Original Article

DOI: 10.7860/JCDR/2026/82545.23654

Dentistry Section

Formulation and Evaluation of Antimicrobial, Anti-inflammatory, and Physicochemical Properties of Herbal Oral Gel Prepared from *Jasminum grandiflorum* Leaf Extract: An In-vitro Study

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ABSTRACT

Introduction: Periodontitis is a chronic inflammatory disease that requires effective management, often involving adjunct therapies like chlorhexidine, but it comes with its own set of side-effects, creating a need for alternatives. *Jasminum grandiflorum* (jasmine), rich in bioactive compounds with anti-inflammatory, antioxidant, and antimicrobial properties, holds potential for periodontal therapy. Given the limitations of chlorhexidine-based adjuncts, exploring safer, plant-derived formulations is essential.

Aim: To formulate a gel containing *Jasminum grandiflorum* leaf extract and evaluate its anti-inflammatory, antimicrobial, and physicochemical properties in comparison to chlorhexidine gel.

Materials and Methods: The present in-vitro study was carried out in Saveetha Dental College, SIMATS University (Chennai, Tamil Nadu, India) from January 2024 to March 2024. A *Jasminum grandiflorum* leaf extract gel was formulated by combining bioactive compounds from dried leaves with Carbopol and carboxymethyl cellulose and evaluated its anti-inflammatory and antimicrobial properties compared to chlorhexidine gluconate gel (Hexigel). Anti-inflammatory activity was tested using the egg albumin denaturation assay, while antimicrobial activity was assessed against anaerobic bacteria using the agar well diffusion method, along with evaluations of wettability to assess the contact angle, and temperature stability. Statistical comparisons were performed using one-way Analysis of Variance (ANOVA), and p-values<0.05 were interpreted as statistically significant.

Results: The Jasmine gel showed 77% anti-inflammatory activity at 50 µg/L, comparable to chlorhexidine (81%) and diclofenac sodium (80%), but its antimicrobial activity was weaker, with a 9 mm zone of inhibition compared to chlorhexidine's 24 mm. It demonstrated excellent stability across various temperatures. Jasmine gel shows good anti-inflammatory and stability profiles but no antimicrobial action, requiring further optimisation before it can be considered alongside chlorhexidine.

Conclusion: *Jasmine grandiflorum* demonstrated potent anti-inflammatory activity, combined with its superior physicochemical properties, it can be a useful adjunct in non-surgical periodontal therapy.

Keywords: Anti-infective agents, Anti-inflammatory agents, Chlorhexidine, Periodontitis

INTRODUCTION

Periodontitis is a multifactorial chronic inflammatory disease that causes the destruction of the periodontium and loss of the alveolar bone, which eventually disrupts the natural support of the tooth [1]. Periodontal disease significantly impacts oral health, general health, and quality of life, contributing to systemic conditions such as diabetes and cardiovascular diseases. The economic burden of periodontal disease is substantial, with costs associated with treatment, productivity loss, and long-term healthcare implications. The global economic impact of periodontal disease is estimated to be billions of dollars annually, emphasising the need for cost-effective and accessible treatment alternatives.

Non-surgical periodontal therapy is the first line of treatment in the management of periodontitis [2]. Scaling and root planing, as a non-surgical therapy, intends to mechanically debride the pocket and remove plaque and calculus from the surface of the tooth [2]. The use of adjunctive therapy is dictated when these mechanical measures prove to be ineffective in cases where access for periodontal instrumentation is difficult, resulting in incomplete debridement [3]. These adjuncts in the form of chips, fibres, and gels have been formulated and tested clinically. Chlorhexidine has been the benchmark adjunct for the past three decades to non-surgical periodontal therapy worldwide. The use of chlorhexidine has been in various forms, ranging from mouthwashes to chips, for use as a Local Drug Delivery (LDD) agent [4]. Several systematic reviews have verified its efficacy as a potent antimicrobial in the adjunctive treatment of periodontitis. This eventually leads to a reduced microbial load, potentially resolving the signs and symptoms of inflammation. Nonetheless chlorhexidine doesn't come without its own set of side-effects, such as tooth discoloration, and calculus formation [5]. One of the potential solutions to these problems lies in the use of herbal alternatives with fewer side-effects, equivalent biological properties, and cost-effectiveness.

These alternatives have been described in traditional Indian medicine with the use of naturally available herbal substances that can be concentrated and utilised for the treatment of a broad range of diseases and conditions affecting the oral cavity, owing to their significant therapeutic potential and relatively low risk of adverse effects on overall health. Traditionally, herbs like *Ocimum sanctum* [6], *Curcumin* [7], *Punica granatum* [8], *Cassia lanata, Cassia alata* [9] have demonstrated good anti-inflammatory and antimicrobial activity. Other herbal-based products like acemannan from aloe vera have been used to expedite the healing process in the oral cavity [10]. Khuntia P in 2023 used cranberry extract and PRF to stimulate periodontal bone regeneration and hasten the resolution of inflammation [11].

However, the search for alternatives with efficacy equivalent to the gold standard continues.

This search led to the discovery of one of the lesser-explored herbs, Jasmine. Jasmine has been known to give beautiful white flowers. It is found in several parts of the country, including Tamil Nadu, Kerala, Madhya Pradesh, Assam, Bihar, Gujarat, Maharashtra, and Uttar Pradesh, and is easily cultivable.

