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Development of Antibacterial Finish from Leaves of *Psidium Guajva* and *Azadirachta Indica*

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ABSTRACT

Aim of the Study: This study aimed to develop an eco-friendly antibacterial finish from the leaves of *Psidium guajava* and *Azadirachta indica* and to evaluate its effectiveness on cotton fabric.

Methodology: Fresh leaves of *Psidium guajava* and *Azadirachta indica* were collected, washed, microwave-dried, and ground into fine powder. The extracts were prepared using distilled water and applied to cotton fabric through the dip-dry method using alum as a mordant. Antibacterial activity was evaluated using the ASTM E2149 shake flask method. The effectiveness of treated and untreated samples was assessed by measuring the zone of inhibition.

Findings: The results showed that untreated cotton fabric exhibited no antibacterial activity, while treated samples demonstrated significant zones of inhibition. Neem-treated fabric showed higher antibacterial effectiveness with inhibition zones of 24 mm, 35 mm, and 49 mm, whereas guava-treated fabric showed comparatively lower values of 22 mm, 30 mm, and 38 mm. This indicates that *Azadirachta indica* possesses stronger antimicrobial properties than *Psidium guajava*.

Conclusion: The study concludes that plant-based antibacterial finishes are effective and sustainable for textile applications. Neem extract, in particular, showed superior performance and can be recommended for use in medical textiles, sportswear, and home furnishings to enhance hygiene and protection.

Keywords: Antibacterial Finish, Cotton, Psidium Guajava, Azadirachta Indica, Microorganisms.

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1. INTRODUCTION

Microorganisms are the smallest living organisms present ubiquitously in the environment and are not visible to the unaided eye. These microorganisms are associated with various natural processes, diseases, and ecological functions. They grow rapidly in warm and moist environments, which makes textile surfaces particularly susceptible to microbial contamination. The application of chemical and natural antimicrobial agents can inhibit bacterial growth on textile materials. Recently, antimicrobial agents such as triclosan, quaternary ammonium compounds, metallic and salt-based formulations, serum toxins, and nano-silver have been widely used for surface treatment (Gulati et al., 2022).

The evergreen small tree *Psidium guajava* produces leaves that measure approximately 2 to 6 inches in length and 1 to 2 inches in width. The leaves emit a strong aromatic scent when crushed and are dull green in appearance with prominent veins. Guava leaves contain several bioactive compounds that exhibit antibacterial, antidiabetic, and potential anti-obesity properties. A unique composition of essential compounds such as cineol, tannins, triterpenes, flavonoids, sap, eugenol, malic acid, fats, cellulose, chlorophyll, and other fixed components is present in *Psidium guajava* leaves (Butt et al., 2025).

Guava is one of the most widely known natural products and a rich source of nutrients. While its fruit is well recognized for health benefits, its leaves also possess significant medicinal properties. Guava leaves exhibit antimicrobial and antioxidant activities. Studies have shown that guava leaf aqueous extract is effective against a variety of microbial strains (Kumar et al., 2021). Several natural plant-based compounds have been known since ancient times for their antibacterial and antifungal properties. These plant extracts are directly applied to skin or wounds in paste form or controlled applications for wound healing and skincare purposes. Such natural products are widely available, economically feasible, and minimally processed, making them suitable as raw materials for various applications (Kareru et al., 2010).

These medicinal plants possess distinct aromas and coloration, which aid in their identification. Although some of these plant materials may cause mild skin irritation, they are generally non-toxic. Various plant parts including stems, bark, leaves, roots, and tubers can be utilized for therapeutic applications. Neem is one such medicinal plant with well-documented antibacterial and antiparasitic properties across its bark, stem, leaf, root, and fruit components (Wylie & Merrell, 2022).

Neem is considered one of the most potent natural defenses against microbial infections. Neem leaves contain glycerides and fatty acids, primarily stearic and oleic acids. They also contain various limonoids, neem compounds, and quercetin, which is known for antiviral, antifungal, antibacterial, and antimalarial activities. These properties contribute to neem's effectiveness in wound healing and treatment of skin infections such as scabies. Neem is widely used in the treatment of respiratory disorders, skin diseases, and infected wounds (Kamble, 2025).

