Assessing the Antimicrobial Efficacy and Compressive Strength of Rose and Jasmine-Infused Glass Ionomer Cement: an In Vitro Analysis

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**Abstract:** Lack of information in the literature regarding the addition of natural antibacterial agents to glass ionomer cement (GICs). Therefore, the goal of the study was to enhance the antibacterial capabilities of GICs through their modification with a combination of rose and jasmine extract to be assessed against streptococcus mutans and lactobacillus in reference to antimicrobial and compressive strength qualities. The extract mixture was added in three different proportions to the dental cement Group I,Group II,Group III 2:1:1, 3:1:2 and 3:2:1). Specimens were then prepared and tested against the unmodified GIC Group IV (control). Antimicrobial activity was evaluated using MIC assay against lactobacillus and Streptoccocus mutans. Compressive strength was evaluated according to ISO 9917- 1:2007 using cylindrical molds (4.0 mm diameter × 6.0 mm height). Antimicrobial activity against Streptococcus mutans and Lactobacillus there was no significant difference between the extract-modified materials compared to the control group. Compressive strength results revealed that there was no statistically significant difference between the different mixtures and the control group. The extracts of rose and jasmine formulation based GIC against S. mutans and Lactobacillus showed similar results as that of control and compressive strength was unaltered. Thus the modified glass ionomer cement (GIC) with rose and jasmine components yields comparable outcomes to conventional GIC.

**Keywords:** Rose and jasmine, GIC, antimicrobial activity, compressive strength, streptococcus mutans and lactobacillus

