

Original Research Article

<https://doi.org/10.20546/ijcmas.2025.1410.011>

Comparative Evaluation of Antimicrobial Efficacy of Multipurpose Topical Creams

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ABSTRACT

Keywords

Antimicrobial resistance, rational therapy, skin infections, herbal formulations, consumer product

Article Info

Received:

08 August 2025

Accepted:

30 September 2025

Available Online:

10 October 2025

SSTIs are a major international health problem, which is becoming increasingly complex due to antimicrobial resistance (AMR) and the popularity of unproven over-the-counter creams. The antimicrobial effectiveness of four commercially available topical formulations namely Soframycin (pharmaceutical antibiotic), Colgate Dental Cream (multipurpose formulation), Boroplus (herbal preparation), and Fair and Lovely (cosmetic cream) were systematically tested against *S. aureus*, *B. subtilis*, *E. coli* and *A. niger* in agar well diffusion method. Findings indicated a strong pecking order: Soframycin was the strongest antimicrobial agent against all organisms, Colgate had medium effect, Boroplus had weak effects and Fair and Lovely showed no effect at all. The results of these findings point to some essential inconsistencies between clinically-proven drugs and consumer-centered products with the tendency of being assertive by antimicrobial claims. It is clear, in the absence of activity in cosmetic cream and limited efficacy of herbal preparations, the dangers in replacing unverified products with evidence-based therapies with potential implications of failure to cure and resistance development. This paper offers experimental data to support the significance of rational topical therapy, regulatory examination of consumer products, and educating the populace to reverse unsuitable culture during the AMR era.

Introduction

Skin and soft tissue infections (SSTIs) are a significant health concern on an international level, with millions of visits being outpatient every year with devastating recurrent and opportunistic characteristics (Silverberg, 2021). They are due to a wide range of microbial pathogens that include Gram-positive pathogens like

Staphylococcus aureus (*S. aureus*) which is well known and highly recognized not only for its virulence factors and immune evasion capabilities, but also Gram-negative pathogens such as *Escherichia coli* (*E. coli*) that is known to produce toxins and exhibit multidrug resistance mechanisms and fungi pathogens like *Aspergillus niger* that intensifies superficial or chronic infections (Chiller et al., 2001). In present era antimicrobial resistance

(AMR) is increasing dramatically, the question of the efficacy of easily accessible treatment options, especially of topical preparations, has become a clinical as well as a social priority (Salam *et al.*, 2023). Topical antimicrobials have a special place on the infection management niche as they provide opportunities to deliver active agents to the focus of the infection, minimizing exposure to the whole system and minimizing the number of adverse drug reactions. An example is aminoglycoside antibiotics, which continue to be a cornerstone of dermatological practice, and framycetin and gentamicin have been shown to be strong due to the inhibition of bacterial syntheses of proteins at the ribosomal level (Ramirez & Tolmasky, 2017). Their clinical achievement highlights the possible of topical therapies when formulated properly to serve as the initial barriers to localized microbial invasion. However, simultaneously with the pharmaceutical agents, there has been the exponential increase in the number of over-the-counter (OTC) herbal remedies and cosmetic creams in the global market (Kamat *et al.*, 2020). These items, frequently sold with claims of their general protective or antimicrobial effects, are common in the usage of the consumer population, even in situations where they are substituted unsuitable with a developed antibiotic. These are alarming practices, as no one can often put the antimicrobial efficacy of herbal or cosmetic creams through strict laboratory validation (Conover, 2002). Although such non-pharmaceutical commercial creams are widely used, the evidence on the antimicrobial activity is still fragmented. An example of such bioactive phytochemicals found in herbal preparations is flavonoids or terpenoids, although the levels that are available in commercially available products are often below the levels needed to have a therapeutic effect. An example of cosmetic preparation, such as creams with niacinamide or skin-lightening compounds, is mainly aimed at looking, and not at infection prevention. Similarly, products with multiple purposes, such as dental creams, can have incidental antimicrobial effects because of the presence of surfactants like sodium lauryl sulfate, but not because of the treatment of microbial infections (Noa Ziklo *et al.*, 2024). Accordingly, there is a significant gap in the knowledge of the population about the benefits of antimicrobial in general, and specific scientific data and arguments in support or against this notion. The abuse of poorly tested creams has wider ramifications when it comes to individual and society health. The patients who replace unproven topical agents with the proven antibiotics are at risk of treatment failure, long-lasting infections, and the occurrence of