Neem contains a biologically active compound known as "Azadirachtin" (C30H36O9), which exhibits strong antimicrobial activity against microorganisms. The use of neem-based extracts for surface finishing, particularly on cotton fabrics, has been widely reported in recent literature. When neem seeds or leaves are crushed either fresh or dried and extracted in aqueous solution, insoluble particles are removed through filtration, and the resulting filtrate is used for further application and evaluation (Islam et al., 2023).

Cotton is extensively used in the textile industry due to its excellent comfort and breathable nature. However, its hydrophilic structure makes it highly susceptible to microbial growth. Therefore, functional modification of cotton fabrics using natural plant extracts is necessary to impart antibacterial properties and enhance textile performance (Sadaf et al., 2025). Neem and guava extracts are applied separately to modify cotton fabric surfaces. Plant-based extracts are increasingly used as natural biocides for textile finishing due to their antimicrobial potential. These natural antibacterial agents are non-toxic, non-allergenic, and do not promote microbial resistance, making them highly advantageous for textile applications (Vastrad & Byadgi, 2018).

Extensive research has demonstrated increasing interest in antibacterial finishing of textile materials. Fabrics used in hospitals and hotels are highly prone to cross-contamination and microbial transmission. Therefore, improving the functional properties, durability, and performance of textile surfaces has become essential. Given the increasing demand for eco-friendly antimicrobial agents, the prevention of microbial growth on textiles has gained significant attention. Cotton fabrics, due to their close contact with human skin, provide an ideal medium for microbial adhesion and proliferation, particularly in healthcare, food industry uniforms, and hygiene-related garments. Such microbial growth can lead to health risks and fabric deterioration (Granados et al., 2021).

1.1 Study Objectives

• To develop antibacterial finishes from the leaves of *Psidium guajava* and *Azadirachta indica*.
• To apply antibacterial extracts from *Psidium guajava* and *Azadirachta indica* leaves onto cotton fabric.
• To evaluate the antibacterial effectiveness of treated cotton fabric using plant leaf extracts.

2. MATERIALS AND METHODS

This study employed a quantitative experimental research design to develop and evaluate an eco-friendly antibacterial finish derived from *Psidium guajava* (guava) and *Azadirachta indica* (neem) leaves on cotton fabric. The antibacterial efficacy of treated fabrics was assessed using the ASTM E2149 shake flask method.

2.1. Preparation of Fabric

The cotton fabric samples were pre-treated to remove impurities. The fabric was boiled in a 10% sodium hydroxide (NaOH) solution for 10 minutes to eliminate starch and other contaminants. After treatment, the samples were thoroughly rinsed with cold distilled water and air-dried.

2.2. Development of Antibacterial Finish

2.2.1. Extraction from Plant Leaves

Fresh leaves of *Psidium guajava* and *Azadirachta indica* were collected, washed, and air-dried to remove surface moisture. Approximately 20 g of leaves were placed on a microwave-safe plate lined with paper towels and dried in a microwave oven at 212°F for about one minute until completely dehydrated. The dried leaves were ground into fine powder using a stainless steel grinder and stored in airtight containers labeled accordingly.

The extraction process involved mixing 100 g of powdered leaves with 500 mL of distilled water and 30 g of alum (as a mordant) in separate containers for guava and neem. The mixtures were sealed and left to soak for 48 hours with intermittent stirring twice daily. The extracts were then filtered first through muslin cloth and subsequently through Whatman filter paper to obtain a clear solution.

Cotton fabric samples (2 × 2 inches) were prepared for treatment. The antibacterial finish was applied using the dip-dry method. Fabric samples were immersed in the respective plant extracts for 48 hours. After soaking, the samples were heated at 37°C for 15 minutes to facilitate fixation, followed by drying at room temperature.

2.3. ASTM E2149 Shake Flask Method

2.3.1. Media Preparation

Luria-Bertani (LB) broth was prepared by dissolving 0.25 g of LB powder in 10 mL of distilled water, while nutrient agar was prepared by dissolving 2.8 g in 100 mL of distilled water. The media were mixed thoroughly, covered with cotton plugs and aluminum foil, and sterilized in an autoclave at 110°C for one hour.

