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APPLICATION OF MUSA BALBISIANA LOTION AGAINST STAPHYLOCOCCUS AUREUS

Aplikasi Losion Pisang Kepok Kuning (Musa balbisiana) terhadap Staphylococcus aureus

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ABSTRAK

Staphylococcus aureus merupakan bakteri patogen yang dapat menyebabkan berbagai infeksi, terutama pada kulit, seperti bisul, impetigo, dan abses. Infeksi ini sering kali ditandai dengan peradangan, nekrosis, dan pembentukan nanah, yang secara signifikan dapat mengganggu fungsi kulit sebagai pelindung tubuh. Tantangan utama dalam pengelolaannya adalah meningkatnya resistensi antibiotik, termasuk Methicillin-Resistant Staphylococcus aureus (MRSA), sehingga diperlukan alternatif yang efektif, seperti bahan herbal, untuk mengatasi permasalahan ini. Kulit pisang kepok kuning yang sering berakhir sebagai limbah organik, diketahui mengandung senyawa aktif seperti flavonoid, alkaloid, saponin, tanin, dan antioksidan. Senyawa-senyawa tersebut memiliki aktivitas antibakteri yang signifikan, disertai dengan kemampuan melindungi kulit dari kerusakan akibat radikal bebas. Penelitian ini bertujuan untuk menjelaskan perbedaan efektivitas losion berbahan dasar ekstrak kulit pisang kepok kuning dengan tiga konsentrasi berbeda, yaitu formula I (30%), formula II (60%), dan formula III (90%) dalam menghambat pertumbuhan Staphylococcus aureus. Penelitian berbentuk quasi eksperimental desain ini menggunakan metode difusi cakram. Hasil penelitian menunjukkan bahwa rata-rata diameter zona hambat formula I adalah 5,60 mm, formula II adalah 8,30 mm, dan formula III adalah 8,70 mm. Analisis statistik dengan uji Kruskal-Wallis menunjukkan nilai p = 0,004, yang mengindikasikan adanya perbedaan signifikan antar formula. Kesimpulannya, losion ekstrak kulit pisang kepok kuning menunjukkan efektivitas yang signifikan dalam menghambat pertumbuhan Staphylococcus aureus. Efektivitas ini meningkat secara proporsional dengan konsentrasi ekstrak, sehingga produk ini memiliki potensi untuk digunakan sebagai losion antibakteri.

Kata Kunci: *antibakteri, kulit pisang kepok kuning, losion, Staphylococcus aureus*

ABSTRACT

Staphylococcus aureus is a pathogenic bacterium that can cause various infections, particularly skin-related conditions such as boils, impetigo, and abscesses. These infections are often characterized by inflammation, necrosis, and pus formation, significantly impairing the skin's function as the body's protective barrier. A major challenge in managing these infections is the increasing antibiotic resistance, including Methicillin-Resistant *Staphylococcus aureus* (MRSA), necessitating effective

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alternatives such as herbal-based remedies. The peel of yellow kepok bananas, often discarded as organic waste, contains active compounds such as flavonoids, alkaloids, saponins, tannins, and antioxidants. These compounds exhibit significant antibacterial activity and can protect the skin from damage caused by free radicals. This study aims to explain the differences in the effectiveness of lotion formulations based on yellow kepok banana peel extract at three different concentrations: Formula I (30%), Formula II (60%), and Formula III (90%) in inhibiting the growth of *Staphylococcus aureus*. This quasi-experimental study employed the disc diffusion method. The results showed that the average inhibition zone diameter for Formula I was 5.60 mm, Formula II was 8.30 mm, and Formula III was 8.70 mm. Statistical analysis using the Kruskal-Wallis test revealed a p-value of 0.004, indicating a significant difference among the formulas. In conclusion, lotions containing yellow kepok banana peel extract demonstrated considerable effectiveness in inhibiting the growth of *Staphylococcus aureus*. The effectiveness increased proportionally with the extract concentration, suggesting the potential of this product as an antibacterial lotion.

