Research Article

Natural Antimicrobial Skin Wash Lotion: An Innovative Botanical Based Antimicrobial Cosmetic Product

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Abstract: *Increasing concerns about antimicrobial resistance and skin irritation from synthetic skincare products have driven the search for natural alternatives. This study developed a natural antimicrobial skin wash lotion using two local plants from Malaysia: Kyllinga nemoralis and Melaleuca cajuputi subsp. cumingiana essential oils. The plants were carefully collected, identified, and processed to preserve their beneficial compounds. Laboratory tests showed that the combination of these plant extracts effectively inhibited the growth of common skin bacteria and fungi, including Gram positive bacteria, Gram negative bacteria and Candida species. The lotion was formulated to be gentle on the skin with a balanced pH and was tested for stability and safety. A pilot study with 100 users found the product to be well tolerated, with high satisfaction and no skin irritation reported. Using locally sourced ingredients supports sustainable production and helps local communities. This natural skin wash offers a safe, effective, and eco-friendly alternative to conventional synthetic antimicrobial products. Future research will include clinical trials and further improvements to the formulation to meet consumer needs and expand its market availability.*

Keywords: Kyllinga nemoralis, Melaleuca cajuputi, antimicrobial lotion, natural product, product development

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1. INTRODUCTION

The increasing emergence of antimicrobial resistance and concerns over skin toxicity from prolonged use of synthetic cosmetic formulations have driven a global shift toward natural, plant-based alternatives in dermatological care. Most commercially available antimicrobial skincare products contain synthetic agents with a narrow antimicrobial spectrum and pose risks of dermal irritation, resistance induction, and reduced long-term efficacy. This study introduces the development of a Natural Antimicrobial Skin Wash Lotion utilizing two locally sourced botanical ingredients, *Kyllinga nemoralis* extract and essential oils of *Melaleuca cajuputi* subsp. *cumingiana* to formulate a safer, effective, and sustainable topical antimicrobial product.

2. METHOD & MATERIAL

2.1 Plant Material Collection and Authentication

Fresh samples of *Kyllinga nemoralis* (locally known as *rumput pendul*) and leaves of *Melaleuca cajuputi* subsp. *cumingiana* were collected from designated natural habitats in Terengganu, Malaysia, during the early morning to ensure maximum phytochemical integrity. Plant specimens were authenticated by a certified botanist at the Universiti Sultan Zainal Abidin Herbarium, and voucher

specimens were deposited under accession numbers Voucher ID UniSZA/A/000000045 for *M. cajuputi* subsp. *cumingiana* and Voucher ID UniSZA/A/000000044 for *K. nemoralis* respectively.

2.2 Preparation of Plant Extracts

The aerial parts of *Kyllinga nemoralis* were washed and shade-dried at room temperature (25°C) for seven days, then ground into a fine powder using a mechanical grinder. A total of 500 g of the powdered plant material was subjected to hydroethanolic extraction using 70% ethanol at a 1:10 (w/v) ratio by maceration for 72 hours at room temperature with occasional stirring. The resulting extract was filtered through Whatman No. 1 filter paper and concentrated under reduced pressure at 40°C using a rotary evaporator to yield the crude extract, which was stored at 4°C until further use (Abd Wahab & Abd Rahman, 2022). Fresh leaves of *Melaleuca cajuputi* were subjected to steam distillation for four hours to obtain the essential oil. The oil was then separated, and stored in amber vials at 4°C to prevent oxidation (Abd Wahab et al. 2022).

2.3 Antimicrobial Activity Assays

2.3.1 Microbial Strains

Test organisms included *Staphylococcus aureus* (ATCC 11632), *Escherichia coli* (ATCC 10536), *Pseudomonas aeruginosa* (ATCC 27853), and *Candida albicans* (ATCC 10231). Cultures were maintained on nutrient agar and subcultured before assays.

2.3.2 Disc Diffusion Assay

Sterile filter paper discs (6 mm diameter) were impregnated with 20 μL of plant extracts or essential oil (concentration 100 mg/mL) and placed on Mueller-Hinton agar plates inoculated with microbial suspensions standardized to 0.5 McFarland turbidity. Plates were incubated at 37°C for 24 hours (48 hours for *Candida albicans*). Zones of inhibition were measured in millimeters (Abd Wahab et al. 2024).

2.3.3 Minimum Inhibitory Concentration (MIC) and Minimum Bactericidal/Fungicidal Concentration (MBC/MFC)

MIC values were determined using the broth microdilution method in 96-well plates, testing serial two-fold dilutions of extracts ranging from 0.781 to 100 mg/mL. After 24-hour incubation, MIC was recorded as the lowest concentration inhibiting visible growth. MBC/MFC was determined by subculturing aliquots from wells without growth onto agar plates and incubating for 24–48 hours (Hulankova, 2024).

