



Research Article

Doi: <https://doi.org/10.29244/jji.v11i2.470>

Formulation, Physicochemical Characterization, and Antibacterial Activity of Ethanolic *Rosa spp.* Extract Topical Gel Against *Cutibacterium acnes*

Formulasi, Karakterisasi Fisikokimia, dan Aktivitas Antibakteri Gel Topikal Ekstrak Etanol *Rosa spp.* terhadap *Cutibacterium acnes*

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ARTICLE INFO

Article history

Received on: 2025-12-10

Revised on: 2026-01-09

Accepted on: 2026-02-24

Keyword:

Antibacterial activity
Cutibacterium acnes
Physicochemical evaluation
Rosa spp.
Topical gel

Kata kunci:

Aktivitas antibakteri
Cutibacterium acnes
Evaluasi fisikokimia
Gel topikal
Rosa spp.



ABSTRACT

This study evaluated a topical gel containing ethanolic red rose (*Rosa spp.*) extract against *Cutibacterium acnes*. Phytochemical screening identified alkaloids, flavonoids, tannins, and anthocyanins. Five gel formulas were developed using 0.25–1.25% Carbopol 940. All formulations showed pseudoplastic flow characteristics. Measured pH values ranged from 7.02 to 7.08, indicating a need for adjustment to meet physiological skin pH (4.5–5.5). Formulas with 0.5% and 0.75% Carbopol (F2 and F3) exhibited the most balanced viscosity, spreadability, and adhesiveness. In vitro antibacterial tests via disc diffusion showed inhibition zones of 14–15 mm against *C. acnes*. These results indicate that the extract can be formulated into a stable gel while maintaining antibacterial activity. Future optimization should focus on pH correction and long-term stability to ensure dermatological safety.

ABSTRAK

Penelitian ini mengevaluasi gel topikal ekstrak etanol mawar merah (*Rosa spp.*) terhadap *Cutibacterium acnes*. Skrining fitokimia mengidentifikasi alkaloid, flavonoid, tanin, dan antosianin. Lima formula gel dikembangkan menggunakan Carbopol 940 (0,25–1,25%). Seluruh formulasi menunjukkan sifat alir pseudoplastik. Nilai pH yang terukur berkisar antara 7,02–7,08, menunjukkan perlunya penyesuaian agar sesuai dengan pH fisiologis kulit (4,5–5,5). Formula dengan 0,5% dan 0,75% Carbopol (F2 dan F3) menunjukkan keseimbangan viskositas, daya sebar, dan daya lekat yang paling optimal. Uji antibakteri in vitro melalui metode difusi cakram menunjukkan zona hambat 14–15 mm terhadap *C. acnes*. Hasil ini mengindikasikan bahwa ekstrak dapat diformulasikan menjadi gel yang stabil dengan tetap mempertahankan aktivitas antibakteri. Optimasi mendatang harus difokuskan pada koreksi pH dan stabilitas jangka panjang untuk memastikan keamanan dermatologis.

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Citation: Zaelani, D., Irfani, A. M., Sanggo, M. S., Sodik, J. J., & Pratama, R. (2026). Formulation, Physicochemical Characterization, and Antibacterial Activity of Ethanolic *Rosa spp.* Extract Topical Gel Against *Cutibacterium acnes*. *Jurnal Jamu Indonesia*, 11(2), 128–134. <https://doi.org/10.29244/jji.v11i2.470>



1. INTRODUCTION

Acne vulgaris is a chronic inflammatory skin disease primarily affecting the pilosebaceous unit, with a global prevalence reaching nearly 10% (El-Shiekh et al., 2025; Vasam et al., 2023). Its multifactorial pathogenesis involves increased sebum production, follicular hyperkeratinization, colonization by *Cutibacterium acnes*, and complex inflammatory responses (El-Shiekh et al., 2025; Vasam et al., 2023). Beyond inflammation, oxidative stress caused by an imbalance between free radicals and antioxidant systems significantly exacerbates lesion severity and scar formation (Chandimali et al., 2025). Current standard therapies, including retinoids and antibiotics, are effective but often limited by side effects such as skin irritation, erythema, and the rising challenge of antibiotic resistance (El-Shiekh et al., 2025). Consequently, there is an increasing demand for natural active ingredients with multi-target activities—antibacterial, anti-inflammatory, and antioxidant—to mitigate both acne lesions and oxidative stress-related skin aging (Lee et al., 2018; Song et al., 2020).