Jasminum grandiflorum, a species belonging to the *Oleaceae* family, is less known for its leaves, which are rich in ascorbic acid, salicylic acid, and glucosides [12]. The plant has a broad ecological distribution and is traditionally utilised for its therapeutic properties. These bioactive compounds in the leaves also demonstrate anti-inflammatory, anti-oxidant, anti-ulcer, sedative, and anti-depressant properties that can be used for the treatment of certain basic ailments of the body, such as ulcers, wounds, skin disorders, and spasms [13]. These effects of the herb can be employed for the management of a wide array of oral conditions, like oral ulcers, aphthous ulcers [14], gingival conditions, including gingivitis, gingival enlargements, gingival abscesses [15], periodontal conditions like periodontal abscess and periodontitisbased on the reported anti-inflammatory and antimicrobial properties of the herb [16]. Given its beneficial properties, *Jasminum grandiflorum* leaves could serve as a natural adjunct in the form of LDD or wound dressing in periodontal care. The advantage is that of fewer side-effects and better patient acceptance [17].

Therefore, the present study aimed to assess the pharmacological potential of *Jasminum grandiflorum* leaves by evaluating the anti-inflammatory, antimicrobial, and physicochemical properties of a Jasmine leaf gel in comparison with a commercially available chlorhexidine gluconate gel (Hexigel).

The objectives of the present study were to evaluate the anti-inflammatory activity of the formulated *Jasminum grandiflorum* leaf gel, to assess its antimicrobial efficacy against oral pathogens, to compare these properties with those of chlorhexidine gel (hexigel), and to characterise its physicochemical properties, including wettability and temperature stability.

The null hypothesis (H_0) stated that there is no significant difference between Jasmine leaf gel and chlorhexidine gel in anti-inflammatory activity and antimicrobial activity, while the alternate hypothesis (H_1) proposed that there is a significant difference between the two gels in one or more of the evaluated parameters.

MATERIALS AND METHODS

The present in-vitro experimental study was conducted at Saveetha Dental College and Hospitals, Chennai, Tamil Nadu, India, over a three-month period from January 2024 to March 2024. Ethical approval for the study was obtained from the Scientific Review Board (SRB/SDC/PERIO-2301/24/329).

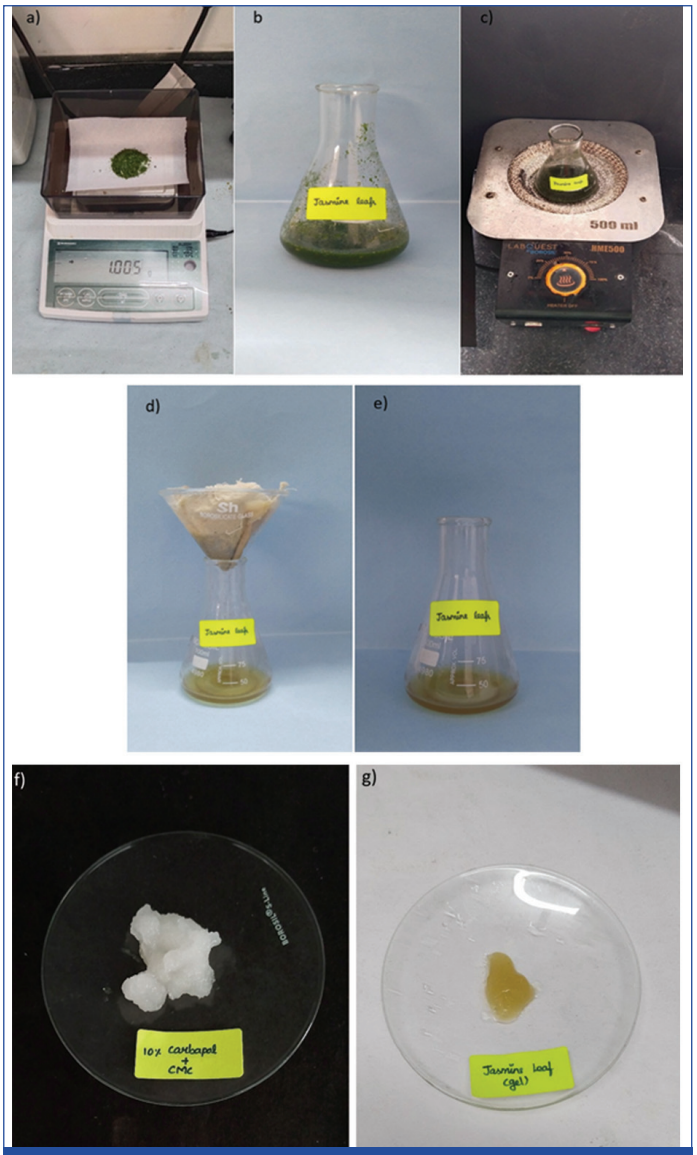
Inclusion and Exclusion criteria: The study included freshly obtained egg albumin, anaerobic periodontal pathogens (*Porphyromonas gingivalis*, *Tannerella forsythia*, and *Treponema denticola*) obtained from the institutional microbiology repository were included in the study. Jasmine leaf extract that were fresh, disease-free, and free from pesticide exposure were selected for extract preparation, along with commercially available chlorhexidine gel, while samples showing contamination or improper potential of Hydrogen (pH) were excluded.