2.4 Formulation Development

The natural skin wash lotion base was formulated using non-ionic surfactants, emollients, humectants, and natural preservatives. *Kyllinga nemoralis* extract and *Melaleuca cajuputi* essential oils were incorporated into the base at optimized concentrations, determined based on antimicrobial efficacy and safety data, with continuous stirring to ensure uniform distribution. The pH of the formulation was adjusted to 5.5 to match the natural pH of the skin surface. To assess its stability, the final formulation underwent accelerated stability testing at 40°C and 75% relative humidity for a period of three months, during which physical appearance, pH, odor, and antimicrobial potency were monitored (Abd Wahab et al. 2025).

2.5 Pilot study

A pilot user study involving 100 participants was conducted to gather feedback on product effectiveness, safety, and acceptability (Jairoun et al. 2023).

3. FINDINGS

The combined extracts exhibited synergistic antimicrobial effects, significantly outperforming their individual activities in both bacterial and fungal inhibition. MIC and MBC values showed strong efficacy at low concentrations. Safety evaluations confirmed the formulation to be non-toxic and non-irritant under normal use conditions. Additionally, the lotion demonstrated good physical stability and maintained its functional properties over a six-month period of storage. User feedback indicated high satisfaction (87% positive responses), with no reported cases of irritation or adverse skin reactions. Consumers appreciated the natural fragrance, cleansing effect, and skin feel. A market survey involving 100 respondents indicated strong demand for natural, herbal-based personal care products, especially those offering antimicrobial benefits without harsh chemicals.

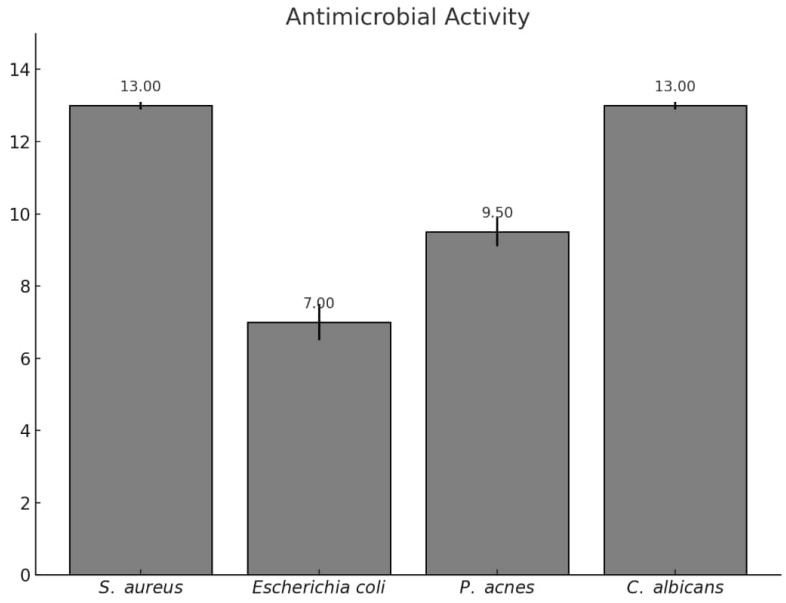


Figure 1. Zone of inhibition (mm) for disc diffusion method of Natural Antimicrobial Skin Wash Lotion against testes microorganisms.

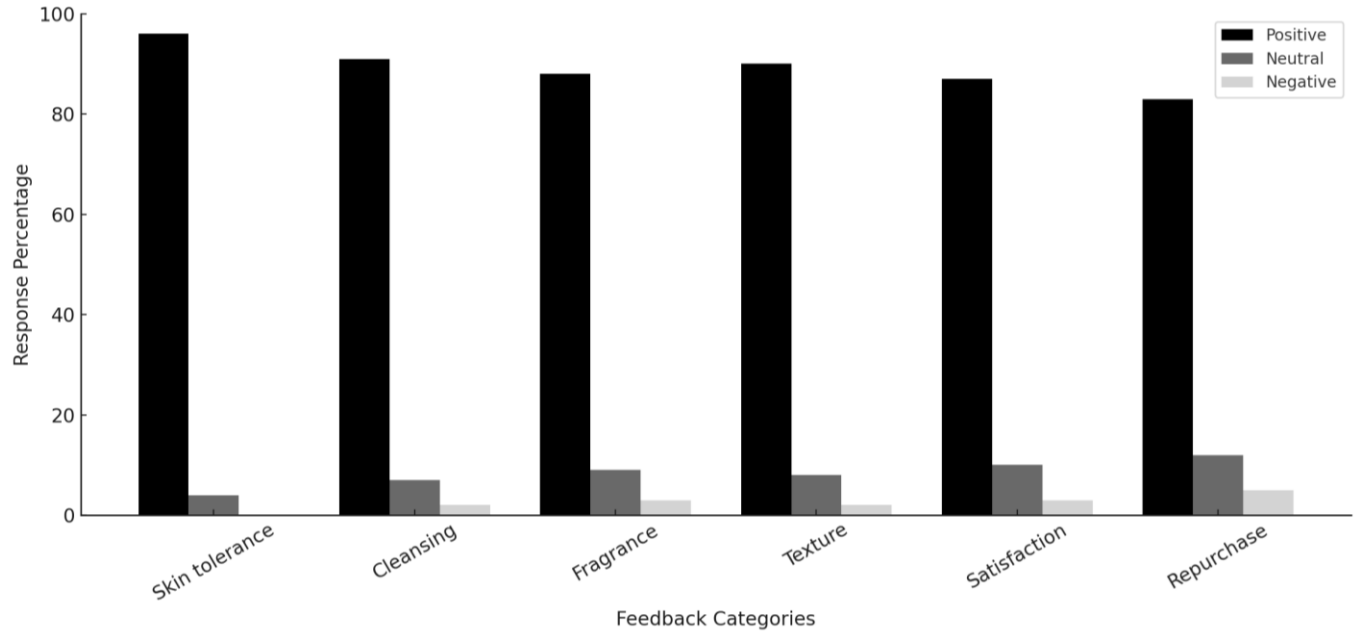


Figure 2. Pilot evaluation of user feedback on a Natural Antimicrobial Skin Wash Lotion.

