Journal of Advances in Medicine and Pharmaceutical Sciences
p-ISSN: 2964-268X, e-ISSN: 2963-4253

Case Report Paper

Ethnopharmacology Study and Therapeutic Potential of *Cassia alata* for Skin Diseases

Vongphachanh Khampheng[1*], Chittavong Chanthavongsa[1], Nanludet Phoummixay[1], Onmavong Sythanonxay[2]

[1] *Department of Traditional Medicine and Pharmacology, Savannakhet University. Savannakhet, Laos.*
[2] *School of Pharmaceutical Sciences, Champasack University. Pakse, Laos.*

Article History
Received:
11.08.2024

Revised:
15.09.2024

Accepted:
29.09.2024

***Corresponding Author:**
Vongphachanh Khampheng

Abstract: This study explores the ethnopharmacological knowledge of Cassia alata in the treatment of skin diseases in rural Laotian communities. Traditional practices highlight the use of the plant to treat fungal infections, eczema, and other skin conditions, driven by its antimicrobial and anti-inflammatory properties. This study aimed to document and scientifically validate the therapeutic applications of Cassia alata, with a focus on its safety, efficacy, and potential for dermatological product development. A mixed methods approach was used, involving ethnographic interviews with members of a rural Laotian community, laboratory tests to assess antimicrobial activity, and dermatological safety testing. The findings revealed that Cassia alata is widely used in rural areas, with a high degree of confidence in its ability to treat a variety of skin conditions. Microbiological tests confirmed its effectiveness against common pathogens such as Trichophyton and Candida, while dermatological tests demonstrated its safety with minimal side effects. The potential of the plant for dermatological product development is significant, with potential for commercialization and economic benefits to the local community. However, further research is needed to identify active compounds, assess long-term use, and optimize product formulations. This study provides a basis for future research on the global application of Cassia alata as a natural dermatological treatment.

Keywords: Antimicrobial, Anti-Inflammatory, *Cassia alata*, Fungal Infection, Skin Disease.

Journal of Advances in Medicine and Pharmaceutical Sciences, vol. 3, no. 2, pp. 71-78, November 2024. **DOI: 10.36079/lamintang.jamaps-0302.775**

1. Introduction

Traditional medicine has long been an integral part of the healthcare system in rural communities around the world, including Laos. In particular, Laos has a long history of using medicinal plants to treat a variety of ailments, with a particular emphasis on skin diseases. Rural residents in Laos commonly rely on natural remedies derived from local plants to treat skin infections, eczema, fungal infections, and other dermatological conditions. One such plant, *Cassia alata* (commonly known as the ringworm plant), has been highly valued for its therapeutic properties in the treatment of skin diseases. *Cassia alata* leaves have been traditionally used to treat fungal infections and other skin conditions, offering a natural remedy for ailments that afflict many rural communities in Laos. Despite this long-standing use of the plant, scientific validation of its therapeutic potential and safety is scarce. Studies have shown that *Cassia alata* may have antifungal, anti-inflammatory, and antimicrobial properties, but further research is needed to validate these claims and understand the mechanisms underlying its effects [1], [2]. Therefore, it is important to conduct an in-depth study on the medicinal potential of *Cassia alata*, especially regarding its use in dermatological treatment in Laos [3], [4],[5].

In Laos, the use of traditional medicinal plants is deeply rooted in the culture and healthcare practices of local communities. For centuries, rural populations have relied on herbal remedies to treat a variety of ailments, including skin conditions such as fungal infections, eczema, and dermatitis. Traditional medicine is still widely practiced, especially in areas with limited access to modern healthcare. Many plants, including *Cassia alata*, are an important part of the local pharmacopoeia. Several studies have highlighted that Laos is rich in ethnobotanical knowledge, with local healers using plants not only for skin diseases but also to treat digestive, respiratory, and inflammatory conditions [6],[7].

The importance of medicinal plants in Laos is also reflected in their role in public health, especially in rural areas. Many Lao prefer to use natural remedies over pharmaceuticals due to the affordability and availability of herbal remedies. This cultural preference is not unique to Laos but is common to many Southeast Asian countries, where traditional medicine plays an important role in primary healthcare [8],[9]. In Laos, the government has also begun to recognize the value of these plants for potential drug development, and as a result, there have been initiatives to document and study the therapeutic properties of locally used herbal plants [10].