# Introduction

Glass ionomer cements (GICs), classified as acid-base cements, are commonly referred to as "glass ionomer" in the dentistry field, although the International Organization for Standardization (ISO) officially designates them as "glass n cement" [(Chou et al., 2025; D. Singh et al., 2025)](https://paperpile.com/c/4yaJHk/zJoA+cTAt)[(Tiddy et al., 2012)](https://paperpile.com/c/4yaJHk/aF3G). Over the past several years, GICs have been extensively utilized in dentistry for tasks such as the final cementation of dental crowns, bridges, orthodontic brackets, and non-traumatic restorative treatment [[(Craig & Powers, 2002)](https://paperpile.com/c/4yaJHk/ft37)]. GICs are favored due to their ability to adhere adhesively to enamel and dentin, biocompatibility, and sustained release of fluoride ions [[(Experts, 2021; Sidhu, 2015)](https://paperpile.com/c/4yaJHk/RqQ6+wYtC)]. Furthermore, research has indicated that GICs can be recharged with fluoride ions. [(Ramsundar et al., 2023; Rieshy V. et al., 2023; Shenoy et al., 2023; S. Singh et al., 2023)](https://paperpile.com/c/4yaJHk/LAqbJ+6q6Ik+LQ631+V58BC) However, limitations such as minimal antibacterial properties and deficiencies in physical and mechanical characteristics have led to the development of modified GIC formulation 7s.[(Mahfouz et al., 2025; Mount, 2002; Virdi, 2015)](https://paperpile.com/c/4yaJHk/TMjX+Mo6B+ePP9)Research has indicated that bacteria can remain viable under Glass Ionomer Cement (GIC) for up to two years [[(Alsayed Tolibah et al., 2025)](https://paperpile.com/c/4yaJHk/0u2r)]. Although GICs release fluoride, studies have shown that the amount released within the first 48 hours after placement is typically less than 10 ppm, which is considered insufficient for desired antibacterial effects [[(AlMawash et al., 2025)](https://paperpile.com/c/4yaJHk/MxH4)]. To address this, researchers have explored the incorporation of additional antimicrobial agents into GICs, which may offer therapeutic benefits [[(Htet et al., 2025)](https://paperpile.com/c/4yaJHk/Z44R)]. These agents include antibiotics, zinc ions, silver ions, iodine, and chlorhexidine, with the latter being commonly used due to its effectiveness [[(Kuşçu et al., 2025; Wahab et al., 2024)](https://paperpile.com/c/4yaJHk/4YBa+J4nF)]. Several in vitro studies have demonstrated enhanced biological properties of GIC when combined with chlorhexidine [[(Kini et al., 2025)](https://paperpile.com/c/4yaJHk/yWZ2)]. However, the addition of antibacterial agents to restorative materials can negatively impact their physical and mechanical properties over time [[(Torres et al., 2025)](https://paperpile.com/c/4yaJHk/ZFEQ)].[(Doshi et al., 2023; Pandiyan et al., 2023; Pavithra et al., 2023; Thomas & Jain, 2023)](https://paperpile.com/c/4yaJHk/VB2gp+v7RGF+rPrvH+jyDcZ) Improper dosing or release control may also lead to short-term effectiveness and potential harm to surrounding tissues, which may explain the limited utilization of GICs combined with other antimicrobials in manufacturing [[(Enming et al., 2025; Jain et al., 2024; Shams et al., 2024; Vishnu & Jeevanandan, 2024)](https://paperpile.com/c/4yaJHk/hw3A+B3jm+rmbo+VPeg)Plants have been employed for both prevention and treatment of ailments for many centuries, predating the emergence of iatrochemistry in the 16th century [[(Ninawe et al., 2025)](https://paperpile.com/c/4yaJHk/rmzT)]. Phytomedicine, a form of herbal medicine utilizing various plant components or extracts, offers the advantage of yielding positive outcomes without the risk of bacterial resistance [(Sapuan et al., 2023)](https://paperpile.com/c/4yaJHk/02Ry)]. According to the World Health Organization, up to 80% of the global population relies on traditional herbal medicine for essential medical needs. Recent studies have focused on exploring the therapeutic properties of plants like rose and jasmine, known for their antioxidant and antibacterial activities in animal and in vitro experiments [[(Ge et al., 2024; International Organization for Standardization, 2007)](https://paperpile.com/c/4yaJHk/SBOt+R2Ih)].The Rosaceae family, also referred to as the rose family, constitutes a significant plant group, with the original genus Rosa giving the family its name. Genera such as Alchemilla, Sorbus, Cotoneaster, Rubus, and Prunus, which includes plums, cherries, peaches, and almonds, are among those with the highest number of species [[(Barathi et al., 2024)](https://paperpile.com/c/4yaJHk/9zXW)]. While further taxonomic work is necessary, these figures provide approximate estimates [[(Jadhav et al., 2024)](https://paperpile.com/c/4yaJHk/R1PK)]. The family encompasses trees, shrubs, and herbs, with some species being evergreen and others deciduous, distributed across the globe, though predominantly in the Northern Hemisphere [[(Gayathrie et al., 2024; Ilancheran et al., 2024; Rajput et al., 2024)](https://paperpile.com/c/4yaJHk/Akxk+xRvm+E8Jy)]. Jasmine, a genus of shrubs and vines in the olive family, comprises approximately 200 species native to tropical and warm temperate climates in Eurasia, Africa, and Oceania [[(Schmalz & Bindslev, 2008; Van Noort & Barbour, 2023)](https://paperpile.com/c/4yaJHk/Z9pz+5tIR)]. Jasmines are often cultivated for their distinctive floral scent. Phytochemical studies on jasmine flowers have identified various bioactive compounds such as phenols, flavonoids, tannins, alkaloids, and saponins, contributing to its reported antioxidant and anti-inflammatory activities [[(Padma Suresh et al., 2014)](https://paperpile.com/c/4yaJHk/wbJi)]. Given the rising incidence of recurrent caries post-restorative treatment, there is a growing need for effective direct filling materials. Thus, the primary objective of this study is to enhance the antimicrobial properties of Glass Ionomer Cements (GICs) through modification with a combination of rose and jasmine extracts, with a concurrent evaluation of their compressive strength properties.

# Materials and methods

## Preparation of extract

## Rose and jasmine extract

The flowers were subjected to a drying process for a duration of 5 days. Glassware utilized in the experiment was thoroughly cleaned, rinsed with distilled water, and then dried in a hot air oven set at 70 degrees Celsius prior to usage. In a beaker, 1 gram of leaves was accurately measured and combined with 100 milliliters of distilled water. The mixture was heated using a heating mantle to a temperature range of 60-70 degrees Celsius and maintained at this temperature for a duration of 15 minutes. Subsequently, the solution underwent filtration using Whatman No: 1 filter paper, with the resulting 80 milliliters of filtrate being collected in a separate conical flask. This filtered extract was further concentrated to a volume of 5 milliliters, while maintaining a temperature range of 60-70 degrees Celsius.