Study Procedure

The study procedures involved the formulation of a *Jasminum grandiflorum* leaf extract gel, and were included only if they exhibited acceptable pH (5.5-7.0), homogenous consistency, uniform texture, appropriate viscosity, and absence of phase separation or precipitation followed by investigation of its anti-inflammatory activity using the egg albumin denaturation assay, evaluation of antimicrobial activity using the agar well diffusion method, and characterisation of physicochemical properties such as wettability and temperature stability. Samples were excluded if the egg albumin showed turbidity, coagulation, or contamination; if bacterial cultures exhibited mixed growth, contamination, or failure to grow under anaerobic conditions; if jasmine leaves were wilted, infected, chemically treated, or improperly dried; if the extract or gel showed abnormal pH, phase separation, non-homogenous consistency, or visible contamination; or if the chlorhexidine gel was expired or improperly stored.

Preparation of Gel: *Jasminum grandiflorum* leaf extract was obtained by dissolving one gram of jasmine leaf powder (prepared from jasmine leaves, obtained from Natural Remedies, Bangalore, washing them under tap water, drying them under the shade, and grinding them into a fine powder) in 50 millilitres of distilled water. The solution was then boiled on a heating mantle at 50°C for 15 minutes and then cooled down to room temperature. The cooled solution was then filtered using No.1 Whatman filter paper, and the filtered solution was concentrated up to 5 mL by heating the solution over the heating mantle to acquire the extract [18].

To bring this solution into a gel form, 5% of carabapol and 5% of carboxy methyl cellulose were mixed, and 2mL of the concentrated Jasmine leaf extract was added [Table/Fig-1a-g] [18]. The resultant gel was mixed using a homogeniser. The chlorhexidine gluconate gel (Hexigel), the comparator, was purchased from a pharmaceutical shop.



[Table/Fig-1]: Steps in the formulation of the jasmine gel: a) 1 gm of jasmine leaves powder; b) Jasmine leaves powder mixed with 50 ml of distilled water; c) Resultant solution heated on a mantle at 50 degree Celsius; d) Solution filtered with Whatman No.1 filter paper; e) Concentrated solution; f) 5% cabapol and 5% carboxymethl cellulose (CMC) mixed; g) 2mL of jasmine extract mixed with the carbopol, CMC mix to obtain the Jasmine gel.

Anti-Inflammatory Activity: To assess and compare the anti-inflammatory activity, both the gels were subjected to the Egg albumin denaturation assay [19]. A 0.2 mL of fresh egg albumin was mixed with 2.8 mL of Phosphate buffer solution. Different concentrations (ranging from 10-50 microgram/litre) of Jasmine gel (Group-1) and Chlorhexidine gel (Group-2), and diclofenac sodium (Group 3) were added to the reaction mixture. The pH was adjusted to 6.3. Following this, the mixture was kept at room temperature for 10 minutes after which it was incubated in a water bath at 55 degrees Celsius for 30 minutes. Jasmine gel (Group-1) was the test group, Chlorhexidine (Group-2) was the control, and Diclofenac sodium (Group 3) was used as the standard. The samples were then measured spectrophotometrically at 660nm (using JASCO Double Beam UV-Visible Spectrophotometer V-730) [Table/Fig-2]. The anti-inflammatory activity was assessed based on the inhibition of the protein denaturation of egg albumin by the test and control products. The higher the percentage of inhibition, the better the anti-inflammatory activity.

[Table/Fig-2]: UV spectrophotometer used to assess the absorbance of samples for the anti-inflammatory activity.

Percentage inhibition of protein denaturation was calculated by using the following equation-

$$\text{Percentage inhibition\%} = \frac{\text{Absorbance of the control} - \text{Absorbance of the sample} \times 100}{\text{Absorbance of the control}}$$

The percentage of inhibition was determined and tabulated [20]. All experiments were performed in triplicate for each group and each concentration, and the mean and standard deviation were calculated from three independent measurements.

Antimicrobial Test: Agar well diffusion technique [21] was used to assess the antimicrobial activity of the gels. Brain Heart Infusion (BHI) agar plates were prepared and then sterilised using an autoclave at 121 degrees Celsius for 15-20 minutes. Following the process of sterilisation, anaerobic organisms (*Porphyromonas gingivalis, Tannerella forsythia,* and *Treponema denticola*) were cultured in the BHI agar in an anaerobic environment with an atmosphere of 5% H_2, 10% CO_2, and 85% N_2. The bacterial suspensions, named Bacterial samples I and II (Bacterial Sample-I and Bacterial Sample-II represent two independently prepared pooled inocula from fresh cultures of the same red-complex organisms and were used as technical replicates to ensure reproducibility, they do not represent biologically different microbial populations), were spread evenly onto the agar plates using sterile cotton swabs for culturing. A 9-millimeter diameter wells were created onto the plates using sterile polystyrene strips. Different concentrations (25, 50, and 100 micrograms) of the Jasmine and Chlorhexidine gels were then filled into the wells. Following this, McIntosh and Filde's anaerobic jar was used for anaerobic microorganism culturing.

The antimicrobial activity was evaluated by measuring the zone of inhibition around the wells in mm (measured using a ruler in mm) and the results were tabulated. The BHI agar plates were prepared and sterilised in an autoclave at 121°C for 15-20 minutes. The anaerobic bacterial strains *Porphyromonas gingivalis*, *Tannerella forsythia* and *Treponema denticola* were procured from the Microbiology Culture Repository, Department of Microbiology, Saveetha Dental College, Chennai, Tamil Nadu India. These organisms were specifically selected because they constitute the "red complex", a highly pathogenic microbial consortium strongly associated with chronic periodontitis and periodontal tissue destruction.

