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The Effect of Adding Patchouli Essential Oil (*Pogostemon Cablin Benth.*) on Setting Time Of GIC

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ABSTRACT

Essential oils are widely incorporated into dental materials to enhance their antibacterial properties, including patchouli essential oil (PEO) derived from *Pogostemon cablin* Benth. PEO contains bioactive compounds such as Patchouli Alcohol (PA), phenols, steroids, and terpenoids, which contribute to its antimicrobial activity. This study aimed to evaluate the effect of PEO addition on the setting time of glass ionomer cement (GIC). Twenty cylindrical GIC specimens (2 mm × 10 mm) were tested using Vicat's needle and divided into four groups based on the powder:PEO:liquid ratios: Group A (control), Group B (2:1:1), Group C (3:1:2), and Group D (3:2:1). Data were analysed using One-Way ANOVA and Tukey's test ($p < 0.05$). The addition of PEO to GIC's liquid is significant ($p < 0,05$) decreased the setting time of group B, C, and D. Modifying GIC with PEO showed a significant decrease in setting time in group B with a comparison ratio (2 : 1 : 1). All results remained within ISO 9917-1:2007 limits. Further studies are needed to assess long-term stability and mechanical performance.
Keyword : patchouli essential oil, setting time, GIC

Introduction

In Indonesia, many people experience oral health problems due to improper health maintenance, which eventually leads to tooth decay. [1]. Dental caries is the destruction of hard tooth tissues, which are highly vulnerable to bacterial fermentation of carbohydrates that are acidic in nature. Proper treatment for dental caries involves removing carious tissue and restoring it using restorative materials.

Glass ionomer cement (GIC) can be used in ART (Atraumatic Restorative Treatment) and ITR (Interin Therapeutic Restorations). Indications for the use of ART and ITR treatments include young patients, uncooperative patients, patients with special needs, and patients requiring postponed treatment. ART and ITR treatments can be used on both primary and permanent teeth. [2]. GIC is an acid-based cement produced from the reaction between ionically soluble fluoro-aluminosilicate glass and polyalkenoic acid in water. [3]. GIC, as a restorative material, has a unique chemical composition that allows it to chemically adhere to enamel and dentin, release caries-protective fluoride, and refill fluoride particles through

external exposure from other fluoride sources. [4]. GIC, as a filling material, has several beneficial properties: fluoride release, good aesthetics, high translucence, and antibacterial properties. Fluoride released from GIC can help prevent caries or reduce caries growth. [5]. However, GIC only releases 10 ppm of fluoride during the first 48 hours after insertion into cavities, which is still considered low in terms of antibacterial effectiveness[6].

Previous research has shown that various antimicrobials can improve the antibacterial properties of GIC [7]. Essential oil, as a natural antimicrobial material, is biodegradable and eco-friendly. Essential oils are abundantly available, especially in Indonesia, which produces various types of essential oils, ensuring their availability. In addition, essential oils are also safe as antimicrobial agents. The Food and Drug Administration (FDA) has included essential oils in the Generally Recognized as Safe (GRAS) list, meaning they can be used without requiring approval through technical analysis [8]. *Pogostemon cablin Benth* is one of the essential oil-producing plants that is widely cultivated in Indonesia, particularly in Aceh, Sumatra, Lampung, West Java, and East Java. Patchouli essential oil (PEO) has good prospects as it is commonly used in cosmetic products, perfumes, soaps, food industry needs, paint manufacturing industry, and pharmaceutical industry [9]. Some studies have shown that patchouli leaf essential oil has antibacterial activity against *Staphyloyacoccus aureus, S. epidermidis, Streptococcus pyogenes, Echerichia coli, Salmonella tyhi, and Pseudomonas aeruginosa* [10]. The chemical components of essential oil in patchouli leaves include patchouli alcohol (PA), Δ-guaiene, and a-guaiene, which have antibacterial properties [11]. Patchouli Alcohol (PA) is a factor that determines the quality and gives a distinctive odor to patchouli essential oil [12]. Additionally, patchouli alcohol compounds are also useful against fungi (antifungal) [13].