2.3.2. Inoculation and Testing Procedure

Sterilized Petri dishes were placed in a laminar airflow cabinet to maintain aseptic conditions. Nutrient agar was poured into Petri dishes and allowed to solidify. The plates were incubated at 37°C for 24 hours to ensure sterility. A bacterial culture (*Xanthomonas* species) was inoculated into LB broth and incubated in a shaking incubator at 37°C for 24 hours to achieve sufficient bacterial growth. The bacterial suspension was then evenly spread over the nutrient agar plates using a sterile cotton swab.

Fabric samples (1 × 1 cm) from control (untreated) and treated groups (guava and neem) were placed onto the inoculated agar surface using sterile tweezers. The plates were sealed and incubated at 37°C for 72 hours. After incubation, the antibacterial activity was evaluated by measuring the zone of inhibition around each fabric sample using a measuring scale. The measurements were recorded in centimeters and converted into millimeters for analysis.

3. RESULTS

The antibacterial finish was successfully developed from the leaves of *Psidium guajava* and *Azadirachta indica* and applied to cotton fabric. The preparation process involved drying, grinding, and extracting the active compounds from plant leaves.

Figures 1 and 2 illustrate the preparation of plant-based extracts. Fresh leaves of neem and guava were collected, washed, and dried using a microwave oven. The dried leaves were ground into fine powder, followed by extraction using distilled water and alum as a mordant. The obtained extracts were filtered thoroughly to remove impurities and obtain a uniform solution suitable for textile finishing. The prepared antibacterial finishes were stored in airtight containers for further application on fabric samples.

Figure 1: *Extract of guava finish*

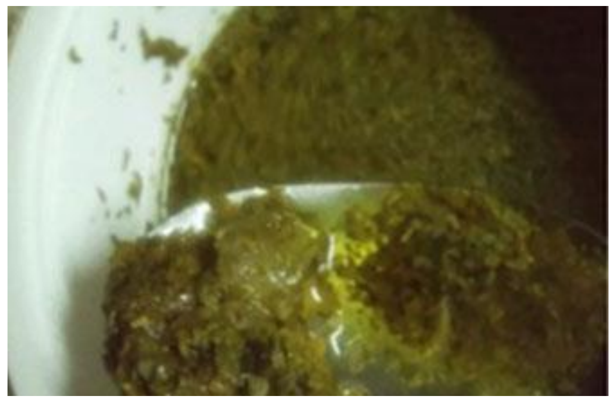

Figure 2: *Extract of neem finish*

Figures 3 and 4 demonstrate the application of the antibacterial finish to cotton fabric using the dip-dry method. The fabric samples were immersed in the prepared plant extracts for 48 hours to ensure adequate absorption of the active compounds. Following immersion, the samples were heated at 37°C for 15 minutes to facilitate fixation of the finish and then thoroughly dried. Alum was used as a mordant to enhance the binding of the antibacterial agents to the fabric surface. A noticeable change in fabric color was observed after treatment, indicating successful deposition of the plant-based finish onto the cotton substrate.

Figure 3: *Fabric after applying neem finish*

Figure 4: *Fabrics after applying guava finish*

3.1. Control Group (Untreated Cotton Fabric)

The control group consisted of untreated cotton fabric samples used for comparison with the treated samples. Antibacterial activity was evaluated by measuring the zone of inhibition after exposure to microbial growth. For analysis, untreated and treated fabric samples were tested under identical conditions. The zone of inhibition was measured in centimeters and subsequently converted into millimeters (1 cm = 10 mm) for accuracy.

Figure 5 illustrates the antibacterial activity of the untreated cotton fabric. No zone of inhibition was observed around the control sample, indicating the absence of inherent antibacterial properties in untreated cotton. The recorded value was 0 mm, demonstrating that untreated cotton fabric does not inhibit microbial growth and is therefore susceptible to bacterial contamination.

