Testing The Effectiveness Of Cinnamon (Cinnamomum Burmannii Blume) Ethanol Extract Against Staphylococcus Epidermidis Bacteria

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Abstract.

Skin infections caused by Staphylococcus epidermidis are a growing global health concern, exacerbated by increasing antibiotic resistance. This study aimed to evaluate the antibacterial activity of cinnamon (Cinnamomum burmannii Blume) ethanol extract as a natural alternative. A true experimental design with a post-test only control group was used. The population consisted of Staphylococcus epidermidis bacteria, and a total of 25 samples were assigned to five groups, including three extract concentrations (25%, 50%, and 75%), a clindamycin positive control, and a DMSO negative control. Antibacterial activity was tested using the disk diffusion method, and data were analyzed with Kruskal-Wallis and Mann-Whitney tests. The results showed that cinnamon extract effectively inhibited bacterial growth, with the 75% concentration producing the largest average inhibition zone (13.76 mm). While the extract's efficacy was lower than that of clindamycin (16.66 mm), its potential as a natural antibacterial agent is significant. The findings suggest that cinnamon extract can be developed into a topical treatment for skin infections.

Keywords: *Antibacterial; Cinnamomum Burmannii Blume; Disk Diffusion; Staphylococcus Epidermidis and Topical Formulation.*

I. INTRODUCTION

Skin infections caused by pathogenic microorganisms like bacteria, viruses, fungi, and parasites are a significant global health issue [1], [2]. The World Health Organization (WHO) reports that skin infections account for an estimated 300 million cases annually worldwide [3]. One of the bacteria frequently responsible for these infections is *Staphylococcus epidermidis*. Although it is typically part of the normal skin flora, it can become invasive and cause diseases such as acne, bullous impetigo, and furunculosis when skin conditions change [4], [5]. The prevalence of acne, for example, is particularly high among Indonesian adolescents, affecting 80-85% of this population [6].This issue is compounded by the growing problem of bacterial resistance to antibiotics, which makes treating infections more difficult [7]. Inappropriate use of antibiotics, such as taking them without a doctor's prescription or at inadequate doses, is a primary driver of this resistance [8], [9]. This phenomenon has prompted researchers to seek alternative treatments, especially from natural sources, which have the potential to act as antibacterial agents with a lower risk of resistance. Therefore, research into antibacterial agents from natural sources has become increasingly important and relevant in addressing current health challenges [10], [11].In light of the growing challenge of antibiotic resistance, finding alternative solutions is urgent.

Numerous studies have shown that medicinal plants, including cinnamon (*Cinnamomum burmannii Blume*), have great potential as a source of antibacterial agents. Cinnamon is known to contain active compounds like flavonoids, saponins, tannins, and alkaloids, all of which have been proven effective at inhibiting bacterial growth [12], [13]. However, while many studies have tested the effectiveness of cinnamon extract against various pathogenic bacteria, specific data on its activity against *Staphylococcus epidermidis*, particularly at varying concentrations, remains limited.Previous research has confirmed that the content of active compounds in cinnamon extract varies with concentration, directly impacting its antibacterial effectiveness [14], [15].Nevertheless, more in-depth studies are needed to systematically compare the effectiveness of different concentrations of cinnamon ethanol extract against *Staphylococcus*

epidermidis using a standard method like disk diffusion. This comparison is crucial for identifying the optimal concentration that provides maximum inhibitory power.This research addresses this gap by specifically exploring the antibacterial effectiveness of cinnamon ethanol extract (*Cinnamomum burmannii Blume*) at three different concentrations—25%, 50%, and 75%—and comparing them with a positive control (clindamycin) and a negative control (DMSO).