Modification of restoration materials with the addition of antimicrobial agents should be considered. The ideal antimicrobial agent should provide effective antibacterial action without affecting the physical, mechanical properties and bond strength of the material. Variations in the ratio of GIC powder and liquid can affect the physical properties of the material. Increasing the ratio of GIC powder and liquid can reduce the working time and increase the viscosity of the SIK mixture. If a low GIC powder-to-liquid ratio is used, it can prolong the setting time and increase the risk of moisture contamination, thereby degrading the physical properties of the GIC and reducing the radiopacity of the material [14], [15]. The working time in GIC manipulation is short and critical, so it is important to place the material with minimal manipulation time. This is because if the gelation reaction stage of GIC is disturbed, the physical properties will be significantly low and the adhesive power may be lost [14]. The setting time characteristic is associated with the reaction rate and affects the practical application of many dental filling materials. Modification of restoration materials with the addition of antimicrobial agents should be considered. The ideal antimicrobial agent should provide effective antibacterial action without affecting the mechanical properties and bond strength of the material. In addition, modifying the GIC composition affects setting time, hardness, fluoride release and antibacterial activity [16]. Until now, there are no researchers who have assessed the effects of modifying Glass Ionomer Cement (GIC) materials using patchouli essential oil (PEO) as a dental caries restoration material.

Methods

The type of research conducted was laboratory experimental. The research design was post-test-only control group design to evaluate the effect of patchouli essential oil (PEO) on the setting time of GIC. This research was conducted at the Dental Material and Testing Center of Research and Education (DMT Core) laboratory, Faculty of Dentistry, Universitas Trisakti, Jakarta. Patchouli essential oil was obtained from patchouli leaves (*Pogostemon cablin Benth*) from North Aceh patchouli farmers. The GIC used was GC Gold Label Universal Restorative Glass Ionomer Cement, GC Corporation, Tokyo, Japan.

The research sample consisted of 40 GIC samples with added PEO, molded into cylinders (10 mm in diameter and 2 mm in height). The samples were divided into four groups: a control group and 3 treatment groups, with each group consisting of 10 samples. GIC powder and liquid with PEO were weighed using an analytical balance according to the ratio of the control group: Group A (1 : 1) and treatment groups (GIC Powder : PEO : GIC Liquid): Group B (2: 1: 1), Group C (3: 1: 2), Group D (3: 2: 1).

The setting time test was conducted using the Vicat's needle test apparatus. The surface of the 10 mm diameter, 2 mm high cylindrical sample was slightly pressed with a glass slide to remove

excessive cement, then placed under a 1 mm diameter Vicat's needle to measure the initial setting time (T1). The Vicat's needle was then lowered until it touched the surface of the cement and released quickly to penetrate the cement. The Vicat's needle penetrated the cement for 5 seconds to the bottom of the sample, and this process was repeated every 30 seconds until the needle could no longer penetrate the bottom of the sample (T2). If the Vicat's needle could not penetrate the bottom of the sample, an annular Vicat's needle was used to measure the final setting time (T2). This process was repeated at 10-second intervals until there were no indentations on the cement surface. If the Vicat needle could not penetrate the cement, the final setting time had been reached (T3).

To determine the normal distribution of the data for statistical analysis, the Shapiro-Wilk test was used. A homogeneity test was conducted using Levene's Test. The One-Way ANOVA test was used, followed by Tukey's post-hoc test to determine significant differences between each group.

Results and Discussion

The mean value and standard deviation of setting time in the four sample groups can be seen in Figure 1.

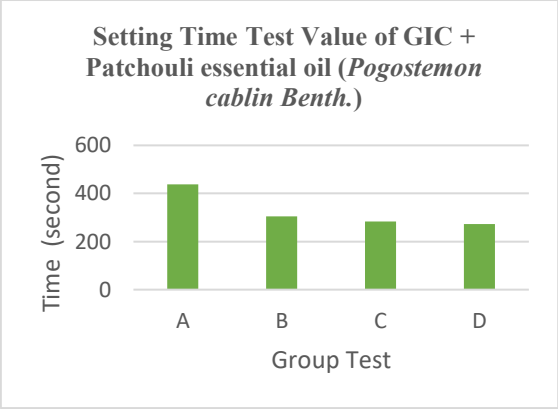

Figure 1. The graph of the setting time test results shows that there are differences between the four test groups. The modified groups (B, C, D) had faster setting times than the control group (A).