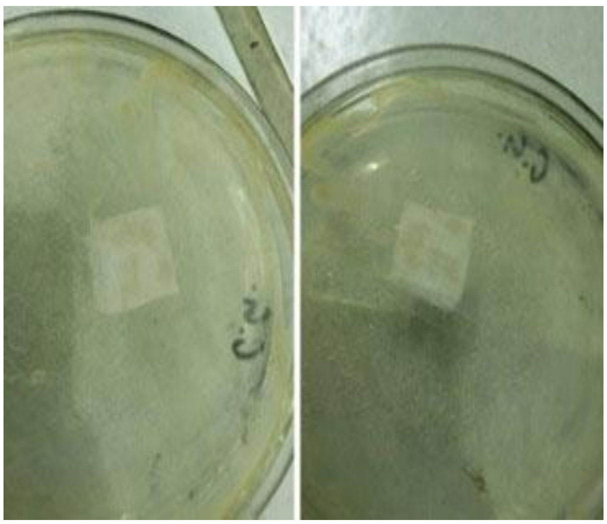

Figure 5: *Untreated cotton fabric*

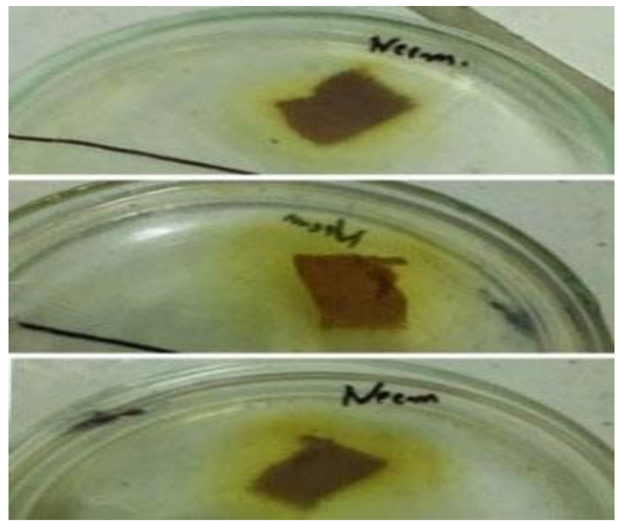

Figure 6: *Sample representation of neem*

3.2. Experimental Group (Treated Cotton Fabric)

3.2.1. Neem Treatment

The antibacterial activity of neem-treated cotton fabric was evaluated by measuring the zone of inhibition in millimeters using a standardized measuring scale. Three replicate samples were tested to ensure reliability of results. The recorded zones of inhibition for neem-treated samples were 24 mm, 35 mm, and 49 mm, respectively. These results indicate a strong antibacterial effect of *Azadirachta indica* extract on microbial growth. Figure 6 illustrates the neem-treated sample showing the maximum zone of inhibition (49 mm), which represents the highest antibacterial performance among the tested samples.

3.2.2. Guava Treatment

The antibacterial activity of guava (*Psidium guajava*)-treated cotton fabric was evaluated by measuring the zone of inhibition in millimeters using a standardized measuring scale. Three replicate samples were analyzed to ensure consistency of results. The recorded zones of inhibition for guava-treated samples were 22 mm, 30 mm, and 38 mm, respectively. These results indicate that guava leaf extract exhibits moderate antibacterial activity against the tested microorganism. Figure 7 illustrates the guava-treated sample, with the maximum observed zone of inhibition being 38 mm, representing the highest antibacterial response among the guava-treated replicates.