**Table 1:** (The type II GIC (GC corporation) was used in the present study)

|  |  |
| --- | --- |
| Groups | Description |
| I | PGIC: E: LGIC = 2:1:1 |
| II | PGIC: E: LGIC = 3:1:2 |
| III | PGIC: E: LGIC = 3:2:1 |
| IV | Control group –conventional GIC |

## Bacterial Strain and Inoculum Preparation

Streptococcus mutans and Lactobacillus acidophilus bacterial strains were sourced from the Department of Microbiology. Pure cultures of each strain were obtained by using a sterile loop to transfer a sample onto Mueller Hinton Agar plates. The facultative strains of S. mutans and Lactobacillus acidophilus were cultured on appropriate media and inoculated into separate tubes containing 5 milliliters of sterile Mueller Hinton broth. These tubes were then incubated at 37 degrees Celsius for a duration of 24 hours.

## Specimen preparation for antimicrobial testing

Following the mixing of the powder and liquid components of conventional GIC, the plant extract was introduced into the mixture. The resulting cement was then placed into cylindrical molds with dimensions of 6 mm in diameter and 2 mm in thickness. Once the cement had set, the specimens were carefully removed from the molds. Each specimen was accurately measured using calipers, and the measurements were recorded. Twelve specimens were prepared for each group. To assess the antibacterial effects of the tested groups, standard strains of S. mutans and Lactobacillus were employed.

## MIC Assay

The antimicrobial effectiveness of modified and unmodified GIC was evaluated using standard strains of S. mutans and Lactobacillus. Mueller Hinton Agar (MHA) broth was prepared, sterilized, and 200 µL was added to all wells of a microplate. Bacterial suspensions containing approximately 5×10^5 CFU/ml of S. mutans and Lactobacillus acidophilus were added to all four wells. Three different concentrations of GIC (2:1:1), (3:1:2), and (3:2:1) were tested, while the fourth well served as the control containing conventional GIC. Incubation was conducted under appropriate conditions for varying time intervals (1h, 2h, 3h, 4h). The percentage of dead cells was determined using an ELISA reader, measuring absorbance at a wavelength of 540nm at regular intervals.

## Specimen preparation for compressive strength evaluation

Compressive strength testing was conducted following the guidelines outlined in ISO 9917-1:2007, utilizing cylindrical molds with dimensions of 4.0 mm diameter and 6.0 mm height. Six specimens were prepared for each group, with any malformed or void-containing specimens being excluded. The diameter of each specimen was verified using a digital micrometer gauge. Subsequently, the specimens were vertically positioned in a Zwick universal testing machine (Zwick Zmart Pro). A compressive load was applied along the long axis of the specimens at a crosshead speed of 0.5 mm/min until fracture occurred. The maximum force applied at the point of fracture was recorded to determine the compressive strength values in megapascals (MPa).

## Statistical analysis

The collected data were inputted into a Microsoft Excel spreadsheet, after which statistical analyses were performed using SPSS version 24.0 developed by IBM Corporation. Mean Minimum Inhibitory Concentration (MIC) values were calculated utilizing descriptive analysis. All quantitative variables exhibited parametric distribution; thus, parametric tests were employed for both antimicrobial and compressive strength testing.