The Shapiro–Wilk and Levene's tests yielded p-values greater than 0.05, indicating that the data were normally distributed and homogeneous. One-Way ANOVA revealed a significant difference among the groups ($p < 0.001$). Tukey's post-hoc analysis confirmed that Groups B (2:1:1), C (3:1:2), and D (3:2:1) differed significantly from Group A (control) ($p < 0.05$). These findings indicate that the modified ratios in Groups B, C, and D significantly influenced the setting time.

Glass-ionomer cement is a dental filling material with the advantage of its fluoride composition, which can protect the tooth surface structure from bacteria. The clinical use of restorative GIC covers class I, II, III and V cavities in primary teeth and class III and V cavities in permanent teeth. However, GIC has several disadvantages, including low compressive strength, hardness, resistance, vulnerability to fracture, and color shading [17], [18]. Dental materials with antibacterial agents are highly recommended because the fluoride release ability can support potential anticariogenic properties. However, the release of fluoride in GIC is very limited [19].

In the development of dentistry worldwide, the use of herbal products is known as photo-dentistry [19]. Increased microbial resistance to antibiotics encourages the development of natural antibiotics from plants as the next generation of synthetic antibiotics [20]. GIC contains limited fluoride to inhibit bacterial growth under the material [16]. However, adding antibacterial agents to the filling material is feared to have adverse effects on the physical and mechanical properties of the material over time [21].

Herbal plants are rich in compounds that are beneficial for preventing or treating diseases. Patchouli essential oil has many benefits such as antibacterial, antifungal, anti-inflammatory, and antiviral properties [22]. The Patchouli Alcohol (PA) component in patchouli essential oil is thought to be the component responsible for its antibacterial activity. The work activity of patchouli essential oil in inhibiting or killing bacteria involves interfering with the formation of cell membranes or walls, which results in imperfect or incomplete cell structures [23].

During the research, it was observed that group B (2: 1: 1), group C (3: 1: 2) and group D (3: 2: 1) had faster setting times than group A. This shows that the value of the difference in GIC's setting time in group B, group C, and group D has significantly increased setting time compared to group A. According to ISO 9917-1:2007, the hardening time should be within the range of 90 to 480 seconds. A slight increase in the initial setting time benefits the dentist by allowing more time to manipulate the cement [24]. Research by Esharkawy et al. (2022) showed that working time and setting time increased as the concentration of GA (Gallic Acid) increased. GA (Gallic Acid) is a well-recognized natural antioxidant, which is

basically a secondary polyphenolic metabolite with the chemical formula $C_6H_2(OH)_3COOH$ [24]. Aceh Patchouli Leaf (*Pogostemon cablin Benth*) contains patchouli alcohol, phenols, steroids and terpenoids. The GIC's setting reaction is an acid-base reaction, in which glass particles are dissolved by polyacrylic acid, followed by the release of metal ions such as Ca^{2+} and Al^{3+}, which then react with carboxylic groups on polyacrylic acid, resulting in the formation of a glass ionomer matrix. Small amounts of complexing agents have been found to alter the GIC's reaction. This can be explained by simulating the behavior of GA (Gallic Acid) and TAC (Tartaric Acid) because they have similar chemical compositions, namely $C_6H_2(OH)_3COOH$ and $COOH(CHOH)_2COOH$. GA (Gallic Acid) is thought to inhibit cross-linking between calcium and polyacid chains, thus slowing down the formation of the initial matrix [24], [25].

The modification of patchouli essential oil in GIC can be attributed to the change in the ratio of powder and liquid GIC. If the powder to liquid ratio of GIC is high, the GIC will become more viscous, thus shortening the duration of setting time [25]. An increase in PLR (powder liquid ratio) also speeds up the hardening time, which can be beneficial when ideal moisture isolation or patient cooperation is difficult to obtain. However, an excessive powder ratio may lead to difficulty in manipulating or mixing the GIC. This can increase the risk of air trapping and create porosity in the material, which can reduce the strength of the material [26].