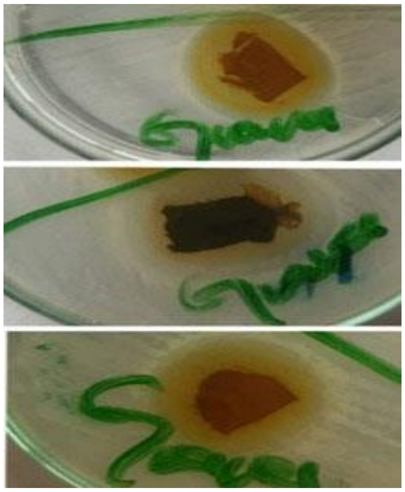

Figure 7: *Sample representation of guava*

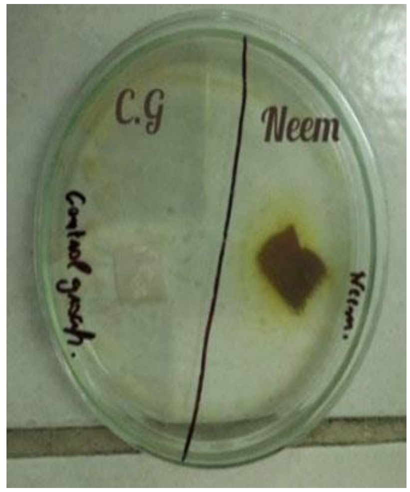

Figure 8: *Comparison of neem with the control group*

Figure 9: *Comparison of guava with the control group*

3.3. Comparison between Control and Experimental Groups

3.3.1. Comparison between Neem-Treated and Control Groups

The antibacterial performance of neem-treated fabric was compared with the untreated control group under identical experimental conditions. The results revealed that the neem-treated samples exhibited a clear zone of inhibition, whereas no zone of inhibition was observed in the control group. This confirms that untreated cotton does not possess inherent antibacterial activity, while the treated fabric effectively inhibits its microbial growth. Figure 8 illustrates the comparison between the control and neem-treated samples, clearly demonstrating the superior antibacterial performance of the experimental group.

3.3.2. Comparison between Guava-Treated and Control Groups

The antibacterial performance of guava (*Psidium guajava*)-treated fabric was compared with the untreated control group under identical experimental conditions on the same agar plate. The results indicated that the guava-treated samples exhibited a clear zone of inhibition, whereas no zone of inhibition was observed in the control group. This confirms the antibacterial effectiveness of guava leaf extract and the absence of antimicrobial activity in untreated cotton fabric. Figure 9 illustrates the comparison between the guava-treated and control samples, clearly demonstrating the superior antibacterial performance of the treated group.

3.4. Comparison between Experimental Groups of Neem and Guava

A comparative analysis was performed between neem (*Azadirachta indica*) and guava (*Psidium guajava*) treated cotton fabrics to evaluate their relative antibacterial performance. The results revealed that neem-treated fabric exhibited higher antibacterial activity compared to guava-treated fabric, as indicated by larger zones of inhibition in all tested samples. This suggests that neem leaf extract possesses stronger antimicrobial potential due to its higher concentration of bioactive compounds. In contrast, guava-treated fabric showed comparatively lower zones of inhibition, indicating moderate antibacterial effectiveness. Figure 10 illustrates the comparative antibacterial performance of both treatments, clearly demonstrating that neem extract provides superior microbial inhibition than guava extract.

Figure 10: *Comparison of neem & guava*

4. DISCUSSION

The present study investigated the development of an eco-friendly antibacterial finish derived from *Psidium guajava* and *Azadirachta indica* leaves and its application on cotton fabric using a dip-dry method. The antibacterial performance was evaluated through zone of inhibition measurements using the ASTM E2149 shake flask method. The results demonstrated clear differences in antibacterial efficiency among treated and untreated samples.

The findings revealed that neem (*Azadirachta indica*)-treated cotton fabric exhibited the highest antibacterial activity, followed by guava (*Psidium guajava*)-treated fabric, while the control (untreated cotton) showed no antibacterial effect. This confirms that cotton fabric does not possess inherent antimicrobial properties and is highly susceptible to microbial contamination due to its porous and hydrophilic structure, which supports bacterial adhesion and growth.

The superior performance of neem can be attributed to the presence of bioactive phytochemicals such as azadirachtin, nimbin, and quercetin, which are known to disrupt bacterial cell wall integrity, inhibit enzyme activity, and interfere with microbial metabolism. The higher zone of inhibition observed in neem-treated samples (up to 49 mm) indicates strong diffusion of these active compounds into the agar medium, resulting in effective microbial suppression.

Guava leaf extract also demonstrated antibacterial activity, though comparatively lower than neem. This may be due to the presence of moderate levels of tannins, flavonoids, and phenolic compounds in *Psidium guajava*. These compounds are known to exhibit antimicrobial properties by denaturing proteins and altering cell membrane permeability. However, in the present study, aqueous extraction was used, which may have limited the extraction efficiency of non-polar bioactive compounds, resulting in moderate antibacterial performance.

Previous studies strongly support the antibacterial potential of neem extracts. Alzohairy (2016) reported significant antimicrobial activity of neem leaf extract against multiple bacterial strains, which aligns with the findings of this study. The consistent effectiveness of neem across studies suggests its broad-spectrum antimicrobial nature, making it suitable for functional textile applications, especially in healthcare environments.

