

ORIGINAL ARTICLE

Evaluation of the Effect of *Graptophyllum pictum* Leaves Extract (GPLE) on Surface Roughness and Color Stability of Acrylic Resin toward Potentially Herbal-Based Denture Cleanser

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ABSTRACT

Introduction: *Graptophyllum pictum*, also known as "purple leaf" in Indonesia, is a popular herbal plant that has been recognized for its antifungal and antibacterial properties. This study aims to evaluate the effect of *Graptophyllum pictum* leaf extract (GPLE) on surface roughness and colour stability of acrylic resin toward potentially herbal-based denture cleanser. **Methods:** Eighteen heat-cured acrylic resin samples measuring 20x10x10 mm were assigned to three groups (Polident, aquadest, and GPLE 5%). All samples were submerged for 5 minutes daily and observed for 1 week for surface roughness testing and 1 month (every week) for colour stability testing. Surface roughness was assessed using Atomic Force Microscopy (AFM), while colour stability was evaluated using the CIELab system via Adobe Photoshop. The data were analyzed using Kruskal-Wallis, one-way ANOVA, and Tukey's HSD ($p < 0.05$). **Results:** There was no significant difference in surface roughness and colour stability among heat-cured acrylic resin samples submerged in Polident, aquadest, and GPLE 50% ($p > 0.05$). Submerging the acrylic resin into the GPLE 50% did not change the surface roughness and colour stability. **Conclusions:** GPLE 50% has maintained the surface roughness and colour stability of the acrylic resin, suggesting a prospective candidate for an herbal-based denture cleanser. *Malaysian Journal of Medicine and Health Sciences (2025) 21(s2): 80–85. doi:10.47836/mjmhs.21.s2.12*

Keywords: *Graptophyllum pictum*, acrylic, colour stability, surface roughness, denture base

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INTRODUCTION

Tooth loss is a condition that arises when one or more teeth are absent, typically as a result of trauma, periodontal diseases, caries, or orthodontic extraction (1). According to the World Health Organization (WHO), tooth loss impacts around 7% of people aged 20 years or older and 23% of those aged 60 years or older (2).

Removable partial dentures (RPDs) are one of the treatment options for replacing missing teeth in order to increase masticatory effectiveness, improve appearance, stop unintentional tooth movement, and enhance phonetics. Additionally, RPDs can aid in overcoming financial constraints and promoting oral hygiene accessibility

(3). Acrylic resin is commonly used as a base material for RPDs due to its biocompatibility, gingival-like colour, and simplicity. However, acrylic resin has high porosity and absorption rates, potentially encouraging microorganism accumulation and plaque formation. Furthermore, the absence of salivary self-cleansing mechanisms due to the contact between the denture base and oral mucosa can exacerbate this condition, leading to denture stomatitis (4,5). Studies indicate that denture stomatitis affects 50% of denture wearers, with *Candida albicans* being the most common microorganism present (6). Compared to those with healthy oral cavities, *Candida albicans* prevalence in denture wearers ranges from 60%-100% (7).

Regularly cleaning acrylic resin-based dentures with a denture cleanser is an effective way to minimize the downsides of acrylic resin. This approach is much simpler than using a toothbrush for mechanical cleaning, which can be challenging, especially for the elderly or

those with psychomotor function difficulties. An ideal denture cleanser should possess several characteristics: non-toxic, non-irritative, stable in storage, bactericide or fungicide, and does not damage denture materials. However, chemically-based denture cleansers can potentially increase surface roughness and cause acrylic resin-based denture discolouration (4). Hence, several studies have proposed using herbal-based materials as a safer and easily obtainable alternative to chemical-based denture cleansers (4,7).