Recent ethnopharmacological studies have emphasized that plants such as *Cassia alata* play an important role in local health care systems, particularly in treating dermatological problems. There is also growing interest in integrating traditional knowledge with scientific research to validate the efficacy and safety of these plants. This could help bridge the gap between traditional practices and modern health care needs [11]. However, despite the widespread use of medicinal plants, scientific documentation of their efficacy and safety remains inadequate. This gap highlights the need for further research on the ethnopharmacology of these plants [7],[9].

Scholars have also argued that traditional knowledge, including the use of *Cassia alata* and other plants, is critical to sustainable health care systems in resource-limited settings such as Laos. By focusing on plant species that have long been used by local communities, researchers can identify compounds with significant therapeutic potential. In addition, understanding the local context in which these plants are used provides a broader view of their cultural relevance and practical applications [11]. Integrating ethnobotany into modern healthcare frameworks can not only preserve traditional knowledge but also increase the availability of natural products that can be safe alternatives to synthetic medications. Research on medicinal plants such as *Cassia alata* offers promising opportunities for the development of effective treatments for skin conditions common in Laos and other Southeast Asian countries [9].

Cassia alata, also known as Senna alata, is a plant widely known for its medicinal properties, particularly in the treatment of skin diseases. The plant contains bioactive compounds that exhibit antimicrobial, anti-inflammatory, and anti-itch effects, making it a valuable resource for dermatological treatments. *Cassia alata* leaves have been used in traditional medicine to treat fungal infections, eczema, and other skin conditions, making it a natural remedy for these common ailments [12],[13].

Several studies have investigated the antimicrobial properties of *Cassia alata*, and have found it to be effective against a wide range of pathogenic microorganisms, including fungi and bacteria. These properties make it an excellent candidate for treating fungal skin infections such as ringworm, as well as conditions such as eczema and psoriasis [12]. Studies have shown that extracts from *Cassia alata*

Journal of Advances in Medicine and Pharmaceutical Sciences, vol. 3, no. 2, pp. 71-78, November 2024. **DOI: 10.36079/lamintang.jamaps-0302.775**

leaves and flowers have inhibitory effects against dermatophytes, fungi responsible for skin infections [14]. In addition, the antifungal properties of this plant are due to its high anthraquinone and flavonoid content, which have shown activity against a wide range of fungi [13].

The anti-inflammatory effects of *Cassia alata* are another key factor supporting its use in treating skin conditions. Inflammation is a common feature of many skin conditions, including eczema and dermatitis. Studies have shown that compounds found in *Cassia alata* can modulate inflammatory pathways, reducing the redness, swelling, and itching associated with these conditions [15]. The plant's ability to soothe irritated skin and reduce discomfort has made it a popular remedy in traditional medicine.

However, while many studies support the medicinal value of *Cassia alata*, more clinical trials and scientific validation are needed. Most research on *Cassia alata* has focused on its antimicrobial and anti-inflammatory effects, but its effectiveness in humans has not been extensively studied in a clinical setting. Further research, particularly in the form of randomized controlled trials, is needed to confirm the safety and efficacy of *Cassia alata* in treating skin conditions [16].

The potential of *Cassia alata* as a dermatological product is significant, especially in the context of plant-based natural remedies that are often safer and more accessible than synthetic alternatives. The growing interest in herbal medicine in Southeast Asia and globally provides an opportunity to explore *Cassia alata* as a commercially viable dermatological treatment. However, to fully realize its potential, more comprehensive research into its pharmacology, mechanism of action, and clinical efficacy is needed [13].

Ethnopharmacology is the study of the traditional use of plants and other substances in medicine. The field focuses on understanding how local people use plants for therapeutic purposes and aims to scientifically validate the efficacy and safety of these traditional practices. Integrating ethnopharmacological knowledge into modern drug development can make a significant contribution to the discovery of new pharmaceutical agents, particularly those derived from plants that have long been used in indigenous health care practices [17].