After sterilisation, the organisms were cultured on BHI agar under strict anaerobic conditions (5% H_2, 10% CO_2, 85% N_2). Two independent bacterial inoculums, referred to as bacterial Sample-I and bacterial Sample-II, were prepared by pooling separate fresh cultures of the red-complex organisms to ensure reproducibility of results. These pooled suspensions represented two independent microbial challenges for comparative testing, not clinical plaque from patients. The bacterial suspensions were spread evenly on agar plates using sterile cotton swabs. Wells measuring 9 mm in diameter were created using sterile polystyrene strips, and different concentrations (25, 50, and 100 µg/mL) of Jasmine gel and chlorhexidine gel were dispensed into the wells. The plates were incubated for 48 hours in a McIntosh and Filde's anaerobic jar. Antimicrobial activity was assessed by measuring the diameter of the zone of inhibition around each well in millimetres (a digital vernier calliper in mm), and the results were tabulated.

Physical Characterisation

Physical characterisation was performed to assess the gel's stability and ability to adhere and spread within the oral cavity, factors essential for its potential use as a periodontal adjunct.

Wettability/Contact Angle Measurement: Contact angle and wettability measurement of the Jasmine gel was done using the OSSILA GONIOMETER with the gel prepared into a dispersion for easy handling within the instrument [22]. Surface hydrophilicity was assessed using a goniometric method with a K100 force tensiometer. Samples measuring 10 mm × 20 mm were placed on a clean glass slide, and a 0.46 g droplet of water was dispensed from the tip of the instrument needle. Advancing contact angles were recorded as water was gradually added until the droplet front moved forward, while receding angles were measured by withdrawing water until the droplet edge retreated.

Temperature change test: To assess the stability of the formulation in different temperatures, tubes containing the Jasmine gel were put in temperatures of 2-8°, 25° and 40°, 45°, and their appearance was observed at Week 1 and Week 2 [8].

STATISTICAL ANALYSIS

Statistical tests were performed using IBM Statistical Package for the Social Sciences (SPSS) Statistics 23. One-way ANOVA was employed to evaluate inter-group comparisons between the Jasmine gel, chlorhexidine gel, and diclofenac sodium groups in the anti-inflammatory test. A p-value <0.05 was considered statistically significant. Antimicrobial activity was assessed descriptively by measuring the diameter of the zones of inhibition in millimeters. As this was a preliminary in-vitro screening study and the differences between the groups were consistently evident across all concentrations, no inferential statistical analysis was performed for the antimicrobial assay.

RESULTS

Anti-inflammatory activity: All gels demonstrated a concentration-dependent increase in anti-inflammatory activity, with the maximum inhibition observed at 50 µg/mL. The Jasmine gel showed 77% inhibition, whereas chlorhexidine exhibited 81% inhibition and diclofenac sodium demonstrated 80% inhibition at the same concentration [Table/Fig-3]. One-way ANOVA revealed no

statistically significant difference in the inter group comparison at all tested concentrations (p-value >0.05) [Table/Fig-4].

Antimicrobial activity: The antimicrobial activity of the Jasmine gel remained consistent across all tested concentrations, demonstrating a 9 mm zone of inhibition for both plaque samples [Table/Fig-5,6]. In contrast, chlorhexidine exhibited markedly greater antibacterial efficacy, with inhibition zones ranging from 17 mm at 25 µg/mL to 24 mm at 100 µg/mL [Table/Fig-7,8].

Wettability/Contact Angle Measurement and Temperature change

The contact angle measurements for the Jasmine gel were 73.71° on the right droplet boundary and 77.99° on the left, resulting in a mean contact angle of 75.85° [Table/Fig-9,10]. As the mean value was less than 90°, the formulation was classified as hydrophilic. This hydrophilic nature indicates favourable spreading characteristics and suggests improved mucosal interaction and retention when applied intraorally [23].

Temperature stability testing demonstrated that the Jasmine gel maintained its physical characteristics including colour, consistency, homogeneity, and absence of phase separation when exposed to a range of storage conditions (2-8°C, 25°C, 40°C, and 45°C). No detectable changes were observed throughout the assessment period, indicating that the formulation remained physically stable under varying thermal environments.

DISCUSSION

The present study aimed to explore the therapeutic potential of *Jasminum grandiflorum* leaf extract in the formulation of a gel intended for use in periodontal therapy. The primary outcomes evaluated were anti-inflammatory activity, antimicrobial efficacy, and physicochemical properties relevant to oral application.

The anti-inflammatory effect of the Jasmine gel, assessed via the egg albumin denaturation assay, revealed a dose-dependent inhibition with a maximum inhibition of 77% at 50 µg/mL, which was comparable to that of the gold standard chlorhexidine (81%) and the non-steroidal anti-inflammatory drug diclofenac sodium (80%), suggesting that the phytoconstituents present in jasmine leaves-such as flavonoids, terpenoids, and phenolic compounds-may exert a membrane-stabilising or protein-denaturation inhibitory effect. These results are consistent with previous research highlighting the anti-inflammatory and antioxidant properties of *Jasminum grandiflorum* in systemic disease models such as inflammatory bowel disease and arthritis [13]. Such equivalence in anti-inflammatory potential supports its candidacy as a natural alternative for managing inflammatory oral conditions like gingivitis and periodontitis.Clinically, a formulation with anti-inflammatory properties could help reduce gingival swelling, bleeding on probing, and patient discomfort, particularly in individuals who are unable to tolerate Nonsteroidal Anti-Inflammatory Drugs (NSAIDs) or are seeking herbal alternatives.