The genus *Rosa* (*Rosa spp.*) is widely recognized for its high content of polyphenols and terpenoids, which exhibit significant therapeutic potential (Zhao et al., 2025). Specifically, *Rosa damascena* and *Rosa gallica* have demonstrated antioxidant, antibacterial, and anti-inflammatory properties (Sopharadee et al., 2025; Zhao et al., 2025). Research indicates that rose petal extracts can inhibit matrix metalloproteinase (MMP) and tyrosinase activities, reducing collagen degradation and melanin accumulation (Song et al., 2020). Furthermore, the essential oils and extracts of *Rosa spp.* show broad-spectrum antibacterial activity, particularly against Gram-positive bacteria, making them relevant candidates for treating acne-associated infections (Elfitriani et al., 2020; Zhao et al., 2025).

In topical drug delivery, gel formulations are preferred for acne treatment due to their high water content, non-sticky texture, and cooling effect on inflamed skin (Putri et al., 2019). While various herbal anti-acne gels containing extracts such as *Aloe vera* or *Centella asiatica* have been developed, scientific studies systematically evaluating red rose flower extract in a gel matrix remain limited (Ansong et al., 2023). Most existing research focuses on essential oils or in vitro models, leaving a gap in comprehensive investigations that integrate gel development with systematic physicochemical characterization and targeted antibacterial assessment against *C. acnes* (Song et al., 2020; Sopharadee et al., 2025).

Based on these gaps, this study aimed to develop and evaluate a topical gel containing ethanolic red rose flower extract. The research involved phytochemical screening, systematic evaluation of physicochemical properties—including pH, viscosity, spreadability, and adhesiveness—and in vitro antibacterial testing against *C. acnes*. This integrated approach is expected to provide reproducible data and a scientific foundation for utilizing *Rosa spp.* extract as a stable and effective active ingredient in anti-acne dermatological formulations.

2. METHODS

This research employed a laboratory experimental design divided into seven stages: extraction, phytochemical screening, gel formulation, physical evaluation, antibacterial testing, data analysis, and manuscript preparation. All procedures were conducted systematically to ensure measurable outcomes and reproducibility.

2.1. Materials and Instruments

The active ingredient used was ethanolic red rose (*Rosa spp.*) extract. Excipients included Carbopol 940 (Corel Pharma Chem), glycerin (Bratachem), Triethanolamine (Brataco), and a preservative system consisting of phenoxyethanol and ethylhexylglycerin (BASF). Analytical grade ethanol 96% and aquadest (Bratachem) were used as solvents. Key instruments included a rotary evaporator (Buchi), homogenizer (IKA), incubator (Mettler), analytical balance and pH meter (Mettler Toledo), and a viscometer (Brookfield).

2.2. Extraction of *Rosa spp.* Flowers

Extraction was performed using a maceration method with a plant material-to-solvent ratio of 1:10 (w/v) in 96% ethanol. The process was conducted at room temperature with periodic agitation. The resulting filtrate was concentrated using a rotary evaporator under reduced pressure at 40–50 °C to yield a dense viscous extract.

2.3. Phytochemical Screening

The concentrated extract underwent qualitative phytochemical screening to detect secondary metabolites, including flavonoids, tannins, saponins, and essential oils, using standard colorimetric and precipitation reagents according to established protocols (Pasril & Okasari, 2020; Pratama et al., 2025).

2.4. Topical Gel Formulation

Five gel formulations (F1–F5) were developed using a Carbopol 940 base at concentrations ranging from 0.25% to 1.25% (w/w). All formulas contained 1% extract, 30% glycerin as a humectant, and 2% Triethanolamine (TEA) as a neutralizing agent. The gels were prepared using a high-shear homogenizer following standard semisolid formulation protocols (Thomas et al., 2023). The complete composition of the formulations is detailed in **Table 1**.

2.5. Physicochemical Evaluation

The formulated gels were evaluated for organoleptic properties and homogeneity through visual assessment of color, odor, and texture on a glass slide. pH was measured using a calibrated digital pH meter at room temperature. Rheological behavior and viscosity were determined using a Brookfield viscometer at various spindle speeds (0.3 to 60 rpm) to evaluate pseudoplastic flow characteristics (Sahoo et al., 2023). Spreadability was assessed by measuring the diameter of gel spreading under a constant 100 g load, while adhesiveness was determined as the time required to separate two glass slides joined by 1 g of the gel sample (Zaelani et al., 2024).