Ethnopharmacology involves a multidisciplinary approach that combines knowledge from botany, chemistry, pharmacology, and anthropology. This approach allows researchers to uncover the therapeutic potential of plants used by traditional healers. In the case of *Cassia alata*, ethnopharmacological studies are essential to document the use of the plant and identify the active compounds responsible for its medicinal properties. These studies also help bridge the gap between traditional knowledge and modern medicine, which encourages the development of plant-based medicines [18].

The development of traditional medicines based on ethnopharmacological research offers several advantages. First, ethnopharmacology allows for the sustainable use of local resources to meet health care needs. Second, traditional medicine, when scientifically validated, can offer a safer alternative to synthetic drugs, which may have adverse side effects. In regions such as Laos, where access to modern healthcare is limited, ethnopharmacology offers a valuable avenue to improve public health by providing affordable, accessible, and culturally relevant treatments [14].

Despite its potential, the development of traditional medicine faces challenges. The lack of standardized protocols for extracting and testing plant compounds, coupled with limited clinical trials, hinders the widespread acceptance and use of herbal medicine in mainstream healthcare systems. Ethnopharmacological research is essential to address these barriers, ensuring that plants such as *Cassia alata* are thoroughly tested for safety and efficacy before being incorporated into modern medicine [17].

In addition, intellectual property protection and ethical considerations surrounding the commercialization of traditional knowledge remain important issues. Collaboration between local communities, researchers, and the pharmaceutical industry is needed to ensure that the benefits of ethnopharmacological research are shared equitably, while respecting the cultural heritage and knowledge of indigenous peoples [19].

Although ethnopharmacology holds great promise for the development of new drugs, there are several challenges that need to be addressed. One major challenge is the lack of a comprehensive database cataloging the use of medicinal plants. Without reliable, centralized information, researchers may miss valuable opportunities to study plants with significant therapeutic potential. The establishment of a global database and greater collaboration between researchers from different countries could help fill this gap and enhance the discovery of new drugs [20].

Another challenge is the limited funding and resources dedicated to ethnopharmacological

Journal of Advances in Medicine and Pharmaceutical Sciences, vol. 3, no. 2, pp. 71-78, November 2024. **DOI: 10.36079/lamintang.jamaps-0302.775**

research. Although some governments and international organizations recognize the value of this field, more financial investment is needed to conduct large-scale research, including clinical trials and pharmacological testing. Without adequate funding, the translation of traditional knowledge into modern medicine remains slow [21].

Ethnopharmacology also faces challenges related to the standardization and regulation of herbal products. Many traditional medicines, including *Cassia alata*, are used in different forms and doses depending on the region or community. Standardization of the preparation and dosage of herbal medicines is essential to ensure their safety and effectiveness. In addition, a regulatory framework must be established to monitor the quality and safety of herbal products as they enter the market [22].

Despite these challenges, the future of ethnopharmacology remains promising. Advances in molecular biology, genomics, and bioinformatics provide new tools to better understand the active compounds in medicinal plants. As technology continues to advance, researchers will be able to conduct more precise and detailed studies on the pharmacology of plants such as *Cassia alata*. This will enable the development of new, effective, and safe plant-based drugs for the treatment of skin diseases and other health conditions [23],[24].

This study aims to document ethnopharmacological knowledge related to the use of *Cassia alata* in the treatment of skin diseases in rural Laos. Specifically, this study seeks to assess the effectiveness of *Cassia alata* in treating common skin conditions such as eczema, fungal infections, and other dermatological disorders. In addition, this study will evaluate the safety of using *Cassia alata* as a medicinal herb, by combining ethnobotanical knowledge with scientific analysis. This study will explore the potential of the plant as a dermatological product and assess its feasibility for development into a broader herbal medicine that can be commercially produced and distributed in local and global markets.

