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CHARACTERIZATION OF DERMATOPHYTE ASSOCIATED WITH TINEA CAPITIS AMONG ALMAJIRI SCHOOL PUPILS WITHIN BAUCHI METROPOLIS, AND ANTIFUNGAL ACTIVITY OF SOME PLANT LEAVES EXTRACT IN THE TREATMENT OF THE DISEASE

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ABSTRACT

Background: Dermatophytic infections remain a global public health challenge, particularly in resource-limited settings where access to conventional antifungal drugs is restricted. This study evaluated the antifungal activity of Azadirachta indica (Neem) and Moringa oleifera (Moringa) leaf extracts against selected dermatophytes, with Ketoconazole serving as a standard control. Methods: A total of 50 participants were recruited, predominantly children aged 8–10 years (34%) and males (76%). Antifungal activity was assessed using agar well

diffusion and minimum inhibitory concentration (MIC) assays. Ethanolic and aqueous extracts of Neem and Moringa leaves were tested against Microsporum canis, Trichophyton tonsurans, T. violaceum, and Epidermophyton floccosum. Results: The Results showed that Ketoconazole exhibited the highest antifungal activity (23 mm). Among the plant extracts, Neem ethanol extract demonstrated greater inhibition (17 mm) compared to Moringa ethanol extract (14 mm). However, MIC analysis revealed that Moringa (25 mg/mL) required a lower concentration for fungal inhibition than Neem (50 mg/mL). Ethanol extracts generally showed higher antifungal activity than aqueous extracts, though Neem aqueous extract was notably effective against T. violaceum. Conclusion: The findings suggest that while Neem and Moringa possess measurable antifungal activity, they are less potent than Ketoconazole. Nevertheless, their efficacy supports traditional medicinal use and highlights their potential as affordable alternative therapies. Further phytochemical, toxicological, and clinical studies are recommended to validate their therapeutic applications. Keywords: Neem, Moringa, Dermatophytes, Antifungal activity, MIC, Ketoconazole.

1. I N T R O D U C T I O N

1.0 Background of the Study: Tinea capitis is a common dermatophyte infection of the scalp and hair shafts caused primarily by Trichophyton and Microsporum species. It presents with scalp scaling, broken hairs, patchy alopecia, inflammation, or sometimes painful kerions, especially in severe cases. Although the condition affects individuals of all ages, its burden is highest among children living in crowded environments with poor hygiene and limited access to healthcare. If left untreated, tinea capitis can result in permanent scarring alopecia, secondary bacterial infections, and psychosocial consequences such as stigma, low self-esteem, and school absenteeism (Ameh *et al*., 2018; Elewski, 2000). In Nigeria, dermatophytosis remains endemic, particularly among school-aged children, where socioeconomic constraints, overcrowded living spaces, and poor sanitation drive persistent transmission. Among the most vulnerable groups are Almajiri pupils children enrolled in Qur'anic schools who often live in congested shelters, depend on street begging for survival, and experience significant barriers to healthcare access. Their daily routines and communal lifestyle, including sharing of combs, caps, bedding, and close contact during sleep or study, create ideal conditions for the spread of dermatophytes. Consequently, outbreaks tend to persist, with recurrent infections and an overall high disease burden in this population (Sani *et al*., 2015).

The dermatophytes implicated in tinea capitis possess keratin-degrading enzymes that enable them to colonize the scalp and hair. Trichophyton tonsurans and T. violaceum commonly cause endothrix infections, whereas Microsporum species such as M. canis produce ectothrix infections. Transmission occurs through direct contact with infected individuals or animals, as well as indirectly via contaminated objects such as hairbrushes, clothing, or bedding. The ability of fungal spores to survive on surfaces for extended periods contributes to persistent community transmission, especially in environments where routine cleaning and disinfection are limited (Ghannoum *et al*., 2013). Despite the availability of antifungal agents, effective management of tinea capitis remains challenging in resource-limited settings. High treatment costs, delayed diagnosis, incomplete therapy, and emerging antifungal resistance reduce the success of conventional treatments. These challenges are even more pronounced among economically disadvantaged groups like the Almajiri community. As a result, children often remain untreated, partially treated, or infected for long durations, contributing to chronic cases and continued transmission within their schools and communities (Irobi *et al*., 2015; Sani *et al*., 2015).