Keywords: antibacterial, lotion, *Staphylococcus aureus*, yellow kepok banana peel

INTRODUCTION

Staphylococcus aureus is a Gram-positive bacterium that poses a significant health risk to humans and animals.[1] His pathogen can cause a wide range of illnesses, from mild skin infections to severe conditions such as pneumonia and sepsis.[2] Various factors, including surface proteins, enzymes, and toxins, enhance S. *aureus*'s virulence and pathogenicity.[3] The emergence of methicillin-resistant *S. aureus* (MRSA) has further complicated treatment options, as these strains exhibit resistance to multiple antibiotics.[4] This growing challenge in healthcare has prompted the exploration of effective and sustainable antibacterial alternatives derived from natural sources.

Yellow kepok banana peels, often regarded as organic waste, have demonstrated significant potential as active ingredients in pharmaceutical products. These peels contain bioactive compounds such as flavonoids, alkaloids, saponins, tannins, and the antioxidant beta-carotene, all of which exhibit antibacterial properties.[5] For instance, flavonoids inhibit bacterial nucleic acid synthesis, disrupt cytoplasmic membrane function, and impair energy metabolism.[6] Similarly, saponins protect cells from potential pathogens and interfere with bacterial cell wall integrity.[7] While tannins coagulate bacterial protoplasm following cell lysis.[8]

Previous studies have shown that extracts from yellow kepok banana peels exhibit antibacterial activity against various bacteria, including *S.aureus*. Research using gel formulations of raw kepok banana peel extract has demonstrated inhibition zones of up to 14.21 mm. However, studies on the utilization of fully ripened yellow kepok banana peel extract as a base ingredient for topical formulations, such as lotions, have not yet been reported. By combining the antibacterial potential and skin-protective properties of yellow kepok banana peel extract, the development of natural-based lotions could offer an innovative and environmentally friendly solution for managing skin infections caused by *S. aureus*.

Moreover, the pharmaceutical application of organic waste, such as yellow kepok banana peels, offers environmental benefits. This approach aligns with sustainable waste management principles and adds economic value to materials previously considered waste. Consequently, this study aligns with global efforts to minimize waste and promote sustainability in the pharmaceutical industry.

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This study aims to explain the differences in the effectiveness of lotion formulations based on yellow kepok banana peel extract at three different concentrations: Formula I (30%), Formula II (60%), and Formula III (90%) in inhibiting the growth of *Staphylococcus aureus*. Additionally, it seeks to contribute scientific insights into the utilization of banana peel waste as an active ingredient in natural-based pharmaceutical preparations.

METHODS

Research Design

This study employed a quasi-experimental design. Quasi-experimental design refers to a type of experiment that involves a control group; however, the control group cannot fully account for external variables due to the non-random assignment of subjects between the control and treatment groups.[9]

Research Location

This research was conducted on February 14, 2022 - June 14, 2022, at the Laboratory of Agricultural Product Processing Technology of Pontianak State Polytechnic for the manufacture of extracts and at the Bacteriology Laboratory of the Poltekkes Kemenkes Pontianak for the manufacture of antibacterial lotions and antibacterial tests.

Ethical Considerations

This study was approved by the Health Research Ethics Committee of Poltekkes Kemenkes Pontianak under Ethical Clearance No. 1234/KEPK-2022.

Research Samples

The samples used in this study were antibacterial lotions formulated with yellow kepok banana peel extract at three different concentrations: formula I (30%), formula II (60%), and formula III (90%). The concentration range of the extract at low (30%), medium (60%), and high (90%) levels can help determine the ideal concentration in the lotion for effectively inhibiting *Staphylococcus aureus*, with the potential for safe application on the skin. The yellow kepok banana peel was selected based on the criterion of being fully ripe, indicated by its yellow skin. The variable studied in this research is the diameter of the *Staphylococcus aureus* inhibition zone. The bacterial culture or *Staphylococcus aureus* (ATCC 25923) isolate was obtained from the Provincial Health Laboratory of West Kalimantan. The instruments used in this study include a sterile Petri dish, autoclave, sterile forceps, antibiotic discs, blank discs, inoculating loop, sterile cotton, incubator, ruler, and others.