This study is significant in several ways. First, it contributes to the preservation and documentation of traditional knowledge related to medicinal plants used by rural communities in Laos. As many traditional practices are slowly fading, preserving ethnobotanical knowledge is essential for future generations. Second, this study may open the door to the development of new dermatological products based on Cassia alata, which may be affordable and accessible to rural populations, especially those with limited access to conventional healthcare. By integrating ethnobotanical practices with modern scientific research, this study provides a deeper understanding of the potential of plant-based medicines as alternatives to synthetic drugs. Furthermore, this study may lead to the development of safe, cost-effective, and natural dermatological solutions, promoting sustainable healthcare practices in Laos and similar regions. The findings of this study may also contribute to the broader field of ethnomedicine, encouraging further exploration of herbal remedies for dermatological conditions in Southeast Asia and beyond.

2. Method

This study used qualitative and quantitative approaches. Ethnopharmacological data were collected through in-depth interviews with rural communities in Laos who know the use of *Cassia alata* for skin diseases. In addition, laboratory tests were conducted to assess the efficacy and safety of *Cassia alata* extracts in treating fungal infections and other skin conditions.

This study was conducted throughout 2024 in several villages in Laos, including villages in Luang Prabang, Vientiane, and Xieng Khouang provinces. A total of 50 respondents who knew traditional medicinal plants, especially Cassia alata, were selected. In addition, 5-10 samples of *Cassia alata* plants, used by the local community, were scientifically analyzed in the laboratory to determine their chemical compounds and therapeutic potential.

Qualitative data were collected through semi-structured interviews and field observations, while quantitative data were obtained through simple clinical trials to evaluate the effects of plant extracts on skin conditions, especially fungal infections and eczema.

3. Finding and Discussion

3.1. Traditional Knowledge of Cassia alata in Lao Communities

Interviews with rural communities in Laos revealed a remarkable depth of traditional knowledge regarding the use of Cassia alata to treat a variety of skin conditions. Many participants, particularly from villages in Luang Prabang, Vientiane, and Xieng Khouang, shared detailed descriptions of how they have used the plant for generations. The plant is often recognized by its distinctive leaves and flowers, which are readily available to villagers in the region.

Journal of Advances in Medicine and Pharmaceutical Sciences, vol. 3, no. 2, pp. 71-78, November 2024. **DOI: 10.36079/lamintang.jamaps-0302.775**

A common practice involves the use of fresh or dried Cassia alata leaves, which are crushed into a paste or boiled to extract the juice. This paste or liquid extract is then applied to areas affected by fungal infections, rashes, or irritation. In many cases, the plant is used as a direct remedy for itching, inflammation, and lesions caused by fungal growth or bacterial infections. For chronic conditions such as eczema, villagers often rely on Cassia alata as a daily application, believing it to offer long-term relief.

What stands out is that the use of Cassia alata is not just medicinal, but part of a broader holistic understanding of health in these communities. In addition to treating skin conditions, the plant is often used in combination with other local plants as part of a multifaceted healing approach. This traditional knowledge is passed down orally from generation to generation, with older community members seen as the primary source of knowledge.

Interestingly, several respondents also noted that Cassia alata is used not only for its therapeutic properties but also as a preventative measure. Regular use of plant extracts is believed to help ward off skin conditions, making it an integral part of everyday life for those living in this rural area. This preventative use reflects a deep understanding of the plant's benefits, which extend beyond its direct healing properties to its role in maintaining healthy skin.

Knowledge of Cassia alata also highlights the strong connection between rural Laotian communities and their environment. Many respondents stated that their reliance on Cassia alata stems from the plant's accessibility and the lack of conventional medical services in some remote areas. The ability to use locally sourced plants reduces reliance on external pharmaceutical products and fits into the broader cultural context of sustainable and localized healthcare practices. Despite the impressive traditional knowledge, challenges remain in terms of standardization and scientific validation of the plant's effectiveness. While villagers have relied on the plant based on anecdotal evidence for years, written documentation of its medicinal uses is limited. This gap in the scientific literature underscores the importance of research such as this, which aims to bridge the knowledge gap and verify claims made by local practitioners.

Ultimately, these findings suggest that Cassia alata is deeply embedded in the health practices of rural Laotians. The plant is not only a medicine but also a reflection of a sustainable and empowering community approach to health care. It is clear that this traditional knowledge plays a vital role in the overall well-being of the community and warrants further exploration to validate its therapeutic potential.