Graptophyllum pictum, also known as "purple leaves" in Indonesia, is a tropical plant species belonging to the Acanthaceae family. This plant has been recognized as one of the 66 biopharmaceutical plant commodities by the Decree of the Minister of Agriculture Number 511/Kpts/PD.310/9/2006 (8). Its pharmacological properties as an antioxidant, anti-inflammatory, anti-implantation, antidiabetic, antibacterial, antifungal, anti-hemorrhagic, nephrotoxic, photoprotective, and immunomodulatory agent have made *Graptophyllum pictum* leaves extract (GPLE) has been widely used as herbal medicine. Previous studies have found that GPLE has fungistatic properties against *Candida albicans*, and has been suggested as a candidate for a herbal-based denture cleanser due to its antifungal and antibacterial properties (4, 9, 10). However, these studies did not evaluate other important characteristics required for an ideal denture cleanser, such as its effect on surface roughness and colour stability of acrylic resin. Thus, the aim is to evaluate the effect of GPLE on surface roughness and colour stability of acrylic resin toward potentially herbal-based denture cleanser.

MATERIALS AND METHODS

Acrylic Resin Sample Preparation

In this study, a "post-test only" control group design was utilized, and the random sampling method was employed. Eighteen samples of heat-cured acrylic resin (Huge Dental, Rizhao, China) measuring 20x10x10 mm were allocated to three groups: Polident, aquadest, and GPLE 5% (n=3). The fabrication process involved placing model wax inside a cuvette and filling it with heat-cured acrylic resin. Following a one-hour boiling process, the samples underwent polishing (9). For the surface roughness test, all samples were submerged for 5 minutes daily with an observation time of 1 week, while for the colour stability test, the submerging period was extended to 1 month with each week observation.

Extraction of *Graptophyllum pictum* Leaves Extract (GPLE)

Graptophyllum pictum specimens were identified and obtained from the Technical Implementation Unit of Herbal Materia Medica Laboratory, Batu, Batu City, East Java, Indonesia. To create the simplicia powder, 1.45 kg of *Graptophyllum pictum* was placed in an oven at 120°C for 20 minutes, and the dried leaves were then

ground into a smooth powder using a blender and a No. 40 Mesh sieve. The extraction process involved soaking 150 grams of simplicia powder in 1500 mL of 70% ethanol for 24 hours, as this polarity of ethanol attracts more active compounds such as flavonoids (10). The extract was filtered using Whatman No. 41 filter paper and underwent maceration until the solution became clear in colour. Finally, the evaporation process was carried out using a rotary vacuum evaporator at a temperature of 60°C (11).

Surface Roughness Test

The Atomic Force Microscopy (AFM) instrument (Bruker-Nano N8 NEOS, Bruker Corp, Billerica, MA, USA) was utilized to conduct surface roughness testing on the acrylic resin (10x10 µm). The AFM analysis involved precise alignment of the cantilever tip with the specimen surface, followed by detection of any deflections using a laser and photodiode as the cantilever tip moved along the surface of the specimen. The measurement data and scanning imagery were displayed on the monitor screen, allowing for accurate measurement of parameters such as the arithmetical mean height of a line to the surface (Sa), root mean square height (Sq), and maximum pit height (Sp) in nanometer units (nm) (12).

Colour Stability Test

The colour stability was achieved by capturing a submerged sample against a white backdrop using a ring light characterized by a cool white colour temperature as the light source. The setup utilized a focal length of 5.23 mm, an exposure duration of 1/50 second, and an ISO sensitivity of 125 (13). The data was processed using the CIE Lab system via Adobe Photoshop CS4 for Windows (Adobe Inc, California, United States) to identify L* for light level, a* for red/green coordinates, and b* for yellow/blue coordinates. ΔE indicates the colour difference between the two samples (14).

$$\Delta E = \sqrt{(L_1 - L_2)^2 + (a_1 - a_2)^2 + (b_1 - b_2)^2}$$

Compared to similar methods such as RGB, the CIE Lab method was chosen for its advantages. This system exhibits extensive colour representation capabilities, theoretically accommodating an infinite array of chromatic combinations and resulting in more accurate results (15).