Given these challenges, there is growing interest in evaluating medicinal plants traditionally used in African communities for managing skin and fungal infections. Many plant extracts contain bioactive compounds such as flavonoids, tannins, terpenoids, and phenolic compounds—that demonstrate antifungal activity. Investigating the antifungal potential of locally available plant extracts offers a promising, affordable alternative to conventional therapies. This approach may improve treatment accessibility and reduce disease burden, particularly among vulnerable populations such as Almajiri pupils in the Bauchi metropolis (Ghannoum *et al*., 2013; Irobi *et al*., 2015).

1.1 Research Gap: Despite the high prevalence of tinea capitis among children in northern Nigeria particularly within the Almajiri population there remains limited contemporary data on the specific dermatophyte species currently circulating in this vulnerable group, as most existing studies are outdated, geographically restricted, or focused on general school populations rather than Almajiri pupils. Furthermore, while medicinal plants have a long history of use in traditional management of fungal infections, there is insufficient scientific validation of their antifungal efficacy against locally isolated dermatophytes affecting children in the Bauchi metropolis. Little is known about the comparative inhibitory effects, minimum inhibitory concentrations (MIC), or fungicidal properties of commonly available

plant extracts on these pathogens. This creates a significant research gap in understanding both the epidemiological pattern of dermatophyte infections and the potential of plant-based therapies as affordable, accessible alternatives to conventional antifungal drugs for managing tinea capitis in resource-limited Almajiri communities.

1.2 Literature Review: Literature shows that tinea capitis remains one of the most common dermatophytoses worldwide, predominantly affecting children aged 3–14 years, with Trichophyton and Microsporum species identified as the major etiological agents causing endothrix and ectothrix infections, respectively (Ameh *et al*., 2018; Ghannoum *et al*., 2013). Studies across Nigeria have consistently reported high infection rates linked to poor hygiene, overcrowding, and low socioeconomic status, with Almajiri pupils identified as a particularly susceptible group due to shared living spaces and inadequate sanitation (Sani *et al*., 2015). Research also shows increasing challenges with conventional antifungal therapy, including treatment failures, drug resistance, toxicity, and poor accessibility in impoverished communities. Consequently, scientific attention has turned toward medicinal plants such as Azadirachta indica, Lawsonia inermis, Ocimum gratissimum, and Senna alata which contain bioactive compounds like flavonoids, alkaloids, phenolics, and terpenoids with demonstrated antifungal activity in vitro (Irobi *et al*., 2015). However, despite promising findings, few studies have evaluated the antifungal activity of plant extracts specifically against dermatophytes isolated from Almajiri pupils in northern Nigeria, highlighting the need for localized, context-specific investigation.

2. M A T E R I A L S

***2.1 Study Area*:** The study area is Bauchi the main city in Bauchi state. It is located in the north-east region of Nigeria. Bauchi state lies between latitudes 10^0 10' and 10^0 33N and longitudes 9^0 40' and 10^0 13'. The climate of the states is semi-arid, characterized by a long dry season. The climatic variables vary considerably during the year and are erratic. The temperature regime is warm to hot. The mean annual temperature is about 25^0C in the coolest month and 40^0C during the hottest month. Most of the state falls within the Sudan Savanna vegetation belt, but traces of Guinea Savanna vegetation are found in the parts of the southern districts. Bauchi state occupies a total land area of 49,119km^2 representing about 5.3% of Nigeria's total land mass.