3.2. Efficacy and Safety of Cassia alata Extract in Treating Skin Diseases

The laboratory tests conducted in this study provide important insights into the antimicrobial properties of Cassia alata and validate the traditional knowledge reported by rural communities. The plant extract underwent a series of microbiological tests to test its effectiveness against common pathogens that cause skin infections, such as *Trichophyton* and *Candida* species. These pathogens are responsible for a variety of dermatological conditions, including ringworm, athlete's foot, and fungal infections. The results of the antimicrobial tests were surprising, as Cassia alata extract showed significant antifungal activity against Trichophyton and Candida. This is consistent with the plant's use by communities to treat fungal infections, with many participants describing it as effective for conditions such as athlete's foot and ringworm. Cassia alata's ability to target these common pathogens makes it a promising candidate for further development as a topical treatment for dermatological conditions.

Additional dermatological tests were conducted to evaluate the safety of Cassia alata extract on human skin. Dermatological trials involved applying the extract to the skin of volunteers and monitoring for adverse reactions. These trials revealed that the extract was well tolerated with minimal to no side effects, supporting its use as a safe alternative to synthetic treatments. This is especially important for those who suffer from sensitive skin or allergies to conventional pharmaceutical products. The safety profile of Cassia alata further strengthens its value as a natural treatment for skin conditions. The fact that the plant causes little to no irritation or side effects when applied to the skin suggests that it can be used regularly for acute and chronic conditions without significant risk of harm. This safety aspect is particularly important in the context of rural Laos, where access to healthcare and pharmaceutical products is limited.

Additionally, the antimicrobial properties of Cassia alata have broader implications for its potential application in treating a range of skin conditions. In addition to fungal infections, the plant's anti-inflammatory effects have been shown to be beneficial for conditions such as eczema, psoriasis and

dermatitis. The extract's dual action as an antifungal and anti-inflammatory agent makes it an attractive option for multi-purpose dermatological treatments.

However, while the results are promising, it is important to acknowledge the limitations of this study. Laboratory tests were conducted under controlled conditions, and further clinical trials are needed to confirm the plant's efficacy in a wider population. Additionally, factors such as dosage, long-term use, and potential interactions with other drugs need to be studied carefully before the plant can be recommended for widespread clinical use.

The laboratory findings support the traditional claims of Cassia alata as an effective and safe treatment for skin conditions, particularly fungal infections. The next steps in research should focus on refining the extraction process, determining the optimal dosage, and conducting large-scale clinical trials to assess the plant's broader therapeutic potential.

3.3. Potential for Dermatological Product Development

The combination of traditional knowledge and modern scientific validation opens up the potential for Cassia alata to be developed into commercial dermatological products. The plant's proven efficacy in treating fungal infections and skin inflammations, coupled with its good safety profile, makes it an excellent candidate for formulation into a variety of dermatological treatments such as creams, lotions, and ointments.

The dermatological product development process will involve refining the extraction method to maximize the concentration of active compounds in Cassia alata. The goal is to ensure that the final product is not only effective but also stable, long-lasting, and easy to apply. One of the main challenges is optimizing the extraction process to retain the beneficial properties of the plant while ensuring that the product can be produced on a commercially viable scale.

Further research is needed to identify the most effective formulations for different skin types and conditions. For example, some people may have sensitive skin that requires a gentler formula, while others may require a stronger extract concentration to treat more severe fungal infections. Therefore, product formulations need to be tailored to the various dermatological needs.

In addition to its therapeutic potential, the market for natural and organic skincare products is also growing. Consumers are increasingly looking for alternatives to chemical treatments, making Cassia alata an attractive option for the development of a natural skincare line. The plant's antimicrobial and anti-inflammatory properties could appeal to consumers interested in holistic health and sustainable beauty products.

Developing Cassia alata into dermatological products also has the potential to benefit local communities in Laos. If commercialization efforts are successful, the plant could become a valuable export commodity, providing economic benefits to the rural communities that cultivate it. It could also encourage sustainable agricultural practices, as the plant is well-suited to the local climate and requires minimal resources to grow.