Statistical Analysis

All data were analyzed using the Statistical Package for Social Science (SPSS) software version 25.0 for Windows (IBM corporation, Illinois, Chicago, United States). The data were analyzed using the normality and homogeneity tests. Non-parametric Kruskal-Wallis analysis was performed on colour stability tests. When appropriate analysis of one way ANOVA was used to assess differences among multiple experimental groups, post-hoc Tukey's Honestly Significant Difference (HSD) test was

used for a direct comparison of each group ($p < 0.05$).

RESULTS

The results of the surface roughness test were shown in the form of representative topographical and physico-chemical features of acrylic resin after submergence in three different solutions: Polident, aquadest, and GPLE 50% (Fig. 1A). Bright-coloured images indicate a higher surface; dark-coloured images indicate a lower surface; brownish-yellow-coloured images indicate a surface between the two extremes. Based on S_a and S_q parameters, GPLE 50% exhibited slightly lower surface roughness compared to Polident but higher than aquadest. In the S_p parameter, GPLE 50% exhibited lower surface roughness compared to Polident but slightly higher than aquadest. However, the statistical analysis results of these parameters indicate no significant difference ($p > 0.05$; Fig. 1B).

The colour stability evaluation was performed through visual and statistical analysis by comparing the appearance of acrylic pre and post submergence in Polident, aquadest, and GPLE 50% for 1, 2, 3, and 4 weeks. All solutions induced visual colour alterations in the acrylic resin. However, the observed changes were markedly not significant as they remained within the same colour palette (dark pink) (Fig. 2A). Statistical analysis using the CIELAB system was performed for further identification, confirming that there were no significant colour differences among aquadest, Polident, and GPLE 50% ($p > 0.05$; Fig. 2B).

DISCUSSION

Graptophyllum pictum is a tropical plant characterized by purple-to-green leaves colour (16). It contains several important phytochemical compounds: flavonoids,

steroids, glycosides, tannins, saponins, chlorophyll, and non-toxic alkaloids (4, 17). The presence of polyphenolic compounds contribute to its distinctive leaves colour (18). This plant possesses abundant therapeutic advantages and pharmacological activities as an antioxidant, anti-inflammatory, anti-implantation, antidiabetic, anti-bacterial, and antifungal agent (4, 9, 17). GPLE 50% was chosen as a candidate for herbal-based denture cleanser because it has fungicidal and non-toxic properties based on our preliminary study, but data is not included. Other characteristics required as an ideal denture cleanser include its effect on surface roughness and colour stability of acrylic resin (4).

Surface roughness constitutes a pivotal characteristic of the denture base. Acrylic resin exhibits pronounced absorption properties, which are influenced by several factors including submersion time and the active component present in denture cleanser. The denture cleanser's active component can fill the gaps between polymer chains, consequently increasing both porosity level and surface roughness (19). Alteration in surface roughness enhances susceptibility to microorganism accumulation and facilitates oral bacterial colonization (20, 21).

The influence of active components on surface roughness can be assessed using S_a , S_q , and S_p parameters. Although S_a is commonly utilized for assessing surface roughness, relying solely on this parameter may not capture the full spectrum of surface irregularities. Hence, the inclusion of S_p and S_q parameters is often necessary to comprehensively evaluate various facets of surface roughness (22).

The result of S_a , S_p , and S_q parameters revealed that Polident exhibited slightly higher surface roughness than GPLE 50% and aquadest. The increased roughness in Polident can be attributed to its alkaline peroxide