Table 1. Composition of ethanolic *Rosa spp.* extract topical gel formulations (% w/w)

Material	Function	F1	F2	F3	F4	F5
<i>Rosa spp.</i> Extract	Active Ingredient	1.00	1.00	1.00	1.00	1.00
Carbopol 940	Gelling Agent	0.25	0.50	0.75	1.00	1.25
Glycerin	Humectant/Emollient	30.00	30.00	30.00	30.00	30.00
Triethanolamine	pH Adjuster/Neutralizer	2.00	2.00	2.00	2.00	2.00
Phenoxyethanol	Preservative	0.18	0.18	0.18	0.18	0.18
Ethylhexylglycerin	Preservative	0.18	0.18	0.18	0.18	0.18
Distilled Water	Solvent	ad 100				

2.6. Antibacterial Activity Against *C. acnes*

Antibacterial efficacy was assessed in vitro using the disc diffusion method against *C. acnes* (ATCC 6919) under strict anaerobic conditions, following established microbiological protocols (El-Shiekh et al., 2025; Pasril & Okasari, 2020). The bacterial inoculum was adjusted to a 0.5 McFarland standard (approximately 1.5×10^8 CFU/mL) and verified spectrophotometrically at 625 nm. Inoculated Nutrient Agar (NA) plates were prepared using the lawn technique. Sterile 6-mm discs were impregnated with 20 μ L of each gel formulation. Clindamycin phosphate (2.5 mg/mL) served as the positive control, while the gel base without extract and the pure extract were used as negative and extract controls, respectively. Plates were incubated in an anaerobic jar at 37 ± 1 °C for 48 hours. Inhibition zones were measured in duplicate perpendicular directions using a digital caliper.

2.7. Data Analysis

All measurements were performed in triplicate ($n = 3$), and results are expressed as mean \pm standard deviation (SD). Data were analyzed descriptively to compare the physicochemical performance across different Carbopol concentrations.

3. RESULTS AND DISCUSSION

3.1. Phytochemical Profile of *Rosa spp.* Extract

Qualitative phytochemical screening of the ethanolic red rose flower extract confirmed a diverse profile of secondary metabolites. The extract contains alkaloids, flavonoids, quinones, tannins, saponins, triterpenoids, and anthocyanins. These constituents suggest a multi-target therapeutic potential against acne pathogenesis. Flavonoids and tannins are known to neutralize

reactive oxygen species (ROS) and suppress pro-inflammatory cytokines, while tannins specifically act as natural astringents to reduce sebum secretion (El-Shiekh et al., 2025; Song et al., 2020). The presence of saponins is also significant as they can function as natural penetration enhancers, potentially increasing the dermal bioavailability of other bioactive molecules.

3.2. Organoleptic Properties and Physical Consistency

The formulated gels exhibited consistent reddish-brown coloration across all variations, as detailed in Table 2. The concentration of Carbopol 940 significantly influenced the texture and fragrance retention of the preparations. Higher concentrations (F4 and F5) resulted in a more intense rose aroma and a highly viscous texture with noticeable stringiness. Conversely, F2 and F3 provided the most desirable sensory attributes, characterized by moderate viscosity and rapid absorption without a greasy residue. These characteristics are consistent with the literature reporting that this concentration range is optimal for producing lightweight cosmetic gels with high application comfort.

3.3. Physicochemical Performance and Dermatological Compatibility

Quantitative evaluation of the gel's physical parameters is summarized in Table 3. The spreadability showed an inverse relationship with Carbopol concentration, where F1 exhibited the highest spreadability (2.22 inches) due to its low viscosity, while F5 showed the lowest (0.88 inches). This inverse relationship is a characteristic feature of carbomer-based gel systems (Sahoo et al., 2023). Adhesiveness increased proportionally with polymer density, with F5 demonstrating the longest skin retention (23 seconds).