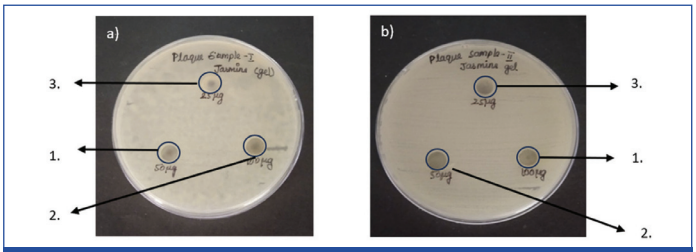
Despite promising anti-inflammatory outcomes, the antimicrobial performance of the jasmine gel was inadequate. The zone

Sample groups Concentration (µg/mL)	Percentage inhibition at different concentrations				
	10	20	30	40	50
Jasmine gel (Group 1)-Test	52%	60%	64%	68%	77%
Chlorhexidine gel (Group 2)-Control	55%	64%	69%	72%	81%
Diclofenac sodium (Group 3)-Standard	53%	61%	67%	70%	80%

[Table/Fig-3]: Percentage of inhibition of egg albumin denaturation of all three samples at different concentrations.
µg/mL - microgram per milliliter.

Zone of inhibition at different concentrations	25 µg/mL	50 µg/mL	100 µg/mL
Bacterial Sample-I	9 mm	9 mm	9 mm
Bacterial Sample-II	9 mm	9 mm	9 mm

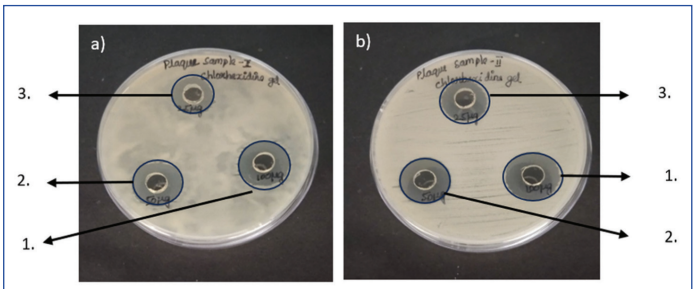
[Table/Fig-5]: Zone of inhibition (measured in mm) of different concentrations of Jasmine gel in two different plaque samples.
µg/mL- microgram per milliliter; mm- millimeter



[Table/Fig-6]: Zone of inhibition of different concentrations of Jasmine gel in two different plaque samples: a) and b) as seen on the agar plate at concentrations of: 1) 25 µg/mL; 2) 50 µg/mL; and 3) 100 µg/mL.
("Plaque Sample" in the images refers to bacterial samples prepared from pooled red-complex organisms and does not represent clinical dental plaque. Plaque Sample-I= Bacterial Sample-I and Plaque Sample-II= Bacterial Sample-II).

Zone of inhibition at different concentrations	25 µg/mL	50 µg/mL	100 µg/mL
Bacterial Sample-I	17 mm	20 mm	22 mm
Bacterial Sample-II	18 mm	22 mm	24 mm

[Table/Fig-7]: Zone of inhibition (measured in mm) of different concentrations of Chlorhexidine gel in two different plaque samples.
µg/mL - microgram per milliliter; mm- millimeter

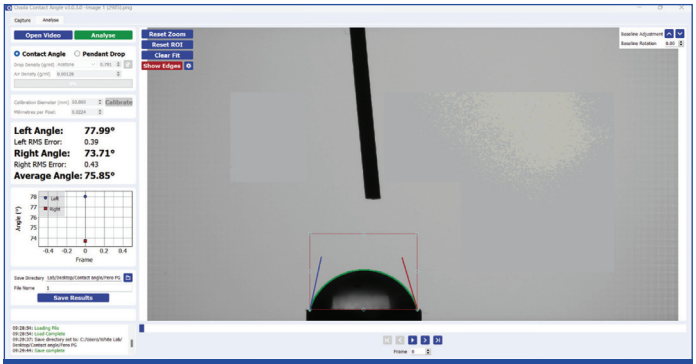


[Table/Fig-8]: Zone of inhibition of different concentrations of Chlorhexidine gel in two different plaque samples: a) and b) as seen on the agar plate at concentrations of: 1) 25 µg/mL; 2) 50 µg/mL; and 3) 100 µg/mL.
("Plaque Sample" in the images refers to bacterial samples prepared from pooled red-complex organisms and does not represent clinical dental plaque. Plaque Sample-I= Bacterial Sample-I and Plaque Sample-II= Bacterial Sample-II).