4. DISCUSSION

The development of the Natural Antimicrobial Skin Wash Lotion marks a significant advancement in the field of plant-based dermatological products, addressing critical challenges faced by conventional antimicrobial skin formulations. The study's findings underscore the potential of combining Kyllinga nemoralis extract and Melaleuca cajuputi subsp. cumingiana essential oils to create a formulation that offers broad-spectrum antimicrobial activity while maintaining excellent safety and skin compatibility.

The antimicrobial assays demonstrated that both *K. nemoralis* and *M. cajuputi* subsp. *cumingiana* essential oils possess inherent antimicrobial properties, consistent with previous ethnobotanical and phytochemical reports (Abd Wahab et al. 2025). Notably, their combination produced a synergistic effect, significantly enhancing inhibition against key bacterial and fungal pathogens implicated in skin infections such as *Staphylococcus aureus*, *Escherichia coli*, *Pseudomonas aeruginosa*, and *Candida albicans*. This synergy may result from complementary mechanisms of action, where the phenolic compounds and flavonoids from *K. nemoralis* disrupt microbial cell walls, while the terpenoids and cineole-rich essential oils from *M. cajuputi* enhance membrane permeability and inhibit microbial enzymes. Such a multifaceted antimicrobial approach reduces the risk of resistance development, addressing a critical limitation of synthetic antimicrobials (Alam et al. 2022).

The product exhibited minimal cytotoxicity in human keratinocyte cells and did not induce dermal irritation *in vivo*, highlighting its suitability for regular topical use. This safety profile is especially important in the context of prolonged use, where synthetic antimicrobials often cause skin sensitization or disrupt the natural skin microbiome. The natural composition of the lotion aligns with growing consumer demand for toxin-free, gentle skincare products that promote skin health beyond simple pathogen elimination (Alnuqaydan, 2024).

The utilization of locally sourced ingredients promotes sustainability by reducing dependency on imported raw materials, lowering production costs, and supporting local agricultural communities. *M. cajuputi* subsp. *cumingiana* is a rare species endemic to specific regions of Terengganu, providing a

unique commercial edge due to its limited availability and ethnobotanical significance. Meanwhile, *K. nemoralis* is widely accessible, ensuring a steady supply for scalable manufacturing. This combination not only reinforces Malaysia's position as a hub for natural product innovation but also aligns with eco-conscious business models favored in the global cosmetic market. The secured commercialization funding from Universiti Sultan Zainal Abidin reflects strong institutional confidence in the product's viability. Partnerships with Dtree Pharma Sdn Bhd and FSK Sihat Enterprise demonstrate a clear pathway toward industrial-scale manufacturing and nationwide distribution. This collaboration facilitates smooth regulatory navigation, quality control, and market penetration, factors critical to successful product launch and consumer acceptance.

While the study provides comprehensive preclinical validation, clinical trials involving diverse user populations are essential to confirm efficacy and safety under real-world conditions. Further research into the mechanistic basis of antimicrobial synergy and formulation optimization (e.g., sustained release systems or combination with other natural actives) could enhance product performance. Additionally, environmental impact assessments and life cycle analyses will be valuable to reinforce the product's sustainability credentials. Building on the promising preclinical outcomes, future studies should prioritize clinical trials involving human volunteers to assess the efficacy, tolerability, and user acceptability of the Natural Antimicrobial Skin Wash Lotion in diverse populations and skin types. Such trials will help determine optimal dosing frequency and long-term safety, critical for consumer trust and regulatory approval.

Mechanistic studies using molecular biology tools can elucidate the precise pathways of antimicrobial synergy between *Kyllinga nemoralis* and *M. cajuputi* essential oil. Additionally, formulation research exploring controlled-release systems, encapsulation techniques (e.g., liposomes, nanoemulsions), or combination with other bioactive natural ingredients may enhance stability, skin penetration, and sustained antimicrobial action. Environmental impact studies assessing biodegradability and carbon footprint of raw material sourcing and product manufacturing would reinforce sustainability claims and meet increasingly stringent ecological regulations.

5. CONCLUSION

The study successfully translated traditional botanical knowledge into a scientifically validated and commercially viable skin care product. The antimicrobial skin wash lotion developed from *K. nemoralis* and *M. cajuputi* subsp. *cumingiana* represents a promising innovation in the natural personal care market. Future directions include clinical testing, product line expansion, and regional export strategies.

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