Table 2. Organoleptic evaluation (color, odor, and texture) of red rose flower extract gel formulations

Formula	Color	Odor	Form / Texture
F1	Reddish brown	Rose odor	Very fluid, non-greasy, light on the skin, and slightly difficult to absorb
F2	Reddish brown	Mild rose odor	Moderately viscous, non-greasy, light on the skin, and rapidly absorbed
F3	Reddish brown	Moderately strong rose odor	Viscous, non-greasy, light on the skin, and rapidly absorbed
F4	Reddish brown	Very strong rose odor	Highly viscous with stringiness, non-greasy, light on the skin, and rapidly absorbed
F5	Reddish brown	Very strong rose odor	Slightly viscous with stringiness, non-greasy, light on the skin, and rapidly absorbed

Table 3. Physicochemical properties of *Rosa spp.* flower extract gel formulations (n = 3)

Formula	pH	Spreadability (inches)	Adhesiveness (seconds)
F1	7.02	2.22	12.11
F2	7.08	1.83	15.3
F3	7.05	1.16	14.81
F4	7.02	1.02	18.34
F5	7.04	0.88	23
Reference	7.03	1.10	17.55

Furthermore, the measured pH values ranged from 7.02 to 7.08. While stable, these values are higher than the physiological pH of human skin (4.5–5.5). This neutral pH is required for the optimal swelling of Carbopol 940 when neutralized with 2% TEA (Kim et al., 2023).

3.4. Rheological Behavior

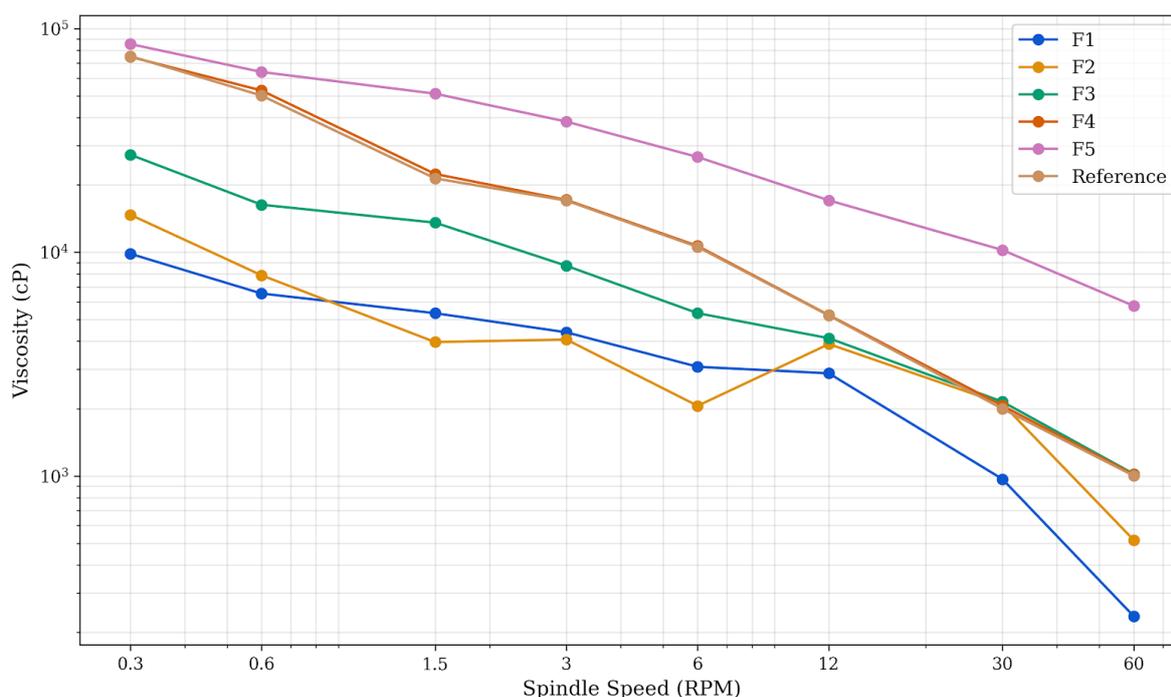
Viscosity analysis demonstrated that all formulations exhibited pseudoplastic (shear-thinning) flow, where viscosity decreased as the shear rate increased, as illustrated in **Figure 1**. This rheological profile is ideal for anti-acne topicals as it allows the gel to thin during application, facilitating easy spreading over inflamed skin without excessive mechanical pressure (Sahoo et al., 2023). Formula 3 showed the closest rheological alignment with the commercial reference, suggesting an optimal balance between structural stability and application comfort. The inclusion of 30% glycerin further stabilized the Carbopol network and enhanced the moisturizing properties of the gel.