Concentrations	Mean and standard deviation			p-value	F-value
	Jasmine gel (Group-1)	Chlorhexidine gel (Group-2)	Diclofenac sodium (Group 3)		
10 µg/mL	52 ± 4.58	55 ± 4.35	53 ± 2.00	0.642	0.477
20 µg/mL	60 ± 2.64	64 ± 2.64	61 ± 2.00	0.196	2.167
30 µg/mL	64 ± 1.73	69 ± 3.00	67 ± 2.64	0.125	3.000
40 µg/mL	68 ± 3.00	72 ± 1.73	70 ± 3.60	0.308	1.440
50 µg/mL	77 ± 3.00	81 ± 2.64	80 ± 3.00	0.285	1.560

[Table/Fig-4]: Table displaying the one-way ANOVA analysis of inter-group differences in anti-inflammatory activity. Values are expressed as mean ± standard deviation. A p-value <0.05 was considered statistically significant
SD: Standard Deviation; ANOVA: Analysis of Variance; F-F statistic; µg/mL: microgram per milliliter.

[Table/Fig-9]: Ossila goniometer for measuring the contact angle.



[Table/Fig-10]: Contact angle measurement displayed on the OSSILA software.

of inhibition remained constant at 9 mm across all tested concentrations, corresponding to the diameter of the agar well, and was markedly lower than that observed with chlorhexidine. This indicates that the formulation did not produce a measurable inhibitory effect against the tested red-complex pathogens under the present experimental conditions. This suggests that while the gel contains bioactive compounds with antimicrobial potential, the concentration or bioavailability of these constituents may be insufficient to inhibit highly virulent red-complex pathogens effectively. Clinically, this means that Jasmine gel may not be suitable as a primary antimicrobial agent in periodontal therapy, but could still be considered as a supportive adjunct when combined with scaling and root planing or other antimicrobial agents. This observation aligns with earlier reports indicating that Jasmine extract alone has moderate antimicrobial properties but may require formulation enhancement for clinical efficacy [24]. Existing evidence indicates that combining *Jasminum grandiflorum* with *Hibiscus rosa-sinensis* may potentiate its antimicrobial spectrum [24]. Thus, while *Jasminum grandiflorum* appears effective in modulating inflammation, it may not serve as a standalone antimicrobial agent for periodontal pathogens. Hirapara H et al., in 2017 conducted an animal study in diabetic Wistar Albino rats and concluded that the ethanolic extract of *Jasminum grandiflorum linn*. flowers had the potential to form new granulation tissue and blood vessels (neo-angiogenesis) and also induced wound contraction and suggested their potential in wound healing [14]. Mortazavi H et al., 2020 formulated a *Jasminum grandiflorum* leaves mucoadhesive and concluded that Jasmine was more effective than a placebo in accelerating wound healing of oral biopsy ulcers [12]. Widowati W et al., in 2018 reported the anti-oxidant and anti-ageing effects of Jasmine Sambac extract and its compounds [25]. Zhao G et al., in 2009 demonstrated the antiviral effect of *Jasmine officinale L. var grandiflorum* against hepatitis B [26]. Even the anti-convulsant and anti-nociceptive hydroalcoholic extract of *Jasminum grandiflorum* leaves has been described by Reddy P and Gupta R in 2013 in experimental animals [27].

Additionally, the contact angle measurements averaging 75.85° indicate that the gel is hydrophilic, favouring wetting and spreadability over mucosal surfaces.This is clinically significant because improved tissue adherence allows the gel to remain longer in the oral cavity, promoting extended exposure of periodontal tissues to the active ingredients. Enhanced wettability also suggests that the gel may remain in situ in the gingival crevice for longer durations, potentially improving its therapeutic efficacy despite its inadequate antimicrobial action.

The formulation demonstrated stability across varying temperature conditions, indicating its suitability for diverse storage environments and enhancing its potential for patient use. Temperature stability is vital for commercial products, as fluctuations can cause phase separation, changes in viscosity, or reduced bioactivity. A thermally stable gel is therefore more likely to deliver consistent therapeutic effects and maintain patient acceptability, supporting its promise as a viable herbal oral care formulation [28]. A noteworthy strength of the present study is its multiparametric assessment, integrating both biological and physical evaluations of the herbal gel.

Furthermore, comparative analysis with other herbal gels- such as those based on *Ocimum sanctum*, *Aloe vera*, or *Punica granatum* was not performed within the present study, although existing literature reports comparable or lower anti-inflammatory activity among those agents [5-8]. However, *Jasminum grandiflorum* demonstrated a balanced profile with good biocompatibility and physical stability, which are often not simultaneously reported with other herbal agents.

Based on the results, the null hypothesis was partially accepted. Jasmine gel showed no significant difference compared to chlorhexidine in anti-inflammatory activity, but it demonstrated significantly lower antimicrobial efficacy, thereby supporting the alternate hypothesis for the antimicrobial outcome.

From a translational perspective, improving the antimicrobial efficacy possibly by incorporating synergistic herbs or encapsulating the extract in nanocarriers may significantly increase the clinical applicability of the formulation. Additionally, evaluation of cytotoxicity, in-vivo biocompatibility, and pharmacokinetics would be crucial next steps before considering clinical trials. Ultimately, integration of this gel into clinical practice as an adjunct in non-surgical periodontal therapy will depend on its ability to demonstrate safety, efficacy, and cost-effectiveness in controlled human studies.

Limitation(s)

However, several limitations should be acknowledged. First, all findings are derived from in-vitro assays, and extrapolation to clinical performance requires caution. Secondly, although plaque samples were used for antimicrobial testing, characterisation of specific anaerobic pathogens (e.g., *Porphyromonas gingivalis*, *Treponema denticola*) using molecular methods could have enhanced the granularity of the data. No confounding factors were encountered during the experimental procedures; however, factors such as operator variability, environmental influences, and sample preparation inconsistencies may influence results in real-world settings and should be considered in future studies.