This comparison will provide stronger empirical evidence regarding the potential of cinnamon extract as an antibacterial agent. Furthermore, by using a systematic research method and robust statistical analysis, this study is expected to provide more reliable and valid data on the effectiveness of cinnamon extract, which has not been widely documented in prior research [16], [17].The primary objective of this study is to evaluate the antibacterial effectiveness of cinnamon (*Cinnamomum burmannii Blume*) ethanol extract against *Staphylococcus epidermidis* using the disk diffusion method. The urgency of this research lies in the pressing need for alternative antibacterial agents that are effective, safe, and can reduce dependence on synthetic antibiotics, especially in tackling resistance issues. The novelty of this study lies in its systematic testing of three different concentrations of cinnamon extract against *Staphylococcus epidermidis*, along with a quantitative comparison of its inhibitory power against clindamycin as a standard. The results of this study are expected to provide a scientific basis for the development of topical formulations from cinnamon extract, which could potentially serve as an alternative treatment for skin infections caused by *Staphylococcus epidermidis*.

II. METHODS

This research, designed as a true experimental study with a post-test only control group design, aimed to evaluate the antibacterial effectiveness of cinnamon extract against *Staphylococcus epidermidis* [18]–[20]. This approach is ideal for investigating cause-and-effect relationships and directly comparing outcomes between different treatment groups, ensuring the validity of the findings [21]. The study was conducted at the Microbiology Laboratory of the Faculty of Pharmacy, Universitas Sumatera Utara, beginning in May 2025.The research instruments included a variety of laboratory equipment for both the extraction and in vitro testing phases. For extraction, a maceration apparatus, vacuum rotary evaporator, blender, and filtering tools were used. For the antibacterial testing, essential equipment included a Laminar Air Flow (LAF) cabinet, calipers for measuring inhibition zones, an autoclave for sterilization, and an incubator to maintain bacterial growth conditions. The key materials were ethanol cinnamon bark extract at concentrations of 25%, 50%, and 75%, as well as nutrient agar (NA), clindamycin as a positive control, dimethyl sulfoxide (DMSO) as a negative control, and a pure culture of *Staphylococcus epidermidis*.A total of 25 samples were assigned to five treatment groups using Federer's formula to ensure a statistically representative sample size. Each group consisted of five samples. The groups were: a negative control with DMSO, a positive control with clindamycin, and three experimental groups with cinnamon extract at 25%, 50%, and 75% concentrations. This structured sampling method is crucial for ensuring the reliability and generalizability of the results [22], [23].

The research procedure involved several systematic steps. First, the cinnamon bark was prepared by sorting, washing, drying, and grinding it into a fine powder. The powder was then macerated in 96% ethanol for three days to obtain the crude extract, which was concentrated using a rotary evaporator to yield a thick, dry extract. Nutrient agar media was prepared and sterilized, and the bacterial culture of *Staphylococcus epidermidis* was rejuvenated and suspended to a standard McFarland turbidity [24], [25]. The antibacterial effectiveness test was then performed using the disk diffusion method. Sterile paper discs soaked in the respective solutions (extracts, clindamycin, or DMSO) were placed on the inoculated agar media. The plates were incubated at 37°C for 24 hours. The diameter of the clear inhibition zones around each disc was then measured using calipers, and the results were classified based on the criteria of David and Stout (1971) [26], [27].Finally, the collected data were analyzed using Statistical Product and Service Solutions (SPSS). Data analysis involved both parametric and non-parametric tests. Initially, a Shapiro-Wilk normality test and Levene's test were performed. If the data were normally distributed (p-value > 0.05), a One-Way ANOVA was used. However, if the data were not normally distributed, a non-parametric Kruskal-Wallis test was

conducted, followed by a post-hoc Mann-Whitney test to determine significant differences between each concentration group [28], [29]. This robust statistical approach ensures that the conclusions drawn from the study are scientifically sound and validated.