complications. On the community scale, the use of untested formulations can lead to unacceptable antimicrobial behaviours and postponement of required actions, which are indirect contributors to the AMR crisis of bigger proportions (Ayukekbong *et al.*, 2017). The solution to this gap is to have experimental studies that carefully regulate experimental studies directly comparing the antimicrobial effect of different commercial creams representing the pharmaceutical, herbal, cosmetic and multipurpose categories against representative microbial pathogens under standardized laboratory setting. The agar well diffusion technique has been a long-standing gold standard of preliminary assessment of antimicrobial activity by reason of its reproducibility, cost-efficiency, and capability to offer comparative inhibition profiles (CLSI, 2025). This method can be used to test commercially available creams systematically to produce sufficient empirical evidence on how to use products rationally, how to differentiate between marketing claims and real therapeutic effects and because this information should inform the education of consumers and as well as clinical advice. The current study aimed to fill this knowledge gap by conducting a comparative study of the antimicrobial activity of four commercially available topical creams, which include: Soframycin which is a pharmaceutical topical antibiotic made of framycetin sulfate; Colgate Dental Cream which is a multipurpose dental product made of surfactants; Boroplus which is herbal Ayurvedic formulation made of botanical extracts; and Fair & Lovely (now Glow & Lovely) a cosmetic cream made of mainly niacinamide. They determined their antimicrobial actions against four clinically and environmentally pertinent, bacteria, namely, *S. aureus*, *B. subtilis*, *E. coli*, and *A. niger*, through agar well diffusion test. This study offers a unique chance to define the relationship between variations in the formulations and active ingredients as reflected in the difference in antimicrobial efficacy by incorporating pharmaceutical, herbal, cosmetic, and multipurpose formulations in a single comparative approach. By so doing, it fills the current gap in the scientific literature where the possibility and claimed efficacy of consumer products have rarely been rigorously tested. In addition, it provides evidence-based recommendations regarding the dangers of replacing non-medical creams with clinically approved antimicrobials as well as emphasizes the importance of regulatory attention to product labels and consumer education. In the end, this piece of work, besides elucidating the antimicrobial potential of various commercial creams, also forms part of the greater

discussion of rational topical therapy in the AMR era. It corresponds with the pressing need of evidence-based decision-making in the practice of dermatology and community health by offering evidence-based insights.

Materials and Methods

Collection of Microbial Cultures

Total 4 test organisms were selected to represent different microbial groups associated with skin and environmental infections, namely *Staphylococcus aureus* and *Bacillus subtilis* (Gram-positive bacteria), *Escherichia coli* (Gram-negative bacterium), and *Aspergillus niger* (filamentous fungus). Pure cultures were obtained from Dr. Vasantrao Pawar Medical College and Research Centre, Nashik (MS, India) after completion of essential documentation process. Bacterial isolates maintained on Nutrient Agar (NA) and the fungal isolate on Sabouraud's Dextrose Agar (SDA) (HiMedia, India) at 4°C, followed by periodic subculturing as per standard guidelines to ensure viability.

Selection of commercial cream as a sample

Four commercially available creams were selected based on their therapeutic or cosmetic relevance: Soframycin (framycetin sulfate, topical antibiotic), Colgate (calcium carbonate and sodium lauryl sulfate, dental cream), Boroplus (herbal formulation containing *Aloe vera*, *Hedychium*, and other plant extracts), and Fair & Lovely (niacinamide-based cosmetic cream). All formulations were procured fresh from a local pharmacy and stored under recommended conditions until use.