***2.2 Study Design**:* This study employed a cross-sectional design, with a clinical of laboratory and fieldwork components

2.3 Sample Size: A Total number of fifty (50) Almajiri pupils were selected randomly for the study .this population include 38 male and 12 female between the ages of 8-13.

2.4 Sample Collection: In all suspected cases of tinea capitis, hair and scalpscrapings were collected aseptically for mycological examination using appropriate techniques as described by (Fathi *et al.*, 2002). The suspected area of the head was thoroughly cleaned with methylated spirit after which hair and scalp scrapings were collected into a white envelope with the aid of the blunt edged of a sterile razor blade. The samples were labeled appropriately and transported to the laboratory for investigation.

***2.5. Direct Microscopic Examination of Specimens*:** A wet mount of the hair and scalp scraping was prepared by placing a few drops of 10o/o potassium hydroxide (KOH) solution on a clean grease free slide and placing the specimen on the 10o/o KOH using sterile forceps. A cover slip was placed on the slide and pressed gently, preventing the formation of air bubbles. The slide was examined under the microscope using x10 and x40objectives respectively. The presence, type of hyphae, spores or conidia was observed and recorded with the aid of charts (Barry, 2003).

2.6. Inoculation of the Specimens*:* The specimens was inoculated onto the surface of sabouraud Dextrose Agar (SDA) containing Chloramphenicol, making sure that the specimen is in direct contact with the medium. Inoculation was done using a sterile wire loop to transfer the specimen onto the surface of the agar plates. The plates were sealed with masking tape to prevent loss of moisture and drying up of the media. Then, the plates were incubated at room temperature for 7-14 days. The growths were checked at regular intervals (Evans and Richardson, 1989).

2.7 Identification of Isolates: The identification of dermatophyte isolates was carried out using both macroscopic and microscopic examinations. This dual approach ensured that the isolates were classified based on gross colony morphology as well as diagnostic microscopic features, thereby reducing the chances of misidentification. The procedure adopted followed the standard descriptions of Evans and Richardson (1989), Ochei and Kolhatkar (2007), and Elmer and Glenn (1985).

2.8 Macroscopic Examination of isolates: Macroscopic examination served as the preliminary step in identifying dermatophyte cultures. Colonies were examined directly on the culture plates before proceeding to microscopic analysis. The features observed included growth rate and duration, colony diameter, surface morphology, texture, and pigmentation. Attention was paid to both the surface and reverse of the colonies since pigmentation often becomes more pronounced on the reverse side (Kanna & Janaki, 2006). Colony textures

varied from cottony, velvety, powdery, to granular, while surface morphology revealed distinct characteristics such as radial grooves, concentric rings, and elevated or flat centers. The colors of the surface mycelium and spores were also recorded, ranging from white to cream, yellow, and reddish-brown. Pigmentation on the reverse ranged from colorless to deep red or brown, depending on the species. These macroscopic attributes, though not sufficient for definitive identification, provided essential preliminary diagnostic clues which guided subsequent microscopic investigations.

2.9 Microscopic Examination of Isolates: Microscopic examination was performed using the teased mount technique, which is regarded as the ideal method for dermatophyte identification (Ochei & Kolhatkar, 2007). A clean grease-free slide was prepared with a drop of 95% ethanol placed at the center. Using a sterile scalpel blade, a small segment of fungal colony was carefully excised from midway between the center and the edge of the growth. This ensured inclusion of both aerial and substrate mycelium, which are necessary for a representative sample. The sample was then teased apart with two sterile dissecting needles and spread thinly. After the ethanol evaporated, a drop of lactophenol cotton blue (LPCB) was added, and the preparation was covered with a cover slip. LPCB acted both as a staining and mounting medium: phenol killed the fungal elements, lactic acid preserved structural integrity, cotton blue enhanced visibility of fungal cell walls by staining chitin, and glycerol prevented drying of the preparation. The slide was examined under a compound microscope using ×10 objective to locate fungal elements and ×40 objective for detailed study.

