form offers a viable alternative to conventional disclosing solutions, as evidenced by its effectiveness in highlighting plaque during examinations. Red dragon fruit shares similar properties with conventional disclosing solutions. Beta-carotene in red dragon fruit is a natural red-orange pigment that is fat-soluble and constitutes the primary pigment in the fruit. The rough, porous structure of plaque biofilm facilitates the absorption and entrapment of beta-carotene. Since plaque has a stickier texture than clean tooth surfaces, the pigment is more visible on plaque than on clean teeth.

This study aligns with previous research by Hakim (2018), which concluded that red dragon fruit extract disclosing agents are most effective at the highest concentration of 75% compared to 35% and 50%. Similarly, research by Putri, et al., (2024) suggested that while conventional disclosing agents are more effective, red dragon fruit disclosing gels offer a promising alternative.

Dental plaque is a thin, whitish-yellow, and transparent layer formed due to bacterial colonization, food debris, saliva, and other substances (Valm, 2019; Jakubovics, et al., 2021). It forms naturally when bacteria in the mouth break down carbohydrates from food and drinks, producing acids that can erode tooth enamel and cause issues such as dental caries (Jaffar, et al., 2021; Rowińska, et al, 2021; Chaurasiya, & Verma, 2024). Dental plaque cannot be completely removed by rinsing or using water sprays; it requires mechanical cleaning (Bastendorf, et al., 2021). When minimal, plaque is invisible unless stained by disclosing agents or pigmented by substances within the oral cavity. Accumulated plaque appears

grayish-yellow to yellow. the red dragon fruit gel meets the requirements for a plaque-staining agent as a substitute for conventional disclosing solutions. It effectively stains plaque without affecting clean areas.

## CONCLUSION

The study concluded that a 35% concentration of red dragon fruit gel is sufficient for use as a disclosing agent, while the 75% concentration provides the best and most intense staining. Future research is recommended to stabilize the anthocyanin content in red dragon fruit extract by incorporating acetic acid or other stabilizing agents.

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