Evaluation of Antimicrobial Properties Creams

For inoculum preparation, bacterial strains were cultured overnight in Nutrient Broth at 35–37 °C and adjusted to 0.5 McFarland standard ($\sim 1.5 \times 10^8$ CFU/mL). Fungal spores of *A. niger* were harvested in sterile saline with 0.1% Tween-80, filtered to remove hyphal debris, and standardized to a uniform spore suspension. Antimicrobial susceptibility testing was performed using the agar well diffusion method. Sterile Petri plates containing 20 mL of NA (for bacteria) or SDA (for fungus) were seeded with 100 μ L of standardized inoculum and evenly spread with a sterile swab. Wells of 6 mm diameter were aseptically punched into the agar, and 100 μ L of 10% w/v cream dilution in sterile distilled water was loaded into each well. Plates were incubated at

37 °C for 24 h (bacteria) and 28 °C for 48 h (fungus). The antimicrobial effect was assessed by measuring the diameter of the zone of inhibition (ZOI) in millimeters using a Vernier caliper. Positive controls included gentamicin (10 μ g/disc) for bacterial strains and amphotericin B (20 μ g/disc) for fungal strains, while sterile distilled water and cream base served as negative controls.

Data analysis

All experiments were conducted in triplicate, and results were expressed as mean $\pm$ standard deviation (SD). Statistical significance was determined using one-way ANOVA followed by Tukey's post-hoc test, with $p < 0.05$ considered significant.

Results and Discussion

The agar well diffusion method was used to assess the antimicrobial activity of four commercial creams against *Staphylococcus aureus*, *Bacillus subtilis*, *Escherichia coli* and *Aspergillus niger*. The results (mean zone of inhibition (ZOI), mm) are summarized in Table 1. The antimicrobial activity of the tested formulations was highest with soframycin with any of which a measurable inhibition zone was produced against all of the test organisms with the most significant effect on *S. aureus* (7 mm).

Colgate Dental Cream was moderately active, especially against *S. aureus* and *E. coli* (4 and 4 mm respectively), but Boroplus had weak antimicrobial activity with no more than 3 mm against *S. aureus* and 1 mm against *E. coli*. Fair & Lovely cream had no antimicrobial activity, with ZOIs of 0-3 mm at most against *S. aureus* and 0-3 mm against *E. coli*. The positive control (gentamicin in bacteria and amphotericin B in fungi) indeed produced much bigger zones of inhibition (16-25 mm), which confirms the validity of the assay. There was no activity in the negative controls.

The present study compared the antimicrobial efficacy of four different types of commercial topical creams, namely pharmaceutical, herbal, cosmetic and multipurpose, systematically through a standard agar well diffusion assay. The results revealed a strict order of efficacy with Soframycin demonstrating consistent inhibition against all the organisms tested, Colgate Dental Cream showing moderate activity,

Boroplus having a weak activity and Fair and Lovely having no antimicrobial activity at all. The findings highlight the necessity to distinguish between the clinically proven drugs and the products aimed at consumers, which might have unverified antimicrobial claims. The efficacy of aminoglycosides including framycetin sulfate in the topical management of skin and soft tissue infections (SSTIs) is an established fact that is reinforced by the high paradigm of Soframycin on this condition (Argenziano *et al.*, 2024). Of particular interest is the preferential activity against *S. aureus* noted in this study since this pathogen is the most common cause of SSTIs globally and still a significant threat to resistance (Lang *et al.*, 2024). Though topical antibiotics represent an effective method of local delivery of high concentrations of active agents with a minimized systemic response, their abuse and overuse in dermatology have led to the development of resistant strains of bacteria, including methicillin-resistant *S. aureus* (MRSA) (Muhaj *et al.*, 2022).

