Dermatophytes, dermatophytosis in the Caribbean and potential for herbal therapy

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Abstract

Introduction: Dermatophytes are a group of morphologically related keratinophilic fungi that invade keratinized tissue (skin, hair, and nails) of humans and warm-blooded animals to produce clinical lesions (dermatophytosis). Clinical lesions are traditionally divided according to the site infected, namely, scalp (*tinea capitis*), feet (*tinea pedis*, commonly called "athletes' foot"), groin, inner thighs, or buttocks (*tinea cruris*, commonly called "jock itch"), beard (*tinea barbae*), hands (*tinea manuum*), toe nails or finger nails (*tinea unguium*, also called onychomycosis), face, non-bearded area (*tinea faciei*) and other parts of the body, such as arms, abdomen, or legs (*tinea corporis*). Dermatophytosis is common world-wide and is caused by species of three genera of dermatophytes, namely *Microsporum*, *Trichophyton*, and *Epidermophyton*. This study presents an update of ecology of different species of dermatophytes and epidemiology of infections caused by them in the Caribbean. Possibility of herbal therapy of these infections as an alternative treatment is also dealt with.

Methods: A thorough search of literature was made using PubMed, MEDLINE, Biomed Lib, Med Facts, and different sets of key words, viz. dermatophytes, tineas in Caribbean, occurrence in animals, soil etc.

Results: It was revealed that incidence of dermatophytic infections and their epidemiologic characteristics depend on social, geographic, and environmental factors and may change with passage of time. For instance, prior to year 2000, the major cause of *tinea capitis* in North America for 100 years was *Microsporum canis* followed by *M. audouinii*; Since 1950 *Trichophyton tonsurans* has advanced from Mexico and the Caribbean to be currently a major cause of *tinea capitis* in North America. The two dermatophytes *Microsporum gypseum* and *M. fulvum*, and several *Chrysosporium* species have been frequently isolated form soils in different countries in the Caribbean.

Conclusions: There is almost complete lack of information on human infections due to dermatophytes in several Caribbean countries. The preponderant occurrence of *M. fulvum* in Anguilla soils with comparatively rare isolation of *M. gypseum* is a significant observation. The need for further epidemiological studies on dermatophyosis in the Caribbean countries cannot be overemphasized.

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Introduction

Dermatophytes are a group of morphologically related filamentous fungi that have the capacity to invade keratinized tissue (skin, hair, and nails) of humans and warm-blooded animals to produce clinical lesions (dermatophytosis), commonly referred to as "ringworm" because of the ring-shaped lesions.[1] Dermatophytes cause a variety of clinical conditions collectively termed as dermatophytosis. The dermatophytes include about thirty clinically relevant species, but their taxonomy has been controversial because of incongruence of phenotypic and molecular characters.[2] In this paper we would follow the traditional classification.

Dermatophytosis is common world-wide and is caused by species of three genera of dermatophytes, namely *Microsporum*, *Trichophyton*, and *Epidermophyton*. Infections caused by these organisms are referred to as *tineas* which precedes the Latin name for the site which they involve.[3] From an ecological and epidemiological point of view, the dermatophytes are classified in to three groups based on their mode of transmissions; geophilic (found in soil and infect both animals and humans), zoophilic (found on animals, but can be transmitted to humans), and anthropophilic (found on humans, but may can occasionally infect animals). Zoophilic and anthropophilic dermatophytes evolved from a geophilic origin, with the anthropophilic dermatophytes being the most highly specialized group.[3-5] Geophilic and zoophilic dermatophytes generally tend to form lesions that are more inflammatory than those produced by anthropophilic dermatophytes, and those lesions are also more likely to heal spontaneously. The incidence of dermatophytic infections and their epidemiologic characteristics depend on social, geographic, and environmental factors and may change with passage of time.[1] *Microsporum audouinii* and *M. canis*, once major agents of