The antimicrobial activity of the Jasmine gel was inadequate, and the extract was not phytochemically standardised, which may affect reproducibility. As the investigation was conducted in-vitro, the findings may not fully reflect clinical conditions. Only selected periodontal pathogens were tested, and key formulation parameters such as viscosity and rheological behaviour were not assessed. Additionally, long-term stability and cytotoxicity evaluations were not performed, limiting conclusions regarding the formulation's clinical applicability.

Long-term stability testing in accordance with standard pharmaceutical guidelines was not performed in the present study, as the two-week assessment was intended only as a preliminary

short-term evaluation to detect immediate physical changes; therefore, extended stability studies are recommended in future investigations.

CONCLUSION(S)

Jasminum grandiflorum leaf extract gel demonstrated a promising anti-inflammatory effect comparable to chlorhexidine and diclofenac sodium in an in-vitro model. Its favourable hydrophilicity and temperature stability further support its potential application in oral therapeutics. However, the formulation showed no antimicrobial activity, highlighting the need for further optimisation. Future research should include formulation enhancement and clinical evaluation to establish its role as an adjunct in periodontal therapy.

REFERENCES

[1] Listgarten MA. Pathogenesis of periodontitis. J Clin Periodontol. 1986;13(5):418-30. Available from: https://doi.org/10.1111/j.1600-051X.1986.tb01485.x.

[2] Jose KA, Ambooken M, Mathew JJ, Issac AV, Kunju AP, Parameshwaran RA. Management of chronic periodontitis using chlorhexidine chip and diode laser-a clinical study. Journal of Clinical and Diagnostic Research. 2016;10(4):ZC76-ZC80. Available from: https://doi.org/10.7860/JCDR/2016/13241.7669.

[3] Annisa ZU, Sulijaya B, Tadjoedin ESS, Hutomo DI, Masulili SLC. Effectiveness of chlorhexidine gels and chips in periodontitis patients after scaling and root planing: A systematic review and Meta-analysis. BMC Oral Health. 2023;23(1):819. Available from: https://doi.org/10.1186/s12903-023-03241-2.

[4] Garg S. Local drug delivery systems as an adjunct to cure periodontitis- the novel dental applicant. Pharm Methods. 2015;6(1):01-08. Available from: https://doi.org/10.5530/phm.2015.6.1.

[5] Van Swaaij BWM, van der Weijden GAF, Bakker EWP, Graziani F, Slot DE. Does chlorhexidine mouthwash, with an anti-discoloration system, reduce tooth surface discoloration without losing its efficacy? A systematic review and meta-analysis. Int J Dent Hyg. 2020;18(1):27-43. Available from: https://doi.org/10.1111/idh.12402.

[6] Ramamurthy J, Jayakumar ND. Anti-inflammatory, anti-oxidant effect and cytotoxicity of Ocimum sanctum intra oral gel for combating periodontal diseases. Bioinformation. 2020;16(12):1026-32. Available from: https://doi.org/10.6026/973206300161026.

[7] Menon VP, Sudheer AR. Antioxidant and anti-inflammatory properties of curcumin. Adv Exp Med Biol. 2007;595:105-25. Doi: 10.1007/978-0-387-46401-5_3.

[8] Aslani A, Zolfaghari B, Davoodvandi F. Design, formulation and evaluation of an oral gel from punica granatum flower extract for the treatment of recurrent aphthous stomatitis. Adv Pharm Bull. 2016;6(3):391-98.

[9] Bharathi DR, Kumar MR, Ajay BV, Pooja RC, Shankar J, Kumar MK, et al. Cassia alata: Phytopharmacological, traditional, and medicinal considerations. World Journal of Current Medical and Pharmaceutical Research. 2022;4(6): 147-150. Available from: https://doi.org/10.37022/wjcmpr.v4i6.244.

[10] Mehrabani D, Sholehvar F, Yaghmaei P, Zare S, Razeghian-Jahromi I, Jalli R, et al. The impact of acemannan, an extracted product from Aloe vera, on proliferation of dental pulp stem cells and healing of mandibular defects in rabbits. Am J Stem Cells. 2024;13(2):75-86. Available from: https://doi.org/10.62347/UAFC3719.

[11] Khuntia P, Nayak R, Panda S, Das AC, Mohanty R. To evaluate and compare the synergetic effect of cranberry extract with PRF versus the use of prf alone in the treatment of chronic periodontitis: A clinical and a radiological study. Journal of Population Therapeutics and Clinical Pharmacology. 2023;30. Available from: https://doi.org/10.47750/jptcp.2023.30.09.022.

[12] Mortazavi H, Mashhadiabbas F, Mortazavi SAR, Rezaeifar K, Farhangi M. Formulation of a Jasmine Grandiflorum containing mucoadhesive and evaluation of its healing effect on oral biopsy ulcers. Clin Oral Investig. 2020;24(1):1591-97. Available from: https://doi.org/10.1007/s00784-019-03171-w.

[13] El-Shiekh RA, Hussein D, Atta AH, Mounier SM, Mousa MR, Abdel-Sattar E. Anti-inflammatory activity of Jasminum grandiflorum L. subsp. floribundum (Oleaceae) in inflammatory bowel disease and arthritis models. Biomed Pharmacother. 2021;140:111770. Available from: https://doi.org/10.1016/j.biopha.2021.111770.