***2.10 Diagnostic Features Observed*:** The microscopic examination focused on hyphal structures, conidia, and other specialized reproductive elements. Hyphae were examined for septation, branching, and modifications such as spiral or racquet hyphae. Macroconidia, when present, were assessed for their shape (cigar, spindle, or pencil-shaped), size, wall thickness, and number of septa. Microconidia were evaluated based on abundance, arrangement along hyphae, and characteristic shapes (spherical, pear-shaped, or club-shaped). Additional diagnostic features, such as chlamydospores, favic chandeliers, and distorted hyphae, were also recorded where present. These features were compared against standard fungal identification guides such as the Fungal Colour Atlas (Ochei & Kolhatkar, 2007) and descriptions by Elmer and Glenn (1985).

2.11 Confirmation of Identification: By combining macroscopic and microscopic observations, a reliable identification of isolates was achieved. While macroscopic features provided important preliminary clues, microscopic examination was essential for distinguishing between closely related dermatophyte species. This integrated approach

ensured accurate classification and minimized the risk of misidentification, thereby strengthening the validity of the study.

2.12 Plant Leaves Extraction: The plant leaves were extracted using a suitable solvent such as ethanol. The extraction was involve grinding the leaves and soaking them in the solvent for a specified period of 3days (72 hours) on Shaker. (Ezeonu *et al*., 2016). The extract was filtered and concentrated using a rotary evaporator.

***2.13 Determine of Minimum Inhibitory Concentration*:** The minimum inhibitory concentration (MIC) of the plant extract was determined using the broth dilution method. The MIC is the lowest concentration of the extract that inhibits visible fungal growth (CLSI, 2018). The MIC was determined using the broth microdilution method in accordance with CLSI guidelines (CLSI, 2008, CLSI 2012), involving serial dilution in a 20- well plate followed by inoculation with fungal isolate. The plate will be incubated at 25°C for 7-14 days and examined for fungal growth.

***2.14 Data Analysis*:** Data were analyzed using descriptive statistics and inferential statistics chi-square test. The results were presented in tables.

3.0 R E S U L T S

3.1 Demographic Distribution of the Study Population: *The* majority of participants were within the age group of 8–10 years (34%), followed by 11–13 years (30%). Males constituted a larger proportion of the study population (76%) compared to females (24%). This distribution suggests that the sample was skewed toward younger age groups and male participants as shown in table 1.

3.2 Comparative Antifungal Activity of Plant Extracts and Standard Drug: The standard drug Ketoconazole produced the highest zone of inhibition (23 mm) against dermatophytes. Among the plant extracts, Neem ethanol extract (17 mm) showed stronger antifungal activity than Moringa ethanol extract (14 mm), although both were less potent compared to the standard drug as shown in table 2.

3.3 Minimum Inhibitory Concentration (MIC) of Plant Extracts against Dermatophytes: The MIC values indicate that Moringa leaves (25 mg/mL) were more effective than Neem leaves (50 mg/mL), as a lower concentration was required to inhibit the growth of dermatophytes. This suggests a stronger antifungal potential of Moringa when compared on a concentration basis as shown in table 3.

***3.4 Zone of Inhibition (mm) of Plant Extracts against Dermatophytes*:** Both ethanol and aqueous extracts of Neem and Moringa leaves exhibited varying inhibitory activity against

dermatophytes. Moringa ethanol extract showed the strongest activity, with zones of inhibition ranging from 6–14 mm, particularly against T. violaceum (13 mm). On the other hand, Neem aqueous extract displayed better inhibition against T. violaceum (11 mm) than its ethanol extract. This suggests that the type of solvent influenced the antifungal potency of the extracts as shown in table 4.

***3.5 Comparative Antifungal Activity (Zone of Inhibition) of Plant Extracts and Standard Drug*:** The standard antifungal drug Ketoconazole was superior to both plant extracts. However, Neem ethanol extract showed higher inhibitory activity than Moringa, indicating that Neem might contain stronger ethanol-soluble antifungal compounds as shown in table 5.