Similarly, guava leaf extracts have been widely reported for their antibacterial properties. Shinde et al. (2018) observed strong antibacterial activity using methanolic extracts of *P. guajava*, with higher inhibition zones compared to aqueous extracts. This indicates that solvent polarity plays a critical role in extracting active phytoconstituents. In comparison, the present study utilized distilled water as an eco-friendly solvent, which is safer and more sustainable but less efficient in extracting certain phytochemicals.

Biswas et al. (2013) further demonstrated that chloroform extracts of guava leaves showed higher antibacterial activity compared to aqueous extracts. This supports the present observation that extraction method significantly influences antimicrobial performance. Likewise, Pereira et al. (2023) reported that ethanol-water combinations enhanced antibacterial activity compared to water alone, suggesting hydroalcoholic solvents improve phytochemical yield and efficacy.

The increase in antibacterial activity observed in neem-treated fabrics can also be linked to better fixation of bioactive compounds onto cotton fibers in the presence of alum as a mordant. Alum may enhance binding efficiency by forming coordination complexes with plant-derived compounds, thereby improving durability and retention of antimicrobial agents on fabric surfaces.

Furthermore, Kumar and Navaratnam (2013) reported that prolonged extraction time increases phytochemical yield, which enhances biological activity. This supports the current methodology where sufficient soaking time was provided to ensure maximum diffusion of active compounds into the extract solution.

From a textile application perspective, the results highlight the potential of plant-based finishes as sustainable alternatives to synthetic antimicrobial agents. Such eco-friendly finishes are particularly relevant for medical textiles, hospital garments, sportswear, and home furnishings where hygiene and microbial resistance are critical requirements. Additionally, the use of natural extracts reduces environmental toxicity and supports green chemistry principles in textile processing.

Overall, the study confirms that both neem and guava leaves possess antibacterial properties; however, neem demonstrates superior effectiveness due to its richer phytochemical profile. The findings strongly support the development of natural, biodegradable, and cost-effective antimicrobial finishes for functional textile applications.

5. CONCLUSION

The present study successfully developed an eco-friendly antibacterial finish from *Psidium guajava* and *Azadirachta indica* leaves and applied it to 100% cotton fabric using the dip-dry method with alum as a mordant. The antibacterial performance was evaluated by comparing treated and untreated samples through zone of inhibition analysis. The results confirmed that the treated fabrics exhibited significant antibacterial activity, while no inhibition zone was observed in the untreated control samples. Among the plant extracts, neem (*Azadirachta indica*) showed higher antibacterial effectiveness compared to guava (*Psidium guajava*), indicating its stronger antimicrobial potential.

The findings highlight that plant-based antibacterial finishes can effectively enhance the functional properties of cotton fabric. Such eco-friendly finishes are suitable for applications in medical textiles, healthcare uniforms, sportswear, and home textiles, where hygiene and microbial resistance are essential. Overall, the study concludes that natural plant extracts offer a sustainable and promising alternative to conventional synthetic antimicrobial agents in textile finishing.

5.1 Novelty Statement

This study introduces an eco-friendly approach to developing antibacterial finishes using natural extracts from Psidium Guajava and Azadirachta Indica leaves. The research uniquely compares the antibacterial effectiveness of these two plant-based extracts when applied to cotton fabric, demonstrating neem's superior microbial inhibition. This novel application provides a sustainable alternative to synthetic antibacterial agents in textile manufacturing.

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Conflict of Interest

Authors declared NO conflict of interest.

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REFERENCES

Alzohairy, M. A. (2016). Therapeutics Role of Azadirachta indica (Neem) and Their Active Constituents in Diseases Prevention and Treatment. *Evidence-based Complementary and Alternative Medicine*, *2016*(1), 7382506. https://doi.org/10.1155/2016/7382506

Biswas, B., Rogers, K., McLaughlin, F., Daniels, D., & Yadav, A. (2013). Antimicrobial activities of leaf extracts of guava (Psidium guajavaL.) on two Gram-Negative and Gram-Positive bacteria. *International Journal of Microbiology*, *2013*, 746165. https://doi.org/10.1155/2013/746165