3.5 Antibacterial Efficacy against *C. acnes*

The antibacterial performance of the formulated gels, as illustrated in **Figure 2**, demonstrates a significant inhibitory effect against *C. acnes*. All gel formulations (F1–F5) produced wider inhibition

zones compared to the pure extract control (12.0 ± 1.1 mm). Specifically, F2 through F5 achieved a "Strong" activity level with inhibition zones ranging from 14.8 mm to 15.2 mm. Statistical analysis confirmed that the incorporation of the extract into the Carbopol 940 gel matrix significantly enhanced its antibacterial diffusion ($p < 0.05$ compared to pure extract).

Visual observation of the test plates, as shown in the representative images of the disc diffusion assay, reveals clear and well-defined transparent zones around the discs impregnated with the gel formulations (**Figure 3**). This enhancement is likely due to the humectant properties of glycerin and the optimized viscosity of the gel, which facilitate a more sustained and controlled release of bioactive compounds—such as flavonoids and tannins—into the agar medium (El-Shiekh et al., 2025; Jafari-Sales et al., 2020). Interestingly, the variation in Carbopol concentration did not hinder the release of active metabolites, suggesting that the gel network provides an ideal balance between physical stability and therapeutic delivery. The positive control (Clindamycin) maintained the highest activity (24.0 ± 1.5 mm), while the negative control (gel base) showed no inhibition (6.0 mm), confirming that the antibacterial effect is solely derived from the *Rosa spp.* flower extract.

**Figure 1.** Rheological profile showing the relationship between viscosity (cP) and spindle speed (RPM) for all formulations.

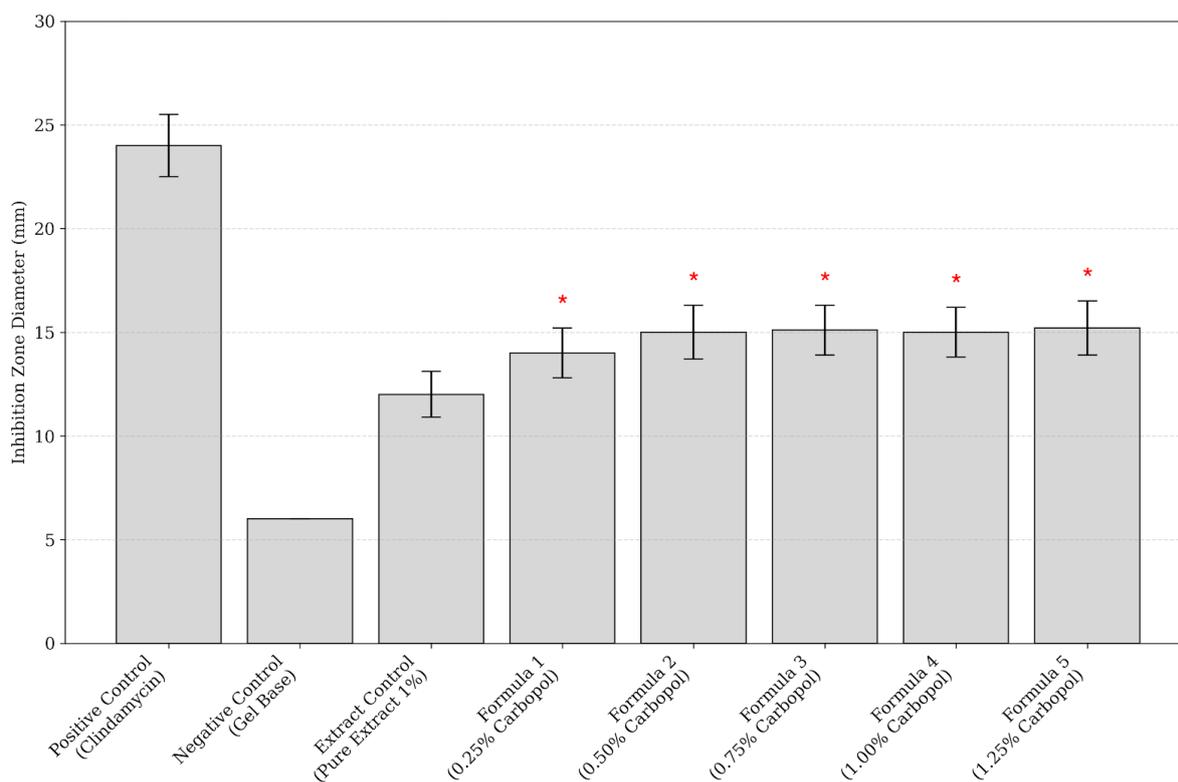


Figure 2. Antibacterial activity of *Rosa spp.* flower extract gel formulations against *C. acnes*. Asterisks (*) indicate significant differences ($p < 0.05$) compared to the pure extract.