3.6 Minimum Inhibitory Concentration (MIC) Values of Plant Extracts against Dermatophytes: Although Neem exhibited larger zones of inhibition than Moringa in some cases, the MIC results revealed that Moringa (25 mg/mL) was more potent, requiring lower concentrations to inhibit fungal growth compared to Neem (50 mg/mL). This suggests that while Neem demonstrates stronger surface inhibition, Moringa has a higher intrinsic antifungal strength at lower concentrations as shown in table 6.

Table 1: Demographic Distribution of the Study Population. (n = 50)

Variable (%)	Category	Frequency (n)	Percentage
Age Group (years):	5 – 7	8	16.0
	8 – 10	17	34.0
	11 – 13	15	30.0
	14 – 16	10	20.0
Gender:	**Male**	38	76.0
	Female	12	24.0

Table 2: Comparative Antifungal Activity of Plant Extracts and Standard Drug

Test Agent	Zone of Inhibition (mm)
Ketoconazole (Standard)	23
Neem (Ethanol Extract)	17
Moringa (Ethanol Extract)	14

Table 3: Minimum Inhibitory Concentration (MIC) of Plant Extracts against Dermatophytes

_Plant Extract (mg/mL)	MIC
Neem Leaves	50
Moringa Leaves	25

Table 4: Zone of Inhibition (mm) of Plant Extracts against Dermatophytes

Plant Extract	Solvent	M. canis	T. tonsurans	T. violaceum	E. floccosum
Neem Leaves	Ethanol	9	6	7	4
Neem Leaves	Aqueous	5	7	11	5
Moringa Leaves	Ethanol	14	8	13	6
Moringa Leaves	Aqueous	6	5	12	5

Table 5: Comparative Antifungal Activity (Zone of Inhibition) of Plant Extracts and Standard Drug

Test Agent	Zone of Inhibition (mm)
Ketoconazole (Standard)	23
Neem Leaves (Ethanol)	17
Moringa Leaves (Ethanol)	14

Table 6: Minimum Inhibitory Concentration (MIC) Values of Plant Extracts against Dermatophytes

Plant Extract	MIC (mg/mL)
Neem Leaves	50
Moringa Leaves	25

3.7 D I S C U S S I O N

This study evaluated the antifungal activity of Azadirachta indica (Neem) and Moringa oleifera (Moringa) leaf extracts against selected dermatophytes, with Ketoconazole serving as a standard reference drug. The results revealed that both plants possess measurable antifungal activity, although they were generally less potent than the synthetic drug. These findings are important because they highlight the potential role of medicinal plants as alternative or complementary sources of antifungal agents, particularly in low-resource communities where access to conventional antifungal therapy is often limited. The demographic characteristics of participants showed that dermatophytic infections were most prevalent among children aged 8–10 years, with a higher proportion of cases among males. This pattern agrees with earlier studies, which reported that school-aged children are more vulnerable due to close physical contact, poor hygiene, and frequent exposure to contaminated surfaces and domestic animals (Ameen, 2010; Kalu *et al.*, 2016). Similar studies in Nigeria and East Africa have shown that dermatophytosis is more common in boys, often attributed to outdoor activities and greater environmental exposure compared to girls (Chepchirchir *et al*., 2009; Nweze & Okafor, 2010). Such demographic evidence underscores the need for targeted preventive interventions, especially within school populations. The antifungal screening revealed that Ketoconazole produced the largest inhibition zones (23 mm), reaffirming its strong efficacy as a conventional antifungal agent (Chaturvedi *et al.*, 2011). Among the plant extracts, Neem ethanol extract demonstrated stronger activity (17 mm) than Moringa ethanol extract (14 mm). This agrees with previous reports by Alzohairy (2016) and Adeyemi et al. (2019), who showed that Neem extracts possess broad antifungal properties due to compounds such as azadirachtin, nimbidin, and quercetin. Despite Neem showing greater inhibition zones, the MIC analysis revealed that Moringa extracts were more potent, requiring a lower concentration (25 mg/mL) compared to Neem (50 mg/mL) to inhibit fungal growth. This suggests that Moringa contains highly active phytochemicals that are effective at lower doses. Similar findings have been reported by Rahman et al. (2010) and Oluduro (2012), who observed that Moringa extracts retain significant antimicrobial activity at minimal concentrations due to bioactive compounds like isothiocyanates, flavonoids, and tannins. The choice of solvent also influenced the antifungal effects. Ethanol extracts generally showed higher activity than aqueous extracts, supporting the observations of Parekh and Chanda (2007) that ethanol efficiently extracts diverse bioactive molecules such as alkaloids, terpenoids, and phenols. However, in this study, Neem aqueous extract exhibited greater inhibition against T. violaceum than its ethanol counterpart, suggesting that some water-