Butt, E., Altemimi, A. B., Younas, A., Butt, M. S., Jalal, M., Bhatty, M., Abdi, G., & Aadil, R. M. (2025). Guava (Psidium guajava): A brief overview of its therapeutic and health potential. *Food Chemistry X*, *31*, 103027. https://doi.org/10.1016/j.fochx.2025.103027

Granados, A., Pleixats, R., & Vallribera, A. (2021). Recent advances on antimicrobial and Anti-Inflammatory cotton fabrics containing nanostructures. *Molecules*, *26*(10), 3008. https://doi.org/10.3390/molecules26103008

Gulati, R., Sharma, S., & Sharma, R. K. (2022). Antimicrobial textile: recent developments and functional perspective. *Polymer Bulletin*, *79*(8), 5747–5771. https://doi.org/10.1007/s00289-021-03826-3

Islam, M., Ahmed, F., Pervez, N., & Mondal, I. H. (2023, March 21). Anti-microbial finishing of cotton fabric using neem leaf extract for medical and healthcare textiles. *Research in Medical & Engineering Sciences*, *10*(3). https://doi.org/10.31031/rmes.2023.10.000736

Kamble, P. K. S. (2025). Antimicrobial properties of Neem (Azadirachta indica): A comprehensive review of phytochemicals and mechanisms of action. *Zenodo (CERN European Organization for Nuclear Research)*. https://doi.org/10.5281/zenodo.15295814

Kareru, P., Keriko, J., Kenji, G., Thiong'o, G., Gachanja, A., & Mukiira, H. (2010). Antimicrobial activities of skincare preparations from plant extracts. *African Journal of Traditional Complementary and Alternative Medicines*, *7*(3), 214–218. https://doi.org/10.4314/ajtcam.v7i3.54777

Kumar, M., Tomar, M., Amarowicz, R., Saurabh, V., Nair, M. S., Maheshwari, C., Sasi, M., Prajapati, U., Hasan, M., Singh, S., Changan, S., Prajapat, R. K., Berwal, M. K., & Satankar, V. (2021). Guava (Psidium guajava L.) Leaves: Nutritional Composition, Phytochemical Profile, and Health-Promoting Bioactivities. *Foods*, *10*(4), 752. https://doi.org/10.3390/foods10040752

Kumar, V. S., & Navaratnam, V. (2013). Neem (*Azadirachta indica*): Prehistory to conte porary medicinal uses to humankind. *Asian Pacific Journal of Tropical Biomedicine, 3*(7), 505–514. https://doi.org/10.1016/S2221-1691(13)60105-7

Pereira, G. A., Chaves, D. S.A., Silva, T. M. E., Motta, R. E.A., Silva, A. B. R.D., Patricio, T. C.D.C., Fernandes, A. J. B., Coelho, S.M.O., Ożarowski, M., Cid, Y. P., & Karpiński, T. M. (2023). Antimicrobial activity of Psidium guajava aqueous extract against sensitive and resistant bacterial strains. *Microorganisms*, *11*(7), 1784. https://doi.org/10.3390/microorganisms11071784

Sadaf, S., Hassan, K., Saeed, A., & Ahmad, Z. (2025). Boosting Cotton Comfort: Ecofriendly Antimicrobial Finishes from Plant Sources. *Journal Plantarum.*, *7*(2), 129–139. https://doi.org/10.46662/plantarum.v7i2.125

Shinde, M., Sawant, A., Dhekale, P., & Sharma, A. (2018). Effect of different extracts of *Psidium guajava* leaves on antibacterial and antifungal activity. *World Journal of Pharm ceutical Research*, *7*(13), 523–528. https://doi.org/10.20959/wjpr201813-12643

Vastrad, J. V., & Byadgi, S. A. (2018). Eco-friendly Antimicrobial Finishing of Cotton Fabric using Plant Extracts. *International Journal of Current Microbiology and Applied Sciences*, *7*(2), 284–292. https://doi.org/10.20546/ijcmas.2018.702.037

Wylie, M. R., & Merrell, D. S. (2022). The Antimicrobial Potential of the Neem Tree Azadirachta indica. *Frontiers in Pharmacology*, *13*, 891535. https://doi.org/10.3389/fphar.2022.891535