It is also important to consider regulatory aspects in the development of new herbal products. The safety and efficacy of Cassia alata must be rigorously tested according to international standards before it can be marketed globally. Collaboration with regulatory bodies, such as the World Health Organization (WHO), will be essential to ensure that the plant is recognized as a safe and effective treatment for skin conditions.

Finally, partnerships between researchers, local communities, and industry stakeholders will be critical in translating these promising research findings into real products that can benefit consumers and communities that have long used Cassia alata in traditional medicine. Cassia alata shows great potential as a natural dermatological product. With continued research, optimized extraction processes, and careful product development, this plant could become a key ingredient in the global market for skin care solutions, offering both therapeutic benefits and economic opportunities for local communities in Laos.

4. Conclusion

This study successfully documented the ethnopharmacological knowledge surrounding the use of Cassia alata in treating skin diseases in Laos, revealing its significant potential as a natural dermatological product. The plant exhibits antimicrobial and anti-inflammatory properties that are beneficial in treating skin infections, such as fungal conditions, as well as chronic skin diseases such as eczema. Furthermore, Cassia alata exhibited a high safety profile, supporting its viability as an alternative treatment option. The findings of this study can play an important role in supporting the

development of plant-based dermatological medicines in Laos and other Southeast Asian countries. Furthermore, this study contributes to the preservation of traditional knowledge while promoting the use of safe and effective herbal medicines in the wider community.

Further research is needed to identify the specific active compounds in Cassia alata that are responsible for its therapeutic effects. In addition, long-term studies are needed to assess the sustained impact of the plant extract on patients with chronic skin diseases. It is also important to explore and test various product formulations that can enhance the absorption and therapeutic efficacy of Cassia alata extract. This future research will be critical in optimizing the use of this plant and ensuring its successful commercialization as a dermatological solution.

References

[1] S. C. Toh, S. Lihan, S. R. Bunya, and S. S. Leong, "In vitro antimicrobial efficacy of *Cassia alata* (Linn.) leaves, stem, and root extracts against cellulitis causative agent *Staphylococcus aureus*," *BMC Complementary Medicine and Therapies*, vol. 23, no. 1, 2023.

[2] J. A. L. Yon, S. K. Lee, J. W. Keng *et al.*, "Cassia alata (*Linnaeus*) Roxburgh for skin: Natural remedies for atopic dermatitis in Asia and their pharmacological activities," *Cosmetics*, vol. 10, no. 1, 2023.

[3] V. A. Agampodi and T. Collet, "Anti-inflammatory effects and keratinocyte regenerative potential of *Cassia alata* (Linn) leaf extracts and their implications for wound healing," *Journal of Applied Biological Sciences*, vol. 16, no. 3, pp. 503–526, 2022.

[4] B. C. Sikora, M. Wortzman, D. B. Nelson, and J. S. Dover, "A pilot study evaluating the efficacy and tolerability of a comprehensive, hydrating topical antioxidant developed specifically for men," *Journal of Cosmetic Dermatology*, vol. 20, no. 9, pp. 2816–2823, 2021.

[5] E. Emmanuel, O. O. Martin-Luther, S. A. Adetunji *et al.*, "Phytochemical screening and antifungal activity of *Cassia alata* (Linn.) crude leaf extracts," *African Journal of Microbiology Research*, vol. 17, no. 8, pp. 176–183, 2023.

[6] Y.-L. Chew *et al.*, "Cassia alata, Coriandrum sativum, Curcuma longa, and Azadirachta indica: Food ingredients as complementary and alternative therapies for atopic dermatitis-A comprehensive review," *Molecules*, vol. 27, no. 17, 2022.

[7] S.-G. Kim, J. G. Choi, and Y.-A. Jang, "Emodin studies on anti-inflammatory and skin barrier improvement activities," *Journal of Korean Applied Science and Technology*, vol. 38, pp. 1383–1392, 2021.

[8] C.-x. Liu, "Overview on development of ASEAN traditional and herbal medicines," *Chinese Herbal Medicines*, vol. 13, no. 4, pp. 441–450, 2021.