soluble compounds may be responsible for its antifungal effects. This variation emphasizes the importance of solvent selection when preparing plant-based extracts for therapeutic use. The findings of this study are consistent with global reports that emphasize the antifungal potential of medicinal plants. Mahboubi and Mahboubi (2014) noted that plant-derived essential oils and extracts demonstrate broad antifungal properties, while Nguefack et al. (2012) confirmed that several plant species inhibit dermatophytes through diverse phytochemical mechanisms. Although plant extracts were less potent than Ketoconazole, their activity is noteworthy because crude extracts contain a mixture of active and inactive compounds, unlike purified pharmaceuticals. Moreover, the reliance on medicinal plants in traditional healthcare is supported by their affordability, accessibility, and reduced risk of resistance development compared to synthetic drugs (Cowan, 1999; Seneviratne *et al*., 2020). From a public health perspective, these findings validate the ethnomedicinal use of Neem and Moringa in the treatment of skin infections and highlight their potential as affordable antifungal agents. Their demonstrated activity against multiple dermatophytes suggests that they could serve as broad-spectrum remedies, particularly in communities where fungal infections are prevalent and treatment options are limited. The lower MIC of Moringa further suggests that it may be more effective for dosage optimization in future formulations. Nonetheless, the comparatively lower potency of crude extracts compared to Ketoconazole underscores the need for further research aimed at isolating and characterizing the active compounds. The study contributes to the growing evidence supporting the therapeutic potential of medicinal plants in combating fungal infections. Future studies should include in vivo assessments, toxicological evaluations, and clinical trials to confirm the safety and efficacy of these plants. Additionally, investigating possible synergistic effects between plant extracts and synthetic antifungal agents could open new avenues in antifungal therapy by enhancing efficacy and reducing drug resistance.

4. S U M M A R Y

This study investigated the antifungal efficacy of Azadirachta indica (Neem) and Moringa oleifera (Moringa) leaf extracts against selected dermatophytes, using Ketoconazole as a standard control drug. Dermatophytic infections remain one of the most common superficial mycoses worldwide, particularly in developing countries where poverty, overcrowding, poor hygiene, and limited access to healthcare contribute significantly to their spread (Ameen, 2010; Kalu *et al.,* 2016). Demographic analysis revealed that infections were most common among children aged 8–10 years and predominantly affected males (76%). This distribution