Extract Preparation

Yellow kepok banana peels were sourced from banana processing waste in Pontianak. Fully ripened peels with uniform yellow coloration were selected. A total of 7 kg of banana peels were sorted to remove any unripe (green) peels and separate the peel from the stem base. The peels were washed under running water to remove dirt, air-dried, and cut into small pieces to facilitate drying. About 5 kg of chopped peels were dried using a cabinet dryer at 45°C, yielding 1 kg of dried simplicia. The simplicia were powdered to maximize surface contact with the solvent, enhancing the efficiency of maceration.[10] 1 kg of dried simplicia ground using a blender will produce 715 grams of simplicia powder. The dried simplicia were ground into powder using a blender and stored in an airtight container for maceration. The simplicia powder was weighed and placed in sterilized glass containers. It was then soaked in 96% ethanol at a ratio of 1:2 (b/v) for 24 hours in a closed vessel. The mixture was filtered, and the residue was pressed. The residue was re-soaked in 96% ethanol, with soaking and filtering repeated for 3 days and three solvent replacements until the filtrate appeared clear, indicating optimal extraction of target compounds. The combined filtrate was evaporated using a rotary

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evaporator to produce a concentrated extract. Drying was performed at 40°C–45°C to preserve bioactive components, such as flavonoids, which are sensitive to temperatures above 50°C.[11] The drying process continued until the moisture content of the simplicia was less than 10%.

Antibacterial Lotion Preparation

The lotion was prepared following a modified method by Noer & Sundari (2018). The lotion formulation includes several ingredients that each contribute to specific functions. The extract serves as the active ingredient, providing the desired therapeutic effects. Stearic acid functions as an emulsifying agent, helping to blend oil and water phases. Liquid paraffin and propylene glycol both act as moisturizers, ensuring skin hydration. Cetyl alcohol serves as a softening agent, leaving the skin smooth and supple. Triethanolamine acts as an emulsifier, stabilizing the mixture. To ensure the lotion remains safe and free from microbial contamination, nipagin and nipasol are included as preservatives. Aerosil serves as a thickening agent, providing the desired consistency, while aquadest functions as a carrier or solvent, facilitating the delivery of other ingredients. Together, these components work synergistically to create a stable and effective topical formulation. The oil phase was prepared by melting stearic acid, cetyl alcohol, liquid paraffin, and nipasol at 80°C until homogenized. A temperature of 80°C is used to melt stearic acid, cetyl alcohol, liquid paraffin, and nipasol without damaging these compounds. This temperature is sufficient to achieve a homogeneous melt of these substances while being low enough to prevent the degradation of their chemical structure. Simultaneously, the aqueous phase was prepared by heating a mixture of distilled water, propylene glycol, triethanolamine, and nipagin to 80°C with continuous stirring until homogeneous. The two phases were then gradually mixed while stirring to form a stable emulsion. Aerosil was added gradually, followed by the gradual addition of yellow kepok banana peel extract into the mortar at 35°C, with continuous grinding to achieve uniform mixing.[12] The resulting lotion was tested for its antibacterial activity against *Staphylococcus aureus*.

Data Collection Procedure

The *Staphylococcus aureus* suspension was prepared in a volume of 5 mL with turbidity adjusted to McFarland standard 0.5, equivalent to 1.5×10^8 CFU/mL. The standard disk size is 6 mm in diameter. The positive control used was an amoxicillin disc (10 µg), and the negative control used was a lotion without the extract. The preparation of antimicrobial discs was done by immersing sterile paper discs in lotion with a certain concentration of extract for 10 minutes. Drain the soaked antibacterial discs, then place the antibacterial discs on the surface of the media using sterile tweezers, slightly pressed with sterile tweezers to ensure full contact with the surface of Mueller Hinton Agar (MHA) media that has been inoculated with bacterial suspensions using the swab method does not use milliliters (mL) as a unit of measurement because it focuses on collecting microbial samples from bacterial suspension tubes adjusted to the McFarland standard using a sterile swab. The spacing between discs was adjusted to prevent overlapping inhibition zones. The plates were incubated at 37°C for 24 hours.[13] After incubation, the inhibition zones around the discs were measured with a ruler accurate to 0.1 mm. The disk diffusion method was performed according to established guidelines.[14] Data analysis was performed using SPSS, with the Kruskal-Wallis test for univariate analysis and the Mann-Whitney test for bivariate analysis.

RESULT

The inhibition zone test results for Formulas I, II, and III are presented in Table 1. This table provides the

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measurements of the inhibition zones for Lotion Formulas I, II, and III, as well as the negative and positive controls. Formula I exhibited an average inhibition zone of 5.60 mm, Formula II had an average of 8.30 mm, and Formula III demonstrated an average of 8.70 mm. Additionally, the table shows that all three lotion formulas fall into the moderate inhibition strength category.