[14] Hirapara H, Ghori V, Anovadiya A, Baxi S, Tripathi C. Effects of ethanolic extract of Jasminum grandiflorum Linn. flowers on wound healing in diabetic Wistar albino rats. Avicenna J Phytomed. 2017;7(5):401-08.

[15] Nuryanti A, Larasati PAA, Almeyda AR, Marandof MA, Irawan CM. A potential of Jasminum sambac (L.) Aiton leaf nano-extract as spray treatment of gingivitis-induced Sprague Dawley rats. Majalah Kedokteran Gigi Indonesia. 2023;9:30. Available from: https://doi.org/10.22146/majkedgiind.69468.

[16] Marappan K, Khanchana K, Lakshmaiah K, Arumugam VA, Sadasivam S. Therapeutic potential of Jasminum species: Exploring anti-inflammatory, antioxidant and anticancer properties. Ann Phytomed [Internet]. 2025;14(1):01-13.

[17] Ginwala R, Bhavsar R, Chigbu DGI, Jain P, Khan ZK. Potential role of flavonoids in treating chronic inflammatory diseases with a special focus on the anti-inflammatory activity of Apigenin. Antioxidants. 2019;8(2):35. Available from: https://doi.org/10.3390/antiox8020035.

[18] Kumari CBN, Ambalavanan N, Kumar SR, Mahendra J, Sudhakar U. Microbiological evaluation of vitamin C rich acerola mediated silver and copperoxide nanogel in treatment of periodontitis with and without diabetes mellitus. J Oral Biol Craniofac Res. 2024;14(6):682-91. Available from: https://doi.org/10.1016/j.jobcr.2024.09.011.

[19] Selvaraj S, Chokkattu JJ, Shanmugam R, Neeharika S, Thangavelu L, Ramakrishnan M. Anti-inflammatory potential of a mouthwash formulated using clove and ginger mediated by zinc oxide nanoparticles: An in-vitro study. World Journal of Dentistry. 2023;14(5):394-401. Available from: https://doi.org/10.5005/jp-journals-10015-2232.

[20] Madhuranga HDT. In-vitro anti-inflammatory egg albumin denaturation assay: An enhanced approach. Journal of Natural & Ayurvedic Medicine. 2023;7(3):01-06. Available from: https://doi.org/10.23880/jonam-16000411.

[21] Hossain TJ. Methods for screening and evaluation of antimicrobial activity: A review of protocols, advantages, and limitations. Eur J Microbiol Immunol (Bp). 2024;14(2):97-115. Available from: https://doi.org/10.1556/1886.2024.00035.

[22] Ashwini K, Balaji Ganesh S. Contact angle analysis of herbal mouthwashes - an in-vitro study. Int J Dent Oral Sci. 2021;8(9):4557-61. Available from: https://doi.org/10.19070/2377-8075-21000928.

[23] Liber-Kneć A, Łagan S. Surface testing of dental biomaterials—determination of contact angle and surface free energy. Materials. 2021;14(11):2716. Available from: https://doi.org/10.3390/ma14112716.

[24] Nagarajappa R, Batra M, Sharda AJ, Asawa K, Sanadhya S, Daryani H, et al. Antimicrobial effect of Jasminum grandiflorum L. and Hibiscus rosa-sinensis L. extracts against pathogenic oral microorganisms--an in-vitro comparative study. Oral Health Prev Dent. 2015;13(4):341-48. Available from: https://doi.org/10.3290/j.ohpd.a30601.

[25] Widowati W, Janeva BW, Nadya S, Amalia A, Arumwardana S, Kusuma HSW, et al. Antioxidant and antiaging activities of Jasminum Sambac extract, and its compounds. Journal of Reports in Pharmaceutical Sciences. 2018;7(3), 270-285. Available from: https://brieflands.com/journals/jrps/articles/147496.

[26] Zhao G, Yin Z, Dong J. Antiviral efficacy against hepatitis B virus replication of oleuropein isolated from Jasminum officinale L. var. grandiflorum. J Ethnopharmacol. 2009;125(2):265-68. Available from: https://doi.org/10.1016/j.jep.2009.06.030.

[27] Gupta RK, Reddy PS. Antinociceptive and anticonvulsant activities of hydroalcoholic extract of Jasminum grandiflorum (jasmine) leaves in experimental animals. Pharmacognosy Res. 5(4):286-90. Available from: https://doi.org/10.4103/0974-8490.118813.

[28] International Conference on Harmonisation of Technical Requirements for Registration of Pharmaceuticals for Human Use ICH Harmonised Tripartite Guideline Stability Testing of New Drug Substances and Products Q1A (R2). 2003.

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PLAGIARISM CHECKING METHODS: [Jain H et al.]

- Plagiarism X-checker: Aug 30, 2025
- Manual Googling: Feb 27, 2026
- iThenticate Software: Mar 01, 2026 (1%)

ETYMOLOGY: Author Origin

EMENDATIONS: 7

AUTHOR DECLARATION:

- Financial or Other Competing Interests: None
- Was Ethics Committee Approval obtained for this study? Yes
- Was informed consent obtained from the subjects involved in the study? NA
- For any images presented appropriate consent has been obtained from the subjects. NA

Date of Submission: **Aug 05, 2025**
Date of Peer Review: **Dec 03, 2025**
Date of Acceptance: **Mar 03, 2026**
Date of Publishing: **Jun 01, 2026**