# RESULTS

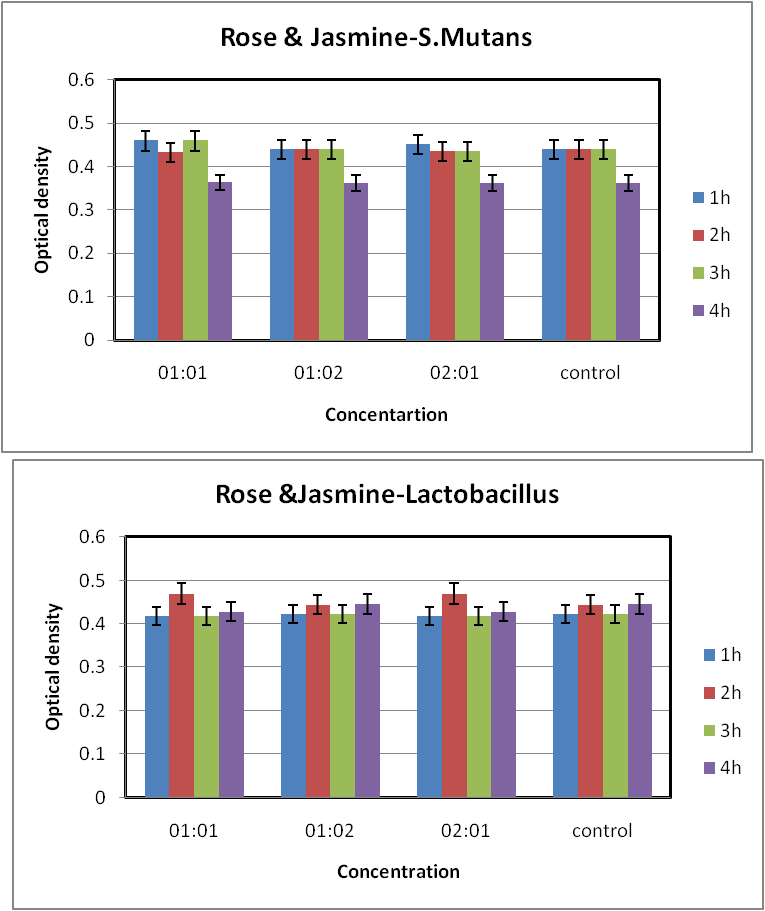
The results of Minimum Inhibitory Concentration (MIC) assays conducted against S. mutans and Lactobacillus demonstrated no significant difference compared to the control group (p > 0.05), as depicted in Figures 1A and 1B. This indicates that similar outcomes were attained with both modified GIC and conventional GIC formulations, as summarized in Table 1 and Table 2.Furthermore, the modification of GIC did not result in any alterations to the compressive strength of conventional GIC, as evidenced by the lack of significant difference (p > 0.05). This further supports the finding that there were no discernible differences between the modified and conventional GIC formulations in terms of their compressive strength properties.

**Table 2:** Mean MIc values of s.mutans

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| S.mutans |  | | | |
| Conc | 1h | 2h | 3h | 4h |
| 01:01 | 0.459 | 0.432 | 0.459 | 0.363 |
| 01:02 | 0.439 | 0.439 | 0.439 | 0.362 |
| 02:01 | 0.45 | 0.435 | 0.435 | 0.362 |
| control | 0.439 | 0.439 | 0.439 | 0.362 |

**Table 3:** Mean MIC values of Lactobacillus

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Lactobacillus | |  | | |
| Conc | 1h | 2h | 3h | 4h |
| 01:01 | 0.418 | 0.47 | 0.418 | 0.428 |
| 01:02 | 0.422 | 0.444 | 0.422 | 0.446 |
| 02:01 | 0.418 | 0.47 | 0.418 | 0.428 |
| control | 0.422 | 0.444 | 0.422 | 0.446 |