In table 2, statistical analysis showed a significant difference between the formulas in inhibiting bacterial growth based on the Kruskal-Wallis test, with a p-value of 0.004, which is smaller than the significance level of α = 0.05.

In table 3, post-hoc analysis using the Mann-Whitney test was conducted to compare the effectiveness between specific formula pairs. The results indicated no significant difference was found between Formula II and Formula III (p = 0.615) which is greater than the significance level of α = 0.05. Based on these results, it can be concluded that Formula II and Formula III have similar antibacterial effectiveness, while Formula I is significantly less effective compared to the other two formulas.

Table 1. Antibacterial Lotion Inhibition Test Results

Replication	Inhibition zone (mm)				
	Formula I	Formula II	Formula III	Control Negative	Control Positive
R1	6 mm	9 mm	9 mm	none	30 mm
R2	7 mm	8 mm	10 mm	none	30 mm
R3	6 mm	9 mm	9 mm	none	30 mm
R4	5 mm	8 mm	8 mm	none	30 mm
R5	4 mm	7 mm	9 mm	none	30 mm
R6	5 mm	9 mm	8 mm	none	30 mm
R7	6 mm	7 mm	10 mm	none	30 mm
R8	4 mm	9 mm	9 mm	none	30 mm
R9	7 mm	8 mm	7 mm	none	30 mm
R10	6 mm	9 mm	8 mm	none	30 mm
Average	5.60 mm	8.30 mm	8.70 mm		
Category	Moderate	Moderate	Moderate		

Table 2. Results of the Kruskal-Wallis Data Analysis

	Inhibition Zone
Kruskal-Walis H	10,920
df	2
Asymp. Sig	0,004

Table 3. Results of the Mann-Whitney Statistical Analysis for Formulas II & III

	Inhibition Zone
Mann-Whitney U	43,500
Asymp.Sig (2-Tailed)	0,615

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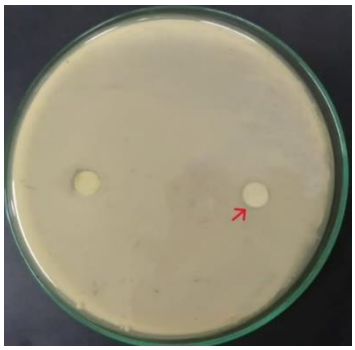

Figure 1. Formula I Inhibition Zone

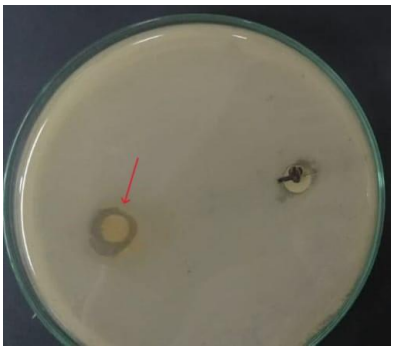

Figure 2. Formula II Inhibition Zone

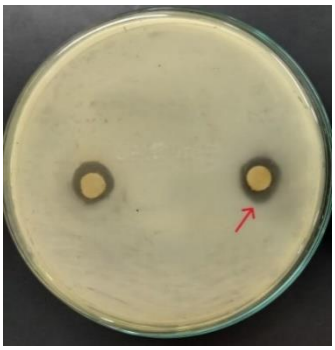

Figure 3. Formula III Inhibition Zone

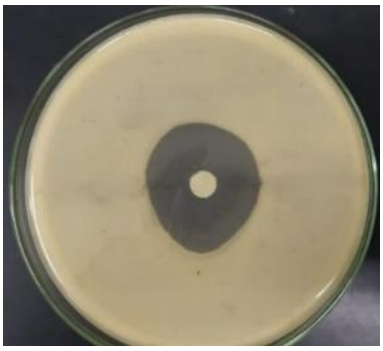

Figure 4. Control Positive

Figure 5. Control Negative

DISCUSSIONS

Staphylococcus aureus is a Gram-positive bacterium that poses significant health risks to humans and animals.[15] This bacterium can cause a wide range of diseases, from mild skin infections to severe conditions such as pneumonia and sepsis.[4] *S. aureus* has numerous virulence factors, including surface proteins, enzymes, and toxins, which contribute to its pathogenicity.[16] The emergence of methicillin-resistant *S. aureus* (MRSA) has further complicated treatment options, as these strains exhibit resistance to multiple antibiotics.[4] This challenge in healthcare has driven the search for effective and sustainable natural antibacterial alternatives.