Conclusion

The modification of adding patchouli essential oil (*Pogostemon cablin Benth*.) to improve the antibacterial properties of the GIC showed results within the normal range according to ISO 9917-1:2007 (90 to 480 seconds). Therefore, test group B with a ratio of 2:1:1 (powder: extract: liquid) can be considered for use as a filling material.

References

[1] Hardiarini D, Ilyas Y. Description of dental caries disease in dental and oral health services in Community Health Center Palmerah. *Makassar Dental Journal*. 2024;13(1):145–8.

[2] Saber AM, El-Housseiny AA, Alamoudi NM. Atraumatic restorative treatment and interim therapeutic restoration: A review of the literature. *Dent J (Basel).* 2019 ; 7(1):28.

[3] Santos MJMC, Leon L, Siddique I, Butler S. Retrospective Clinical Evaluation of RMGIC/GIC Class V Restorations. *Dent J (Basel).* 2023 ;11(9):225.

[4] Chandru TP, Chandran S, Peedikayil FC, Kottayi S, Aparna TP, Aravind A. Comparative Evaluation of Compressive Strength of Self-cure, Dual-cure, and Light-cure Glass Ionomer Cements in a Simulated Oral Environment: An In Vitro Study. *Int J Clin Pediatr Dent*. 2023 ;16(5):715–8.

[5] Nishanthine C, Miglani R, R I, Poorni S, Srinivasan MR, Robaian A, et al. Evaluation of Fluoride Release in Chitosan-Modified Glass Ionomer Cements: Influence of Chitosan Nanoparticles. *Int Dent J.* 2022 ;72(6):785–91.

[6] Singer L, Bierbaum G, Kehl K, Bourauel C. Evaluation of the antimicrobial activity and compressive strength of a dental cement modified using plant extract mixture. *J Mater Sci Mater Med*. 2020 ;31(12):116.

[7] Azalia A, Pratiwi D, Hasan AZ, Tjandrawinata R, Eddy E. In vitro evaluation of the compressive strength of glass ionomer cement modified with propolis in different proportions. *Scientific Dental Journal.* 2023;7(1):6.

[8] Al-Maqtari QA, Rehman A, Mahdi AA, Al-Ansi W, Wei M, Yanyu Z, et al. Application of essential oils as preservatives in food systems: challenges and future prospectives – a review. *Phytochemistry Reviews*. 2022. 21(4). 1209–46.

[9] Hidayatullah Zaini A, Hariyono D, Chrisna Pandu Pradana O, Saitama A, Septiana. Analisis Pertumbuhan dan Hasil Tiga Varietas Tanaman Nilam (Pogostemon cablin Benth.) Akibat Pengaturan Jarak Tanam. *Planta Simbiosa Jurnal Tanaman Pangan dan Hortikultura* [Internet]. 2023;5(1):6–18.

[10] Dechayont B, Phuaklee P, Chunthorng-Orn J, Juckmeta T, Prajuabjinda O, Jiraratsatit K. Antibacterial, anti-inflammatory and antioxidant activities of Mahanintangtong and its constituent herbs, a formula used in Thai traditional medicine for treating pharyngitis. *BMC Complement Med Ther*. 2021 ;21(1):105.

[11] Fauzi M, Lely N. Karakterisasi dan Uji Aktivasi Antimikroba Minyak Atsiri Daun dan Batang Nilam (Pogostemon cablin Benth). *Jurnal Ilmiah Bakti Farmasi*. 2017 ; 2(1) : 41-48

[12] Yulia M, Safitri R, Rahmayulis. Formulasi Lilin Aromaterapi Kombinasi Minyak Atsiri