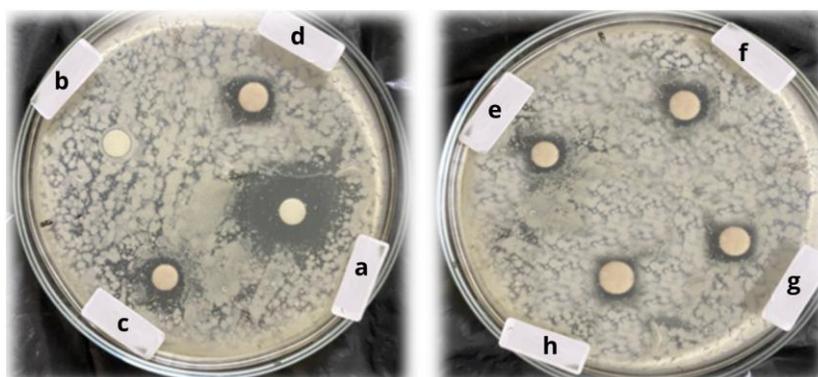


Figure 3. Inhibition zones of antibacterial activity test against *C. acnes* (a) Positive control, (b) Negative control, (c) Extract, (d) Formula 1, (e) Formula 2, (f) Formula 3, (g) Formula 4, and (h) Formula 5.

4. CONCLUSION

This study demonstrated the feasibility of formulating an anti-acne topical gel using ethanolic red rose (*Rosa spp.*) flower extract, where the concentration of Carbopol 940 was found to significantly influence the rheological and physicochemical properties of the preparation. Formulations F2 and F3 (0.5%–0.75%) exhibited physical characteristics and pseudoplastic flow behavior most comparable to the commercial reference used in this study, ensuring suitable spreadability and adhesion for dermal application. While the gel formulations showed *in vitro* antibacterial activity against *C. acnes* that was numerically higher than the pure extract, further investigations are required to evaluate long-term stability and confirm clinical safety and

efficacy through *in vivo* dermatological testing before potential therapeutic application.

AUTHOR CONTRIBUTIONS

Conceptualization, D.Z., R.P., J.J.S.; methodology, D.Z. and J.J.S.; validation, M.S.S. and J.J.S.; formal analysis, R.P. and J.J.S.; investigation, D.Z., R.P., and M.S.S.; resources, A.M.I.; data curation, D.Z. and R.P.; writing—original draft preparation, D.Z.; writing—review and editing, R.P., M.S.S., A.M.I., and J.J.S.; visualization, M.S.S., R.P.; supervision, R.P., A.M.I. and J.J.S.; project administration, D.Z., A.M.I. All authors have read and agreed to the published version of the manuscript.

INSTITUTIONAL REVIEW BOARD STATEMENT

Not applicable.

INFORMED CONSENT STATEMENT

Not applicable.

DATA AVAILABILITY STATEMENT

Data supporting the findings of this study are available from the corresponding author upon reasonable request.

FUNDING

This research was funded by Universitas Bhakti Kencana, through the *Hibah Penelitian Dasar* scheme, Grant Number: 078/01/UBK/VII/2025.

ACKNOWLEDGMENT

The authors wish to thank the laboratory staff at Universitas Bhakti Kencana for their technical assistance and for providing the necessary research facilities. We also acknowledge the support of colleagues who contributed valuable input during the manuscript preparation.

CONFLICTS OF INTEREST

The authors declare no conflict of interest.

DECLARATION OF GENERATIVE ARTIFICIAL INTELLIGENCE (AI) USE

During the preparation of this work, the authors used Gemini to improve the language, grammar, and structural flow of the manuscript. The authors reviewed and edited the content as needed and take full responsibility for the final publication.

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