Yellow kepok banana peel is known to contain bioactive compounds such as flavonoids, saponins, tannins, and alkaloids, which exhibit antibacterial activity.[17] The minimum effective level of yellow kepok banana extract is moderate to strong.[18] The antibacterial mechanisms of flavonoids include inhibiting nucleic acid synthesis, disrupting cytoplasmic membrane functions, and interfering with energy metabolism.[19] Meanwhile, tannins can coagulate bacterial proteins, leading to cell lysis.[20]

Flavonoids, a diverse group of phenolic compounds derived from plants, exhibit strong antibacterial activity against various pathogens. Their mechanisms of action include the inhibition of nucleic acid synthesis, disruption of cytoplasmic membrane function, and interference with energy metabolism.[21] The structure-activity relationship reveals that hydroxyl groups and certain hydrophobic substituents enhance antibacterial potency. Some synthetic flavonoid derivatives have demonstrated efficacy up to 80 times greater than standard antibiotics against multi-drug resistant bacteria. Flavonoids show promise in combating antibiotic resistance when used synergistically with conventional antibiotics. Given the increasing prevalence of antibiotic-

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resistant infections, flavonoids represent a promising avenue for the development of new antibacterial agents.[22]

Saponins,plant-derived compounds, exhibit strong antibacterial properties against various bacterial strains. Studies have shown their effectiveness against both Gram-positive and Gram-negative bacteria, including multi-drug resistant clinical *E. coli* strains. Saponins isolated from green tea seeds and *Solanum trilobatum* leaves have demonstrated potent antibacterial activity both in vitro and in vivo. The antibacterial mechanism of saponins involves the disruption of bacterial cell walls and membranes.[23]Although saponins exhibit cytotoxicity against eukaryotic cells, their antibacterial effects make them promising candidates for the development of new antibiotics. Furthermore, some saponins have demonstrated synergistic effects with traditional antibiotics, offering potential in the fight against antibiotic resistance.[24]

Tannins, high molecular weight polyphenols found in plants, exhibit strong antibacterial properties against various pathogens, including *Streptococcus mutans* and *Staphylococcus aureus.*[25] These compounds inhibit bacterial growth through multiple mechanisms, such as iron chelation, cell wall synthesis inhibition, membrane disruption, and fatty acid biosynthesis inhibition. Tannins also act as quorum-sensing inhibitors and attenuate virulence factor expression.[26] The antibacterial activity of tannins is closely linked to their molecular structure, with factors like flexibility, dipole moment, and hydrophobicity influencing their effectiveness.[27] Given their diverse mechanisms of action and potential health benefits, tannins represent promising alternatives to conventional antibiotics in combating bacterial infections.[28]

Alkaloids, nitrogen-containing compounds found in plants, have shown promising antibacterial properties, offering potential solutions to the growing problem of antibiotic resistance. These natural compounds exhibit diverse mechanisms of action, including inhibition of cell wall synthesis, alteration of membrane permeability, and disruption of bacterial metabolism.[29] Indole-containing alkaloids, in particular, have demonstrated the ability to inhibit efflux pumps and biofilm formation.[30] Recent research has identified several monomeric alkaloids with potent antibacterial activity, showing minimum inhibitory concentrations below 1 µg/mL.[31] Overall, alkaloids represent a promising source for developing new antibacterial agents to combat drug-resistant infections.

Figure 1 shows the inhibition zone of *Staphylococcus aureus* formed using lotion formula I, with an average inhibition zone diameter of 5.60 mm, categorized as moderate. Figure 2 displays the inhibition zone of *Staphylococcus aureus* formed using lotion formula II, with an average inhibition zone diameter of 8.30 mm, also categorized as moderate. Figure 3 represents the inhibition zone of *Staphylococcus aureus* formed using lotion formula III, with an average inhibition zone diameter of 8.70 mm, categorized as moderate. Figures 4 and 5 serve as the positive control and negative control, respectively.