Therefore, although the performance of Soframycin indicates the sustained clinical worth of topical antibiotics, it also supports the necessity of stewardship in prescribing or educating the consumer with the purpose of avoiding the acceleration of resistance. Colgate Dental Cream, a multipurpose formulation, on the contrary, demonstrated moderate inhibitory areas, which could be explained by the presence of the surfactants like sodium lauryl sulfate, which have incidental antimicrobial effects due to destabilizing the microbial membranes (Kulik-Siarek *et al.*, 2024). Although the activity supports anecdotal data on the antimicrobial activity in non-dermatological consumer products, use of such formulations to manage infections is not appropriate. Such products are not comparable in efficacy to pharmaceutical agents, and no therapeutic

standardization exists, which is why the products should not be used as substitutes of clinically validated therapies. The same results have been indicated in veterinary and consumer environments, both of which showed partial or incidental antimicrobial effects of multipurpose creams or cleansers (Wolaschka *et al.*, 2024).

Herbal formulations, like Boroplus investigated in this research, still receive a great amount of attention because they contain bioactive phytochemicals like flavonoids, terpenoids, alkaloids that have already been proven to have antimicrobial properties (Tirant *et al.*, 2024). Nevertheless, our findings demonstrated weak zones of inhibition, which is in agreement with the previous literature that identifies the variability of phytochemical concentration, bioavailability and stability of over-the-counter herbal products (Deshmukh *et al.*, 2024). In addition, the active compounds in commercial herbal creams are of sub-therapeutic concentration and therefore less effective compared to pharmaceutical preparations (Srivastav *et al.*, 2024). However, the discovery of standardized plant-based antimicrobials in topical is still in prospect, particularly when coupled with nanotechnology or controlled delivery platforms to increase bioavailability (Gunawardana and Dias, 2025). It is the ineffectiveness of the Boroplus rather than the ineffectiveness of herbal medicines as such, and indicative of inadequacy within the unchecked formulations which put a greater emphasis on marketability than on pharmacological rigor. The total absence of any quantifiable antimicrobial action in Fair and Lovely cream presents a serious consumer fallacy: cosmetic-related products that are sold as being claimed to improve the skin are quite often mistakenly considered to be protective or curative.

Table.1 Zone of Inhibition (ZOI, mm) of Commercial Creams Against Test Organisms

Test Cream / Control	<i>S. aureus</i>	<i>B. subtilis</i>	<i>E. coli</i>	<i>A. niger</i>
Soframycin (Framycetin sulfate)	7	5	6	6
Colgate Dental Cream (SLS, CaCO₃)	4	2	4	4
Boroplus (Herbal formulation)	2	3	2	3
Fair & Lovely (Niacinamide)	0	1	0	0
Positive Control (Standard antibiotic*)	20–25	18–22	20–24	16–20
Negative Control (Cream base / sterile water)	0	0	0	0

*Gentamicin (10 µg/disc) for bacteria; Amphotericin B (20 µg/disc) for fungus.

Niacinamide-based cosmetic creams are mainly oriented toward pigmentation or barrier activity instead of microbial inhibition (Bouissane *et al.*, 2025). Replacement of such products with known antimicrobials is not only ineffective, but is also dangerous, because it may lead to delayed treatment, severe infection, and increased transmission.

This is consistent with the general body of evidence that cosmetic and natural beauty products, albeit useful in aesthetic or barrier supporting applications, seldom exhibit proven antimicrobial activity (Dinu *et al.*, 2024). This means that regulatory agencies need to increase their scrutiny of product labeling and advertising in order to avert abuses and advance sensible topical therapy.