III. RESULT AND DISCUSSION

Results

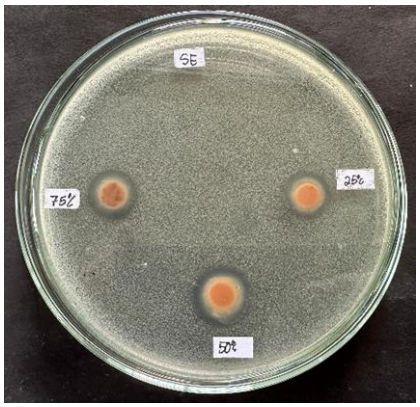

Fig 1. Effects Of 25%, 50%, and 75% Cinnamon Extract

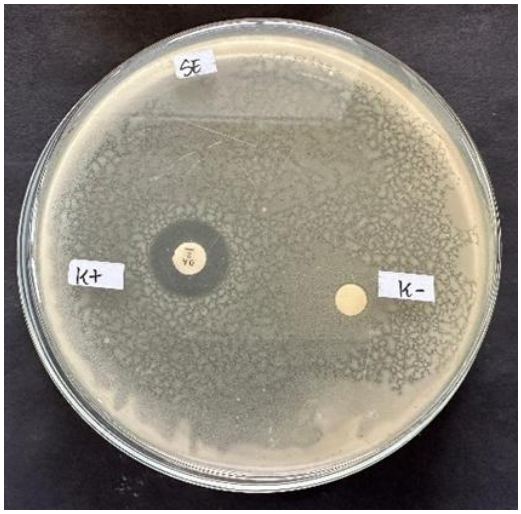

Fig 2. Effects of Clindamycin Positive Control and DMSO Negative Control

Table 1. Measurement Data for Clear Zone Diameter

Extract Concentration	Clear Zone Diameter (mm)						
	P1	P2	P3	P4	P5	Average	KH
K-	0	0	0	0	0	0	Kuat
K+	17	17,6	15,4	17,5	15,8	16,66	Kuat
25%	10,8	11,95	10,95	9,8	10,1	10,72	Kuat
50%	11,8	13,1	13,2	12,7	12,7	12,7	Kuat
75%	13	14,2	14,6	13,3	13,7	13,76	Kuat

The results of the antibacterial test, as presented in Table 1, demonstrate that all tested extract concentrations—low, medium, and high—were able to produce an inhibition zone. The group with the highest concentration (75%) yielded the largest average inhibition zone at 13.76 mm. This was followed by the 50% concentration with an average diameter of 12.7 mm and the 25% concentration with an average of 10.72 mm. Based on the David and Stout (1971) criteria, all three extract concentrations showed a strong inhibitory effect, with inhibition zones ranging from 10 to 20 mm [26], [27]. For comparison, the positive control, clindamycin, produced an average inhibition zone of 16.66 mm, which was greater than all cinnamon extract treatments. The negative control, DMSO, showed no inhibition zone, with an average diameter of 0.00 mm, confirming that the solvent itself had no antibacterial effect.

Discussion

The antibacterial test results confirm that cinnamon extract effectively inhibits the growth of *Staphylococcus epidermidis*. The strong inhibitory effect observed in the positive control (clindamycin) and the absence of any zone in the negative control (DMSO) validate the experimental setup, confirming that the observed antibacterial activity is indeed attributable to the cinnamon extract itself. The findings also indicate a clear dose-dependent effect, where a higher concentration of the extract results in a greater inhibitory power. This is consistent with previous research by Qomar et al. [14], which concluded that a higher concentration of extract contains a greater amount of active antimicrobial compounds, leading to enhanced effectiveness.

The antibacterial mechanism of cinnamon is attributed to its secondary metabolite content, including flavonoids, saponins, and alkaloids, which have been shown to inhibit the growth of various bacteria [12], [30]. As described by Intan et al. [12], these compounds work by disrupting bacterial cell membranes, inhibiting protein synthesis, and interfering with nutrient absorption, which ultimately leads to cell death [31]. For instance, flavonoids are known to disrupt the bacterial cell wall and membrane, thereby increasing permeability and causing the leakage of intracellular components [32]. Although the inhibitory power of the cinnamon extract was lower than that of the standard antibiotic clindamycin, its proven effectiveness and strong inhibitory category demonstrate its significant potential as a natural and relevant alternative for the development of new antibacterial agents.