reflects findings in similar epidemiological studies, where school-aged children were identified as the most vulnerable group due to higher exposure risks and lower immunity (Chepchirchir *et al*., 2009; Nweze & Okafor, 2010). These patterns underscore the urgent need for community-level interventions targeting younger populations. The antifungal activity tests showed that Ketoconazole produced the highest inhibition zones (23 mm), consistent with its established broad-spectrum efficacy (Chaturvedi *et al*., 2011). Among plant extracts, Neem ethanol extract produced greater inhibition zones (17 mm) compared to Moringa ethanol extract (14 mm), suggesting higher surface antifungal activity. However, MIC analysis revealed that Moringa extracts were more potent at lower concentrations (25 mg/mL) compared to Neem (50 mg/mL). This indicates that while Neem has stronger surface inhibition, Moringa may contain highly potent phytochemicals effective at minimal concentrations. Ethanol extracts generally outperformed aqueous extracts, confirming ethanol's efficiency in extracting diverse bioactive compounds (Parekh & Chanda, 2007). Interestingly, Neem aqueous extract showed higher activity against T. violaceum compared to its ethanol counterpart, indicating the presence of water-soluble antifungal constituents. These findings align with earlier reports highlighting the antifungal properties of Neem (Alzohairy, 2016; Adeyemi *et al*., 2019) and Moringa (Rahman *et al*., 2010; Oluduro, 2012). They further validate the ethnomedicinal use of these plants in treating skin infections and reinforce the growing global interest in plant-derived antifungal agents as cost-effective alternatives to synthetic drugs (Cowan, 1999; Mahboubi & Mahboubi, 2014).

4.1 C O N C L U S I O N

The present study demonstrated that both Neem and Moringa leaf extracts possess notable antifungal activity against dermatophytes, though they were less potent than Ketoconazole. Neem ethanol extract exhibited greater inhibitory zones, while Moringa extracts required lower concentrations to achieve inhibition, indicating higher potency at minimal doses. These findings support the traditional use of Neem and Moringa in the treatment of dermatophytic infections and highlight their potential as alternative or complementary antifungal agents, particularly in resource-limited settings. Despite their promise, the relatively lower potency of crude plant extracts compared to standard antifungal drugs underscores the need for further refinement. Plant-based treatments are advantageous in being affordable, accessible, and less likely to trigger resistance compared to synthetic drugs (Seneviratne *et al*., 2020). However, for Neem and Moringa to be integrated into mainstream antifungal therapy, further work is

needed to isolate, purify, and characterize their active constituents, as well as to validate their safety and efficacy in clinical settings.

4.2 R E C O M M E N D A T I O N S

Based on the findings of this study, the following recommendations are proposed:

1. Further Phytochemical Investigations: Detailed phytochemical analyses should be conducted to isolate and characterize the active compounds in Neem and Moringa responsible for antifungal activity. Advanced techniques such as chromatography and spectroscopy should be employed to identify bioactive constituents.

2. Toxicological and Pharmacological Studies: Rigorous in vivo and clinical studies are necessary to establish the safety, therapeutic doses, and possible side effects of Neem and Moringa extracts. Such research would provide a scientific basis for their integration into evidence-based healthcare practices.

3. Herbal Formulation Development: Standardized formulations such as creams, ointments, and gels derived from Neem and Moringa extracts should be developed and tested for topical use against dermatophytic infections. Standardization would ensure consistency, potency, and consumer safety.

4. Synergistic Therapy Exploration: Studies should evaluate the potential synergistic effects of combining Neem and Moringa extracts, or combining plant extracts with synthetic antifungal agents. Such combinations may enhance efficacy, reduce drug resistance, and minimize side effects.

5. Community-Based Health Interventions: Given their accessibility and cultural acceptance, Neem and Moringa extracts should be promoted in community-level interventions, particularly in rural and low-resource areas where dermatophytosis is common and access to conventional drugs is limited.

6. Comparative Ethnomedicinal Studies: Additional research should compare Neem and Moringa with other locally available medicinal plants traditionally used against fungal infections, with the aim of identifying the most effective candidates for antifungal therapy.

7. Policy and Institutional Support: Government health agencies and research institutions should support the development of plant-based antifungal remedies through funding, policy frameworks, and integration into primary healthcare systems. Promoting locally sourced antifungal solutions would reduce reliance on costly imports and strengthen healthcare sustainability.

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