The effectiveness of the lotion used in this study indicates that increasing the concentration of yellow kepok banana peel extract contributes to an enhanced inhibitory effect against *Staphylococcus aureus*. All three lotions demonstrated moderate inhibitory strength, with Formula III, which had the highest concentration (90%), producing the largest inhibition zone diameter. However, the statistical analysis revealed no significant difference in inhibitory effect between Formula II and Formula III. Given that the inhibition zones produced by Formula II and Formula III were not substantially

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different, Formula II is considered the most optimal formula as it requires less extract than Formula III while maintaining a comparable inhibitory effect. Nonetheless, if an even lower extract concentration is preferred, Formula I can be used, as it also exhibits moderate inhibitory strength, albeit with a smaller inhibition zone compared to Formula II and III.

The findings align with previous studies showing the antibacterial properties of banana peel extract.[18] Additionally, the use of ethanol as a solvent in this study facilitated efficient extraction of the active compounds.[32]

This study also provides further evidence that yellow kepok banana peel contains bioactive compounds with antibacterial activity.[33] These active compounds offer significant potential in the formulation of plant-based products with antibacterial properties. Among the three lotion formulas, Formula II (60%) demonstrated optimal antibacterial activity, offering a balance between effectiveness and cost efficiency, making it a more practical choice for commercial applications. As a natural antibacterial agent, the lotion holds promise for further development to address the growing issue of antibiotic resistance.

This study has several significant strengths. One of the key advantages is the use of yellow kepok banana peel, a natural material that is typically considered waste, offering an eco-friendly and sustainable solution. Additionally, this study demonstrates the antibacterial effectiveness of the lotion against *S. aureus*, a major pathogenic bacterium, thus supporting the potential of plant-based topical formulations. The 60% extract concentration in the lotion strikes an optimal balance between antibacterial efficacy and cost-effectiveness, making it a more practical and economically feasible option for commercial applications.

Several limitations of this study should be noted. First, the stability of the lotion was evaluated only over a short period, and further testing is required to assess the long-term stability of the product under various storage conditions, such as varying temperatures and humidity. Second, toxicity testing on human skin was not conducted in-depth to ensure the safety of the product for prolonged use. Additionally, the antibacterial effect was only tested against *S. aureus*, and its efficacy against other pathogenic bacteria remains unknown. Future studies should address these limitations to ensure broader applicability and safety of the lotion formulation.

CONCLUSIONS

This study demonstrated that lotion containing yellow kepok banana peel extract was effective in inhibiting the growth of *Staphylococcus aureus*, with moderate inhibition zone strength. The results showed significant differences in the effectiveness of the lotion across three extract concentration formulas: Formula I (30%), Formula II (60%), and Formula III (90%). The effectiveness of the lotion increased with higher extract concentrations, as indicated by the largest average inhibition zone diameter of 8.70 mm observed in Formula III compared to Formula I and II. Based on these findings, Formula II (60%) is considered the most optimal, as it provides a good antibacterial effect while requiring less extract than Formula III.

Further research involving in vivo studies and testing on a broader spectrum of bacteria is recommended to confirm these findings and expand the potential applications of this formulation. Additionally, long-term stability evaluations and toxicity testing on human skin are necessary to ensure the safety and commercial viability of the product.

REFERENCES

1. Pal M, Kerorsa GB, Marami LM, Kandi V. Epidemiology, Pathogenicity, Animal Infections,

https://doi.org/10.34011/juriskesbdg.v17i1.2818

e-ISSN: 2579-8103
p-ISSN:1979-8253

Antibiotic Resistance, Public Health Significance, and Economic Impact of Staphylococcus Aureus: A Comprehensive Review. *Am J Public Health Res*. 2020;8(1):14-21.