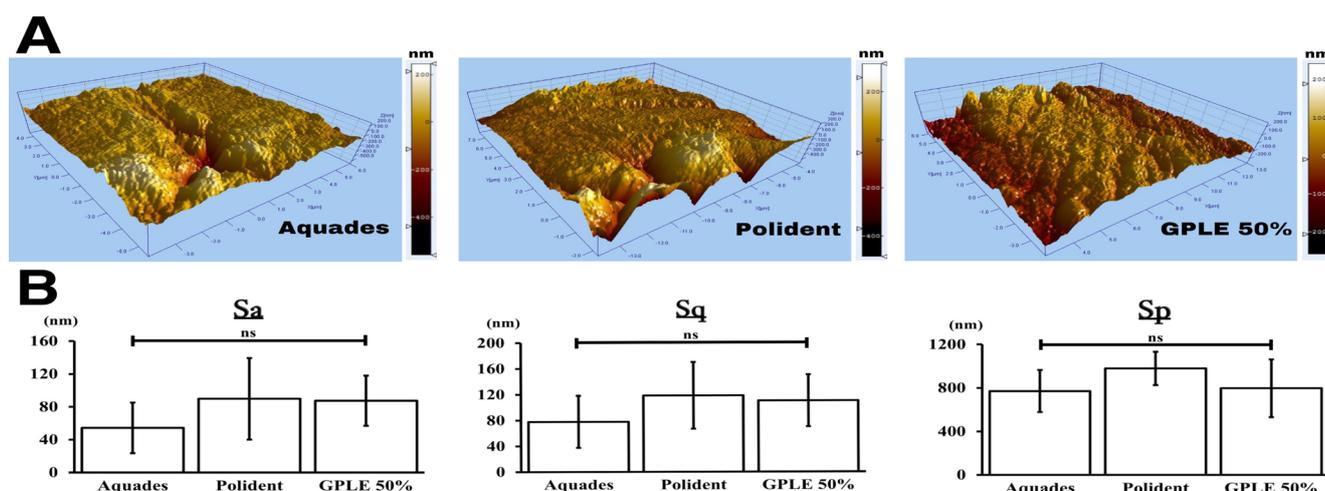


Fig. 1: Representative surface roughness images of acrylic resin with aquadest, Polident, and *Graptophyllum pictum* leaves extract (GPLE) 50% (A). Vertical roughness parameters such as S_a , S_q , and S_p , determined by a laser microscope (B). Data represented as means \pm standard deviation (SD) ($n = 3$). The abbreviation ns indicates statistically no significance ($p > 0.05$; Tukey's honestly significant difference [HSD] test). GPLE, *Graptophyllum pictum* leaves extract; S_a , arithmetical mean; S_q , root mean square; S_p , maximum pit height; ns, non-significant.