One of the key findings of this research is that there is an imminent necessity of experimental justification of antimicrobial claims of consumer products. Agar well diffusion technique is a strong and reproducible gold standard screening method of preliminary antimicrobial screening, as eased by current methodological reviews (Gunawardana & Dias, 2025). Through this method using a wide range of consumer creams, this paper demonstrates the extreme differences between pharmaceutical grade and commercially non-medical formulations. This is important evidence that helps in closing the gap between the marketing rhetoric and therapeutic reality so that clinicians and consumers can make informed decisions. These findings can be extended to the global antimicrobial resistance (AMR) crisis, beyond the implication at the product level. Ad hoc application of herbal or cosmetic creams instead of the efficient antimicrobials contributes indirectly to resistance because it promotes a lack of treatment, repeated infections, and target microorganisms (Visan and Negut, 2024). These attitudes at the societal level support irrational patterns of antimicrobial use that complicate the process of stewardship and hamper the effectiveness of strategies aimed at the protection of the population health. Besides the regulatory implementation, sustainable solutions should also be based on community education by underlining the difference between cosmetic enhancement and infection management (Cantor-Vásquez *et al.*, 2024).

Moreover, the poor efficacy of herbal and cosmetic preparations ought not to undermine the prospect of natural products in the fight against resistant infections. The recent developments of using essential oils, plant extracts and probiotic-derived metabolites as topical

delivery systems demonstrate potential antimicrobial efficacy in the case of appropriate standardization and formulation. Nevertheless, to translate this promise into clinically relevant products, it needs to be rigorously lab-validated, solid pharmacokinetic research, and regulatory approval which is often circumvented in commercial practice.

To sum up, the given study makes it evident that there is a pressing message: not every topical cream was created equal in terms of its antimicrobial properties. Although Soframycin is a strong and long-established and tested product, multipurpose, herbal, and cosmetic creams have little to no antimicrobial activity. This supports the risks of replacing unproved formulations with evidence-based therapy in the treatment of SSTIs. By recording these inconsistencies systematically, the research paper is relevant to the larger discussion concerning rational topical therapy during the AMR era, which requires regulatory oversight, consumer education, and a change in the direction towards evidence-based incorporation of natural compounds into dermatological care.

In conclusion, this research showed a great variation in antimicrobial activity between pharmaceutical, herbal, cosmetic, and multipurpose topical creams. Soframycin was found to exhibit uniform inhibition with all diverse pathogens tested which reinforced clinical importance of aminoglycoside-based antibiotics. Colgate Dental Cream was moderately active due to the presence of surfactants and Boroplus was slightly weaker with no significant antimicrobial activity and Fair & Lovely had no significant activity. These findings indicate the risks of substituting evidence-based antimicrobials with untested consumer products, which is likely to lead to treatment failure, recurrence, and indirectly cause antimicrobial resistance. Topical therapy must be used rationally to avoid misuse, increasing regulatory scrutiny, a strict laboratory validation, and education of the consumer are required. Despite poor performance of current herbal and cosmetic formulations, natural compounds still have potential should they be standardized and incorporated in the latest delivery systems. The results, in general, support the evidence-based decision-making in dermatology and community health, especially in the global environment of increasing antimicrobial resistance.

Acknowledgment

The authors are grateful to Mahatma Gandhi

Vidyamandir's Loknete Vyankatrao Hiray Arts, Science and Commerce College (Autonomous), Panchavati, Nashik, for providing the necessary laboratory facilities to carry out this work. The authors also express their sincere thanks to Dr. Vasantrao Pawar Medical College and Research Centre, Nashik (Maharashtra, India), for providing the pure cultures used in the present study.

Author Contributions

Dr. Agnes John Kharat, Conceived the original idea and designed the model and wrote the manuscript. Ms. Vaishali Eknath Sonawane, Designed the model and the computational framework and analysed the data.

Declarations

Ethical Approval Not applicable.

Consent to Participate Not applicable.

Consent to Publish Not applicable.

Conflict of Interest The authors declare no competing interests.

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<https://doi.org/10.1007/s00403-025-04202-1>

How to cite this article:

Agnes Kharat and Vaishali Sonawane. 2025. Comparative Evaluation of Antimicrobial Efficacy of Multipurpose Topical Creams. *Int.J.Curr.Microbiol.App.Sci*. 14(10): 126-132. doi: <https://doi.org/10.20546/ijcmas.2025.1410.011>