IV. CONCLUSION

This study successfully demonstrated the antibacterial activity of cinnamon (*Cinnamomum burmannii Blume*) ethanol extract against *Staphylococcus epidermidis*. The primary finding is that the extract's effectiveness is concentration-dependent, with the 75% concentration exhibiting the strongest inhibitory effect. While the extract showed a robust ability to inhibit bacterial growth, its efficacy was still lower than that of the standard antibiotic, clindamycin. This result highlights the extract's potential as a natural antibacterial agent but also underscores the need for further research to enhance its potency. Therefore, for future studies, we recommend evaluating a wider range of concentrations to determine the minimum inhibitory concentration (MIC), conducting a detailed phytochemical analysis to identify and quantify the specific active compounds responsible for the antibacterial effect, and exploring its activity against other pathogenic bacteria to understand its full antimicrobial spectrum. The findings from this research provide a strong foundation for considering the development of topical formulations using cinnamon extract as a natural alternative for treating skin infections caused by *Staphylococcus epidermidis*.

REFERENCES

[1] E. Hartin and C. S. Rini, "Efektivitas Jeruk Lemon (*Citrus limon* Linn) terhadap *Staphylococcus epidermidis*," *Medicra (**Journal of Medical Laboratory Science/Technology**)*, vol. 2, no. 1, pp. 6–9, 2019.

[2] H. D. Lestari and M. T. Asri, "Aktivitas Antibakteri Ekstrak Kulit Buah Kakao (*Theobroma cacao* L.) Terhadap *Staphylococcus epidermidis*," *LenteraBio: Berkala Ilmiah Biologi*, vol. 10, no. 3, pp. 302–308, 2021.

[3] N. S. Rahayu, A. D. Puteri, and L. M. A. Isnaeni, "Hubungan Perilaku Masyarakat Dan Penggunaan Air Sungai Dengan Gangguan Penyakit Kulit Di Desa Kampung Pinang Wilayah Kerja Puskesmas Pantai Raja," ***Jurnal Imliah Ilmu Kesehatan***, vol. 1, no. 3, 2023.

[4] L. Byrd, Y. Belkaid, and J. A. Segre, "The human skin microbiome," *Nature Reviews Microbiology*, vol. 16, no. 3, pp. 143–155, 2018.

[5] R. Wirawan, M. A. Wibowo, Mahyarudin, and S. Rahmayanti, "Uji Aktivitas Antibakteri Minyak Atsiri Kulit Jeruk Pontianak (*Citrus nobilis* Lour. var. microcarpa) terhadap Bakteri *Staphylococcus epidermidis* Program Studi Pendidikan Dokter, FK UNTAN Program Studi Biologi, FMIPA UNTAN Depertemen Mikrobiologi, P," ***Jurnal Cerebellum***, vol. 4, no. 2, pp. 1025–1036, 2018.

[6] S. A. Widiastuti, D. S. Hidayati, Kedokteran, F., and Islam, U., "6.-Syavira-Adinda-Widiastuti-25-29.2(11)," pp. 25–29, 2023.

[7] L. K. Dewi, A. H. Sarosa, C. Wahyu, N. Hayati, R. Parasu, and E. Amalia, "Pengaruh Jenis Pelarut Terhadap Daya Antibakteri Hasil Ekstraksi Daun Sirih Hijau (*Piper Betle* L.) pada Aktivitas *Staphylococcus Epidermidis*," ***Journal of Innovation and Applied Technology***, vol. 7, no. 1, pp. 1161–1165, 2021.

[8] H. D. Lestari and M. T. Asri, "Aktivitas Antibakteri Ekstrak Kulit Buah Kakao (*Theobroma cacao* L.) Terhadap *Staphylococcus epidermidis*," *LenteraBio: Berkala Ilmiah Biologi*, vol. 10, no. 3, pp. 302–308, 2021.