2. Bashabsheh RHF, Al-Fawares O, Natsheh IY, Bdeir R, Al-Khreshieh RO, Bashabsheh HHF. Staphylococcus aureus epidemiology, pathophysiology, clinical manifestations and application of nano-therapeutics as a promising approach to combat methicillin resistant Staphylococcus aureus. *Pathog Glob Health*. 2023;118(3):209-231.
3. Cheung GYC, Bae JS, Otto M. Pathogenicity and virulence of Staphylococcus aureus. *Virulence*. 2021;12(1):547-569.
4. Bashabsheh RHF, Al-Fawares O, Natsheh IY, Bdeir R, Al-Khreshieh RO, Bashabsheh HHF. Staphylococcus aureus epidemiology, pathophysiology, clinical manifestations and application of nano-therapeutics as a promising approach to combat methicillin resistant Staphylococcus aureus. *Pathog Glob Health*. 2023;118(3):209-231.
5. Muhammad Fadhil Safari, Vinda Maharani Patricia, Livia Syafnir. Penelusuran Pustaka Kandungan Senyawa dari Ekstrak Kulit Pisang Raja (Musa paradisiaca var raja) dan Kulit Pisang Cavendish (Musa cavendishii) dalam Beberapa Aktivitas Farmakologi. *Bandung Conference Series: Pharmacy*. 2022;2(2):1-6. doi:10.29313/bcsp.v2i2.4714
6. Tan Z, Deng J, Ye Q, Zhang Z. The Antibacterial Activity of Natural-derived Flavonoids. *Curr Top Med Chem*. 2022;22(12):1009-1019. doi:10.2174/1568026622666220221110506
7. Hamzah H. Efek Saponin Terhadap Penghambatan Planktonik Dan Mono-Spesies Biofilm Candida albicans ATCC 10231 Pada Fase Pertengahan, Pematangan Dan Degaradasi. *Majalah Farmaseutik*. 2021;17(2):198-205.
8. Hersila N, M.P MC, M.Si V, M.Si IrBTI. Senyawa Metabolit Sekunder (Tanin) pada Tanaman sebagai Antifungi. *Jurnal Embrio*. 2023;15(1):16-22.
9. Hidayat AA. *Metodologi Penelitian Keperawatan Dan Kesehatan*. Jakarta: Salemba Medika; 2017.
10. Saraswati FN. *Uji Aktivitas Antibakteri Ekstrak Etanol 96% Limbah Kulit Pisang Kepok Kuning (Musa Balbisiana) Terhadap Bakteri Penyebab Jerawat (Staphylococcus Epidermidis, Staphylococcus Aureus, Dan Propionibacterium Acne)*. UIN Syarif Hidayatullah; 2015.
11. Sarfina J, Nurhamidah N, Handayani D. Uji Aktivitas Antioksidan dan Antibakteri Ekstrak Daun Ricinus communis L (jarak kepyar). *Alotrop (Jurnal Pendidikan dan Ilmu Kimia)*. 2017;1(1):1-5. doi:10.33369/atp.v1i1.2725
12. Noer B, Sundari S. Formulasi Hand And Body Lotion Ekstrak Kulit Buah Naga Putih (Hylocereus undatus) dan Uji Kestabilan Fisiknya. *JPP (Jurnal Kesehatan Poltekkes Palembang)*. 2018;11(1):103-104.
13. Hudzicki J. Kirby-Bauer disk diffusion susceptibility test protocol. *American society for microbiology*. 2009;15(1):1-23.
14. Weinstein MP, Lewis JS. *The Clinical and Laboratory Standards Institute Subcommittee on Antimicrobial Susceptibility Testing: Background, Organization, Functions, and Processes*. Vol 58.; 2020. doi:10.1128/JCM.01864-19
15. Pal M, Kerorsa GB, Marami LM, Kandi V. Epidemiology, Pathogenicity, Animal Infections, Antibiotic Resistance, Public Health Significance, and Economic Impact of Staphylococcus Aureus: A Comprehensive Review. *Am J Public Health Res*. 2020;8(1):14-21.