**Figure 1:** Antimicrobial efficacy of Rose and jasmine modified GIC a)s.mutans b)Lactobacillus

# Discussion

Dental caries, commonly known as tooth decay, is a prevalent chronic disease affecting individuals worldwide, with the potential to develop at any stage of life. The onset of dental caries involves a complex interaction among acid-producing bacteria, fermentable carbohydrates, and various host factors such as saliva and tooth structure. This condition can manifest as early childhood caries, posing a significant risk to the primary teeth of infants and toddlers, affecting both the crowns and roots of the teeth [[(Zohoori & Duckworth, 2019)](https://paperpile.com/c/4yaJHk/oIpP)]. Various factors, including high levels of cariogenic bacteria, reduced saliva production, inadequate exposure to fluoride, poor oral hygiene practices, improper infant feeding habits, and socioeconomic status, contribute to the increased risk of dental caries. [(Kachhara et al., 2021; Lakshmi, 2021; Lampl et al., 2023; Subramanian et al., 2023)](https://paperpile.com/c/4yaJHk/h2DED+tBYPW+qGOx1+8Dj6x) These common risk factors should form the basis for primary prevention strategies. Secondary prevention and treatment efforts should focus on managing the caries process over time using minimally invasive approaches that preserve dental tissue, tailored to the individual needs of patients.Glass ionomers have become a common choice among restorative materials for pediatric dental procedures, transitioning from traditional formulations to primarily resin-modified variants, with the exception of the ART approach. The physical characteristics of resin-modified materials have been specifically developed to enhance their clinical handling and inherent properties. [(Gandhi et al., 2021; Janani et al., 2021; Ganapathy, 2021)](https://paperpile.com/c/4yaJHk/0bX6f+3R7Kv+uLRgQ) Notably, the less hydrophobic nature of resin-modified glass ionomers compared to resin composites, which are designed to repel water, is considered one of their most advantageous features as restorative materials(Rafi et al., 2024). In instances where clinical failure of resin-modified glass ionomers may be attributed to visible moisture, the more hydrophilic nature of these materials, containing water themselves, may enable them to tolerate unseen moisture that remains in the tooth structure during the procedure.In this study, mixtures of rose and jasmine extracts were incorporated into glass ionomer cement at three different volume ratios (Tuluwengjiang et al., 2024). The antimicrobial and compressive strength properties of these extract-modified materials were evaluated and compared with those of conventional GIC (Control). The antimicrobial activity against S. mutans and Lactobacillus was assessed using the minimal inhibitory concentration assay (MIC). These microbial strains were selected because S. mutans, which is primarily responsible for fermenting carbohydrates and producing acids, is a major contributor to dental caries formation. [(Dharman et al., 2023; Govindaraj et al., 2023; Neeharika et al., 2023; Ramalingam et al., 2023)](https://paperpile.com/c/4yaJHk/vWhxl+4wUdM+v5vM9+naqh5) Additionally, Lactobacillus was chosen as it serves as a sensitive indicator strain for detecting the release of antibacterial compounds. Furthermore, it is noteworthy that Lactobacillus has been identified as one of the predominant opportunistic pathogens isolated from the teeth and gums of children aged 7–16 years [[(Agarwal et al., 2025; Beierlein et al., 2024; Karim et al., 2025; Ravi et al., 2024)](https://paperpile.com/c/4yaJHk/i9FK+4RDa+Eg2W+odUf)].The results from the minimal inhibitory concentration (MIC) assays conducted on S. mutans and Lactobacillus indicate that the extract-modified GIC exhibits similar antimicrobial activity compared to the control, with no statistically significant difference observed. These findings are consistent with previous studies by Thaweboon et al. [[(Nayik & Ansari, 2023)](https://paperpile.com/c/4yaJHk/t0DP)], which demonstrated significant antibacterial activity against S. mutans, and Antoniadou et al. [[(Imran et al., 2024; Rufasto-Goche et al., 2025)](https://paperpile.com/c/4yaJHk/m5vt+wxhI)], who reported promising results of rose extract against dental caries and oral inflammations, supporting its antimicrobial efficacy.In terms of clinical performance, the compressive strength of dental cements is crucial for withstanding the stresses encountered during mastication and function. According to ISO 9917 (2007), restorations require a compressive strength of 100 MPa, while base/lining materials necessitate a strength of 50 MPa. The current study found that the addition of rose and jasmine formulation did not impact the compressive strength of GIC, aligning with the findings of Farret et al. [[(Davidson & Mjör, 1999)](https://paperpile.com/c/4yaJHk/cpnT)] and Jaidka et al. [[(Duggal et al., 2021)](https://paperpile.com/c/4yaJHk/Z6qF)], who reported that the inclusion of antimicrobial agents at specific concentrations did not affect the compressive strength properties of GIC.However, it is important to acknowledge limitations in the present study, such as the small sample size and potential operator discrepancies. Further research investigating additional bacterial strains, shear bond strength, and practical applicability in dental practice is currently underway.

# Conclusion

In summary, the incorporation of a rose and jasmine formulation into glass ionomer cement (GIC) demonstrated comparable antibacterial activity and compressive strength to conventional GIC. These findings suggest that the modified GIC could serve as a promising alternative for dental restorations, offering similar performance while potentially leveraging the antimicrobial properties of natural extracts. Further research is needed to validate these results and explore the practical application of the rose and jasmine formulation-based GIC in clinical settings.

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