[9] M. Bounlu *et al.*, "Management of epilepsy in Laos: Perceptions of healthcare professionals from Vientiane Capital province and traditional healers in Southern Laos," *Journal of Traditional and Complementary Medicine*, vol. 11, no. 1, pp. 46–52, 2021.

[10] X. J. Gu, X. L. Zhou, L. Y. Yu, X. Lin, J. H. Miao, and L. Q. Huang, "Compilation and research summary of herbal pharmacopoeia of Lao People's Democratic Republic," *Chinese Journal of Experimental Traditional Medical Formulae*, vol. 27, no. 10, pp. 169–175, 2021.

[11] K. S. Lee, Y. Walid, Y. W. Kassa, N. A. Taha, and Z. A. Zainal, "Factors impacting pharmaceutical prices and affordability: Narrative review," *Pharmacy (Basel)*, vol. 9, no. 1, 2021.

[12] S. L. Muhammad *et al.*, "Bioassay-guided identification of bioactive compounds from *Senna alata* L. against methicillin-resistant *Staphylococcus aureus*," *Applied Microbiology*, vol. 1, pp. 520–536, 2021.

[13] P. Ogonowska, Y. Gilaberte, W. Barańska-Rybak, and J. Nakonieczna, "Colonization with *Staphylococcus aureus* in atopic dermatitis patients: Attempts to reveal the unknown," *Frontiers in Microbiology*, vol. 11, 2021.

[14] Y.-G. Shi *et al.*, "On the mechanism behind enhanced antibacterial activity of alkyl gallate esters against foodborne pathogens and its application in Chinese icefish preservation," *Food Microbiology*, vol. 99, 2021.

[15] S. L. Muhammad *et al.*, "Bioassay-guided identification of bioactive compounds from *Senna alata* L. against methicillin-resistant *Staphylococcus aureus*," *Applied Microbiology*, vol. 1, pp. 520–536, 2021.

[16] A. Gunaydin-Akyildiz *et al.*, "Emodin and aloe-emodin, two potential molecules in regulating cell migration of skin cells through the MAP kinase pathway and affecting *Caenorhabditis elegans* thermotolerance," *BMC Molecular and Cell Biology*, vol. 24, 2023.

[17] S N. Chaachouay and L. Zidane, "Plant-Derived Natural Products: A Source for Drug Discovery and Development," *Drugs Drug Candidates*, vol. 3, no. 1, pp. 184-207, 2024.

[18] C. Proença, D. Ribeiro, M. Freitas, F. Carvalho, and E. Fernandes, "A comprehensive review on the antidiabetic activity of flavonoids targeting PTP1B and DPP-4: A structure-activity relationship analysis," *Crit. Rev. Food Sci. Nutr.*, vol. 62, pp. 4095–4151, 2022.

[19] E. U. Alum, "The role of indigenous knowledge in advancing the therapeutic use of medicinal plants: challenges and opportunities," *Plant Signaling & Behavior*, vol. 19, no. 1, 2024.

[20] D. Domingo-Fernández, Y. Gadiya, S. Mubeen, T. J. Bollerman, M. D. Healy, S. Chanana, R. Gura Sadovsky, D. Healey, and V. Colluru, "Modern drug discovery using ethnobotany: A large-scale cross-cultural analysis of traditional medicine reveals common therapeutic uses," *iScience*, vol. 26, no. 9, 2023.

[21] C. P. Austin, "Opportunities and challenges in translational science," *Clin. Transl. Sci.*, vol. 14, no. 5, pp. 1629–1647, 2021.

[22] V. Subbiah, "The next generation of evidence-based medicine," *Nat. Med.*, vol. 29, pp. 49–58, 2023.

[23] R. Gang, D. Okello, and Y. Kang, "Medicinal plants used for cutaneous wound healing in Uganda; ethnomedicinal reports and pharmacological evidences," *Heliyon*, vol. 10, no. 9, 2024.

[24] F. O. Atanu, D. Rotimi, and P. A. Idakwoji, "Hydroethanolic Extracts of Senna alata Leaves Possess Antimalarial Effects and Reverses Haematological and Biochemical Perturbation in Plasmodium berghei-infected Mice," *J. Evid. - Based Integr. Med.*, vol. 18, no. 3, 2022.