https://doi.org/10.34011/juriskesbdg.v17i1.2818

e-ISSN: 2579-8103
p-ISSN:1979-8253

16. Cheung GYC, Bae JS, Otto M. Pathogenicity and virulence of Staphylococcus aureus. *Virulence*. 2021;12(1):547-569.
17. Primadiamanti A, Marcellia S, Sukmawan S. Aktivitas Antibakteri Sediaan Gel Antiseptik Ekstrak Etanol Kulit Pisang Kepok Mentah (Musa paradisiaca L.) Terhadap Bakteri Staphylococcus aureus Dan Staphylococcus epidermidis. *Jurnal Ilmu Kedokteran dan Kesehatan*. 2021;8(2):5.
18. Saraswati FN. *Uji Aktivitas Antibakteri Ekstrak Etanol 96% Limbah Kulit Pisang Kepok Kuning (Musa Balbisiana) Terhadap Bakteri Penyebab Jerawat (Staphylococcus Epidermidis, Staphylococcus Aureus, Dan Propionibacterium Acne)*. UIN Syarif Hidayatullah; 2015.
19. Hamzah H. Efek Saponin Terhadap Penghambatan Planktonik Dan Mono-Spesies Biofilm Candida albicans ATCC 10231 Pada Fase Pertengahan, Pematangan Dan Degaradasi. *Majalah Farmaseutik*. 2021;17(2):198-205.
20. Sunani S, Hendriani R. Classification and Pharmacological Activities of Bioactive Tannins. *Indonesian Journal of Biological Pharmacy*. 2023;3(2):130-136.
21. Tan Z, Deng J, Ye Q, Zhang Z. The Antibacterial Activity of Natural-derived Flavonoids. *Curr Top Med Chem*. 2022;22(12):1009-1019. doi:10.2174/1568026622666220221110506
22. Farhadi F, Khameneh B, Iranshahi M, Iranshahy M. Antibacterial activity of flavonoids and their structure–activity relationship: An update review. *Phytotherapy Research*. 2019;33(1):13-40. doi:10.1002/PTR.6208
23. Khan MI, Ahhmed A, Shin JH, Baek JS, Kim MY, Kim JD. Green Tea Seed Isolated Saponins Exerts Antibacterial Effects against Various Strains of Gram Positive and Gram Negative Bacteria, a Comprehensive Study in Vitro and in Vivo. *Evidence-based Complementary and Alternative Medicine*. 2018;2018(1):1-12. doi:10.1155/2018/3486106
24. Li J, Monje-Galvan V. In Vitro and In Silico Studies of Antimicrobial Saponins: A Review. *Processes*. 2023;11(10):1-17. doi:10.3390/PR11102856
25. Olchowik-Grabarek E, Sękowski S, Kwiatek A, et al. The Structural Changes in the Membranes of Staphylococcus aureus Caused by Hydrolysable Tannins Witness Their Antibacterial Activity. *Membranes (Basel)*. 2022;12(11):1-18. doi:10.3390/MEMBRANES12111124
26. Farha AK, Yang QQ, Kim G, et al. Tannins as an alternative to antibiotics. *Food Biosci*. 2020;38(2):1-18. doi:10.1016/J.FBIO.2020.100751
27. Olchowik-Grabarek E, Sękowski S, Kwiatek A, et al. The Structural Changes in the Membranes of Staphylococcus aureus Caused by Hydrolysable Tannins Witness Their Antibacterial Activity. *Membranes (Basel)*. 2022;12(11):1-18. doi:10.3390/MEMBRANES12111124
28. Farha AK, Yang QQ, Kim G, et al. Tannins as an alternative to antibiotics. *Food Biosci*. 2020;38(2):1-18. doi:10.1016/J.FBIO.2020.100751
29. Yan Y, Li X, Zhang C, Lv L, Gao B, Li M. Research Progress on Antibacterial Activities and Mechanisms of Natural Alkaloids: A Review. *Antibiotics*. 2021;10(3):1-30. doi:10.3390/ANTIBIOTICS10030318
30. Liu Y, Cui Y, Lu L, Gong Y, Han W, Piao G. Natural indole-containing alkaloids and their antibacterial activities. *Arch Pharm (Weinheim)*.

https://doi.org/10.34011/juriskesbdg.v17i1.2818

e-ISSN: 2579-8103
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2020;353(10):1-25. doi:10.1002/ARDP.202000120
31. Thawabteh AM, Ghanem AW, AbuMadi S, et al. Antibacterial Activity and Antifungal Activity of Monomeric Alkaloids. *Toxins (Basel)*. 2024;16(11):1-40. doi:10.3390/TOXINS16110489
32. Dewatisari WF. Perbandingan Pelarut Kloroform dan Etanol terhadap Rendemen Ekstrak Daun Lidah Mertua (Sansevieria trifasciata Prain.) Menggunakan Metode Maserasi. *Journal UIN Alauddin*. 2020;6(1):127-132.
33. Primadiamanti A, Marcellia S, Sukmawan S. Aktivitas Antibakteri Sediaan Gel Antiseptik Ekstrak Etanol Kulit Pisang Kepok Mentah (Musa paradisiaca L.) Terhadap Bakteri Staphylococcus aureus Dan Staphylococcus epidermidis. *Jurnal Ilmu Kedokteran dan Kesehatan*. 2021;8(2):5.

https://doi.org/10.34011/juriskesbdg.v17i1.2818