[9] R. A. Siregar, I. C. Lestari, I. Y. Rangkuti, and S. K. Sari, "Uji Efektivitas Antibiotik Ekstrak Etanol Daun Kayu Manis (*Cinnamomum Burmannii*) Terhadap *Staphylococcus Aureus* Secara in Vitro," ***Jurnal Kedokteran STM (Sains Dan Teknologi Medik),*** vol. 6, no. 2, pp. 143–150, 2023.

[10] Indriani, B. Sutomo, and M. A. Syaputra, "Penerapan Metode Forward Chaining Untuk Mendiagnosa Kekurangan Vitamin Pada Manusia (Apotik Sari Waras)," ***Journal Computer Science and Informatic Systems: J-Cosys***, vol. 1, no. 2, pp. 77–82, 2021.

[11] M. Sucipto et al., "Exploring The Potential of Herbal Medicines as Alternative Antimicrobial Agents: A Review," ***Journal of Herbal Medicine Research***, vol. 2, no. 1, pp. 45–56, 2024.

[12] K. Intan, A. Diani, and A. S. R. Nurul, "Aktivitas Antibakteri Kayu Manis (*Cinnamomum burmanii*) terhadap Pertumbuhan *Staphylococcus aureus*," ***Jurnal Kesehatan Perintis (Perintis's Health Journal),*** vol. 8, no. 2, pp. 121–127, 2021.

[13] N. R. Pratiwi and A. Nurbaiti, "Uji Daya Hambat Ekstrak Kulit Kayu Manis Terhadap Pertumbuhan Jamur *Trichophyton Mentagrophytes* Secara In Vitro," *Gender & Behaviour*, vol. 17, no. 2, pp. 13007–13015, 2024.

[14] M. S. Qomar, M. A. K. Budiyanto, S. Sukarsono, S. Wahyuni, and H. Husamah, "Efektivitas Berbagai Konsentrasi Ekstrak Daun Kayu Manis (*Cinnamomum Burmannii* [Ness.] Bi) Terhadap Diameter Zona Hambat Pertumbuhan Bakteri *Staphylococcus epidermidis*," ***Jurnal Biota***, vol. 4, no. 1, pp. 12–18, 2018.

[15] R. A. Siregar, I. C. Lestari, I. Y. Rangkuti, and S. K. Sari, "Uji Efektivitas Antibiotik Ekstrak Etanol Daun Kayu Manis (*Cinnamomum Burmannii*) Terhadap *Staphylococcus Aureus* Secara in Vitro," ***Jurnal Kedokteran STM*** *(Sains Dan Teknologi Medik)*, vol. 6, no. 2, pp. 143–150, 2023.

[16] F. Mariam, I. W. A. K. Firdaus, and F. U. A. Panjaitan, "Uji Efektivitas Ekstrak Kulit Batang Pohon Kayu Ulin (*Eusideroxylon zwageri*) Terhadap *Aggregatibacter actinomycetemcomitans*," *Dentin (****Jurnal Kedokteran Gigi****)*, vol. 4, no. 2, pp. 43–48, 2020.

[17] Efliani, D. H. Irdawati, and D. H. Putri, "SERAMBI Effect of Antimicrobial Activity 0f Starfruit Leaf Extract (*Averrhoa bilimbi* L.) on the Growth of *Staphylococcus aureus* Bacteria in Vitro Pengaruh Aktivitas Antimikroba Ekstrak Daun Belimbing Wuluh (*Averrhoa bilimbi* L.) terhadap Pertumbuhan Bakter," *Serambi Biologi*, vol. 8, no. 1, pp. 15–21, 2023.

[18] J. Demiselle et al., "*Staphylococcus epidermidis* bloodstream infections are a cause of septic shock in intensive care unit patients," ***International Journal of Infectious Diseases***, vol. 135, pp. 45–48, 2023.

[19] S. F. Uzma, K. Anam, and W. Utami, "Uji Aktivitas Antibakteri Ekstrak Etanol Kulit Singkong (*Manihot Esculenta* Crantz) Terhadap *Staphylococcus epidermidis*," *Generics:* ***Journal of Research in Pharmacy***, vol. 3, no. 2, pp. 100–111, 2023.