Sereh Wangi (Cymbopogon nardus) Dan Minyak Atsiri Nilam (Pogostemon cablin). *SITAWA : Jurnal Farmasi Sains dan Obat Tradisional*. 2024;3(1):18–29.
[13] Setyaningrum PR, Nurjanah S, Widyasanti A, Zain S. Uji Aktivitas Antijamur pada Minyak atsiri nilam Hasil Destilasi dan Fraksinasi Terhadap Jamur C. albicans dan T. mentagrophytes. *Jurnal Teknotan*. 2017 ;11(1):77–86.
[14] Sakaguchi RL, Ferracane JL, Powers JM. *Craig's restorative dental materials*. 14th ed. St Louis, Missouri: Elsevier; 2019.
[15] Panpisut P, Monmaturapoj N, Srion A, Angkananuwat C, Krajangta N, Panthumvanit P. The effect of powder to liquid ratio on physical properties and fluoride release of glass ionomer cements containing pre-reacted spherical glass fillers. *Dent Mater J*. 2020;39(4):563–70.
[16] Noori AJ, Kareem FA. Setting time, mechanical and adhesive properties of magnesium oxide nanoparticles modified glass-ionomer cement. *Journal of Materials Research and Technology*. 2020 ; 9(2):1809–18.
[17] Salem A, Ali M, Abdul Rahim R. Evaluation of compressive strength and setting time of some types of calcium silicate based materials modified with chicken egg shell powder. *Al-Azhar Journal of Dental Science* [Internet]. 2023;26(4):477–83. Available from: https://ajdsm.journals.ekb.eg/article_320525.html
[18] Zhang J, Braun P, Banerjee A. In vitro compressive strength and edge stability testing of directly repaired glass-ionomer cements. *Clin Oral Investig*. 2020 ;24(9):3029–38.
[19] Elkorashy ME. Essential Oil Modification of Glass Ionomer Cement: Antibacterial Activity and Compressive Strength. *Egypt Dent J*. 2022 ; 68(4):3857–68.
[20] Jaikumar Ram A, Paulraj J, V K, Shanmugam R, Maiti S. Comparative Evaluation of Antimicrobial Effectiveness and Compressive Strength in Neem and Lemongrass-Modified Glass Ionomer Cement: An In Vitro Study. *Cureus*. 2024 ;16(3):e56234.
[21] Sherief DI, Fathi MS, Abou El Fadi RK. Antimicrobial properties, compressive strength and fluoride release capacity of essential oil-modified glass ionomer cements-an in vitro study. *Clinical Oral Investigation* [Internet]. 2021;25:1879–88. Available from: https://doi.org/10.1007/s00784-020-03493-0
[22] Isnaini N, Khairan K, Faradhilla M, Sufriadi E, Prajaputra V, Ginting B, et al. A Study of Essential Oils from Patchouli (Pogostemon cablin Benth.) and Its Potential as an Antivirus Agent to Relieve Symptoms of COVID-19. *Journal of Patchouli and Essential Oil Products*. 2022 ;1(2):27–35.
[23] Nurjanah S, Merita Rosi D, Putri Fathoni R, Zain S, Widyasanti A, Kaya Putri IL. Aktivitas Antibakteri Minyak atsiri nilam (Pogostemon cablin Benth) pada Beberapa Tingkat Kadar Patchouli Alkohol. *Jurnal Teknologi Industri Pertanian*. 2019 ;29(3):240–6.
[24] Elsharkawy SM, Gomaa YF, Gamal R. Experimental Glass Ionomer Cement Containing Gallic acid: Antibacterial Effect and Fluoride Release an in vitro Study. *Open Access Maced J Med Sci*. 2022 ;10(D):131–6.
[25] Tahir M, Muflihunna A, Syafrianti. Penentuan Kadar Fenolik Total Ekstrak Etanol Daun Nilam (Pogostemon cablin Benth.) dengan Metode Spektrofotometri UV-VIS. *Jurnal Fitofarmaka Indonesia*. 2017;4(1):215–8.
[26] Dian Firdausy M, Hadianto E, Christiono S. Price Disparities in GICs, Does It Influence The Surface Characterization?. *Dentino Jurnal Kedokteran Gigi*. 2022;7(1):78–81.
[27] Panpisut P, Monmaturapoj N, Srion A, Angkananuwat C, Krajangta N, Panthumvanit P. The effect of powder to liquid ratio on physical properties and fluoride release of glass ionomer cements containing pre-reacted spherical glass fillers. *Dent Mater J*. 2020;39(4):563–70.