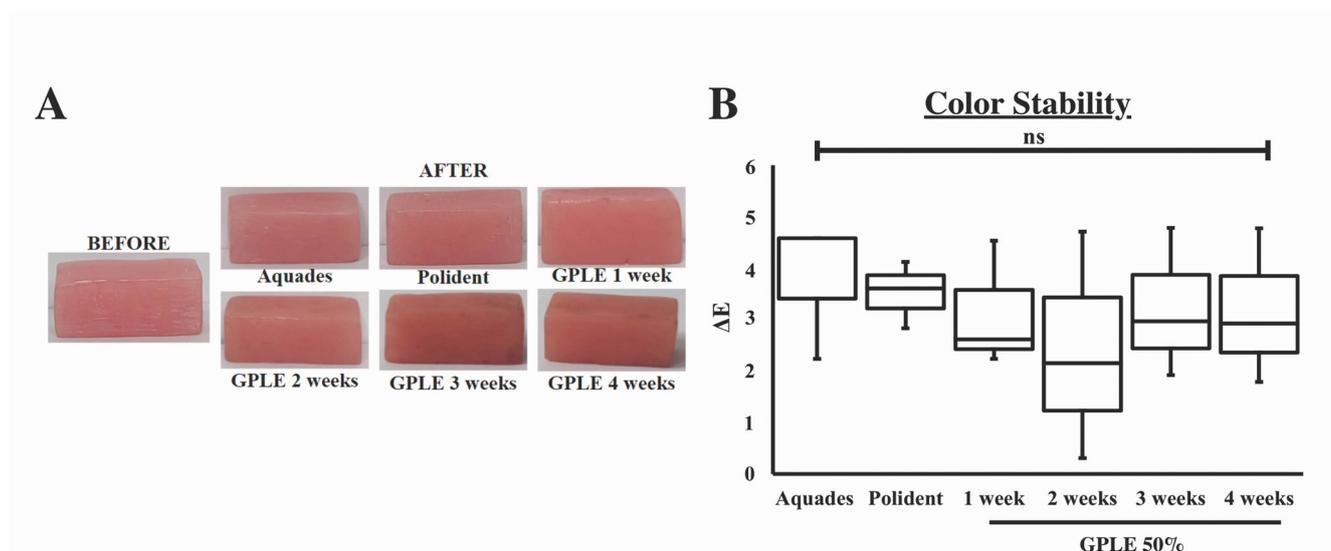


Fig. 2: Representative visual images of color stability in acrylic resin before and after soaking in aquades, Polident, and 50% *Graptophyllum pictum* leaves extract (GPLE) 1 week; 2 weeks; 3 weeks, and 4 weeks (A). The color stability parameter ΔE describes the total color difference from the CIE L*a*b* coordinates (B). GPLE, *Graptophyllum pictum* leaves extract. Data represented as means \pm standard deviation (SD) (n = 3). The abbreviation ns indicates statistically no significance ($p > 0,05$; Kruskal-Wallis test). GPLE, *Graptophyllum pictum* leaves extract; ns, non-significant.

content (23). Alkaline peroxide dissolved into water to produce hydrogen peroxide (H₂O₂) and nascent oxygen (2O). Hydrogen peroxide releases free radicals upon interacting with the resin matrix, initiates an oxidative reaction. These free radicals interfere with the polyamide bonds, consequently increasing oxidation levels and causing higher surface roughness (23, 24).

GPLE 50% showed slightly lower surface roughness than Polident but slightly higher than aquadest. The elevation in surface roughness of GPLE 50% can be attributed to its flavonoid content. Phytochemical analysis revealed that the highest component of *Graptophyllum pictum* leaves was flavonoids (4340,30 mg/100 QE wb), a class of phenolic compounds (4). The high phenolic content is known to enhance the acidity of acrylic polarity. This condition induced the breakdown of acrylic polymer chains, resulting in damaged acrylic resin. The high acid level hydrolyzed the polymer's ester content, increasing surface roughness (25). However, there was no significant difference in surface roughness between all groups. Colour stability also represents a critical characteristic of the denture base. Visible denture discoloration can notably compromise their aesthetic appeal. Such discoloration can be caused from either extrinsic or intrinsic factors. Intrinsic factors include the nature of the material, the monomer used, and the chemical structure of the acrylic resin itself. Extrinsic factors involve stains resulting from the absorption of external dyes found in food, drinks, or denture cleaners (26). As a candidate of herbal-based denture cleanser, *Graptophyllum pictum* exhibits a natural purple-to-green colouration attributed to the presence of polyphenolic compounds such as anthocyanins and leucoanthocyanins (18). Thus, GPLE poses a risk of causing discoloration of acrylic resin,

emphasizing the importance to investigate its impact on aesthetic consideration when utilized to acrylic resin as a denture base material.

The result of statistical analysis showed no significant colour difference between aquades, Polident, and GPLE 50%. As a denture base material, acrylic resin exhibits propensity to gradually absorb water over time through the diffusion of water molecules according to the law of diffusion (27). This diffusion process is related to the presence of chemically activated tertiary amines within the resin. These amines are susceptible to oxidation. Diffusion of water into the resin can trigger oxidation of tertiary amines, causing colour changes. However, colour change will not occur significantly when the immersing time is not excessive (26).

This study proved that there was no significant difference of acrylic resin after submerging in the Polident, aquades, and GPLE 50%, indicating that GPLE 50% did induce alteration in the surface roughness and discoloration of acrylic resin. The significance of all these findings lies in their implication, suggesting that the research serves as a promising groundwork for the future related to the potential of GPLE 50% as an effective herbal-based denture cleanser.

CONCLUSION

GPLE 50% has maintained surface roughness and colour stability of the acrylic resin, suggesting a prospective candidate for an herbal-based denture cleanser. However, this study has some limitations due to the short evaluation time. The future study should evaluate denture-based herbal characteristics over a more extended

period, and in vivo analysis should be conducted.

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