[20] N. R. Pratiwi and A. Nurbaiti, "Uji Daya Hambat Ekstrak Kulit Kayu Manis Terhadap Pertumbuhan Jamur *Trichophyton Mentagrophytes* Secara In Vitro," *Gender & Behaviour*, vol. 17, no. 2, pp. 13007–13015, 2024.

[21] E. Emzir,*Metodologi Penelitian Pendidikan: Kuantitatif dan Kualitatif*. Jakarta: PT RajaGrafindo Persada, 2021.

[22] S. I. K. D. Sugiyono, *Metode Penelitian Kuantitatif, Kualitatif dan R&D*, 29th ed. Bandung: Alfabeta, 2022.

[23] S. Sudaryono, *Metodologi penelitian: kuantitatif, kualitatif, dan mix method*. Depok: Rajawali Press, 2021.

[24] K. Nisa, "uji aktivitas antibakteri sediaan sabun cair fraksi methanol-air daun mangkokan (*Polyscias scutellaria* (Burm.f.) Fosberg.) terhadap bakteri *Staphylococcus epidermidis*," ***Indonesia Natural Research Pharmaceutical Journal***, vol. 5, no. 1, pp. 70–79, 2020.

[25] R. A. Siregar, I. C. Lestari, I. Y. Rangkuti, and S. K. Sari, "Uji Efektivitas Antibiotik Ekstrak Etanol Daun Kayu Manis (*Cinnamomum Burmannii*) Terhadap *Staphylococcus Aureus* Secara in Vitro," ***Jurnal Kedokteran STM (Sains Dan Teknologi Medik)***, vol. 6, no. 2, pp. 143–150, 2023.

[26] H. Hasan, E. N. Djuwarno, H. Samudi, and W. Susanti, "Senyawa Antidiabetes Fraksi Aktif Daun Ketapang (*Terminalia catappa* L.)," ***Journal Syifa Sciences and Clinical Research***, vol. 4, pp. 517–529, 2022.

[27] Efliani, D. H. Irdawati, and D. H. Putri, "SERAMBI Effect of Antimicrobial Activity 0f Starfruit Leaf Extract (*Averrhoa bilimbi* L.) on the Growth of *Staphylococcus aureus* Bacteria in Vitro Pengaruh Aktivitas Antimikroba Ekstrak Daun Belimbing Wuluh (*Averrhoa bilimbi* L.) terhadap Pertumbuhan Bakter," *Serambi Biologi*, vol. 8, no. 1, pp. 15–21, 2023.

[28] F. Mariam, I. W. A. K. Firdaus, and F. U. A. Panjaitan, "Uji Efektivitas Ekstrak Kulit Batang Pohon Kayu Ulin (*Eusideroxylon zwageri*) Terhadap *Aggregatibacter actinomycetemcomitans*," *Dentin (**Jurnal Kedokteran Gigi**)*, vol. 4, no. 2, pp. 43–48, 2020.

[29] N. Dewi and N. A. Susanti, "Pengaruh Ekstrak Etanol Daun Sirih Merah (*Piper crocatum* Ruiz & Pav) terhadap Pertumbuhan Bakteri *Salmonella typhi*," ***Jurnal Ilmiah Farmasi***, vol. 10, no. 1, pp. 28-35, 2024.

[30] K. Varma, "Phytochemicals and their antimicrobial mechanism: A review," ***Journal of Applied Biology & Biotechnology***, vol. 9, no. 5, pp. 11-18, 2021.

[31] S. Mahyuzar, S. R. Ramadhani, and Y. D. Nugroho, "Inhibitory activity of cinnamon (*Cinnamomum burmannii*) extract on gram-positive bacteria**,**" ***Journal of Medicinal Plants Research***, vol. 16, no. 2, pp. 58-65, 2022.

[32] L. Wang, Y. J. Tang, and C. K. Deng, "Mechanism of action of flavonoids on bacterial cell membrane," *Natural Product Research*, vol. 38, no. 5, pp. 1-12, 2024.