tinea capitis in the United States, have been overtaken by *Trichophyton tonsurans*. Since the 1950s, *T. tonsurans* has advanced from Mexico and the Caribbean and is now the major etiological agent of *tinea capitis* in North America. *Microsporum canis* is the principal agent of *tinea capitis* in many regions of the world; this could be related to close association of humans with their pets. Also, *M. canis* is more prevalent in urban areas and *T. mentagrophytes* in rural areas.[1] The clinical manifestations of infection vary depending on the infecting fungus, the body site infected, and the immune status of the host. The dermatophytosis are traditionally divided according to the site infected, namely, scalp (*tinea capitis*), feet (*tinea pedis*, commonly called "athletes' foot"), groin, inner thighs, or buttocks (*tinea cruris*, commonly called "jock itch"), beard (*tinea barbae*), hands (*tinea manuum*), toe nails or finger nails (*tinea unguium*, also called onychomycosis), face, non-bearded area (*tine faciei*) and other parts of the body, such as arms, abdomen, or legs (*tinea corporis*).[6] Several anatomic sites may be infected by a single species of dermatophytes, and different species may produce clinically identical lesions. [6]

Methods

All published papers on dermatophytes in various Caribbean countries were scanned by extensive and thorough search of literature using PubMed, MEDLINE, Biomed Lib, Med Facts, and different sets of key words, viz. dermatophytes, *tineas* in Caribbean, occurrence in animals, soil etc. The recent unpublished work on occurrence of dermatophytes in Anguilla soils is also included.

Results

The prevalence of species of dermatophytes in relation to clinical entities in different countries in the Caribbean as revealed in literature search is shown in the Table 1. Additional retrieved information not covered in the table includes two isolations of *M. nanum* (the Perfect State, PS, *Nannizia nanum*), one each from lesions on the scalp, and glabrous skin in Cuba[17] and report of two cases of mycetoma of scalp due to *M. canis*, one each from French Guiana and Dominican Republic.[18,19] The case from French

Table 1. Prevalence of Dermatophyte species in the Caribbean.

Country	Clinical entity	No. of cases	No. (%) of isolates of different species	Reference no.
Cuba	Tinea capitis	240	*Microsporum canis* 182 (73.1%), *Trichophyton tonsurans* 56 (22.5%), *T. mentagrophytes* 3 (1.2%), *M. gypseum* 5 (2.0%), mixed due to *M. canis* and *T. tonsurans* 3 (1.2%)	7
Cuba	Tinea cruris	227	*T. rubrum* 219 (96.5%), *T. mentagrophytes* 3 (1.3%), *T. tonsurans* 2 (0.9%), *M. gypseum* 2 (0.9%) and *E. floccosum* 1 (0.4%)	7
Cuba	Tinea corporis	78	*M. canis* 46 (59.0%), *T. mentagrophytes* 15 (19.2%), *M. gypseum* 7 (9.0%), *T. tonsurans* 3 (3.8%), and *E. floccosum* 1(1.3%)	7
Cuba	Onychomycosis	144	*T. rubrum* 137 (95.1%)	7
French Guiana	Tinea capitis	119	*T. tonsurans* 88 (73.9%), *T. mentagrophytes* 10 (8.4%), *M. canis* 9 (7.5%), M. audouinii 6 (5.0%), *M. gypseum* 2 (1.7%), *M. langeronii* 1 (0.8%), *T. rubrum* 1 (0.8%) and *M. langeronii* 1(0.8%)	8
French Guiana	Tinea pedis	52	*T. rubrum* 36 (70.6%), *T. mentagrophytes* 11 (21.5%), *E. floccosum* 2 (3.9%), *M. canis* 1 (1.9%) and *T. shoenleinii* 1 (1.9%)	8
French Guiana	Tinea corporis	42	*T. rubrum* 22(52.4%), *M. canis* 7 (16.6%), *E. floccosum* 3 (7.1%) & *T. mentagrophytes* 3 (7.1%), *M. audouinii* 1 (2.4%) and *M. praecox* 1 (2.4%)	8
Dominican Republic	Tinea capitis	118	*T. tonsurans* (61.16%), *M. audouinii* (24.27%), *M. canis* (11.65%), *T. violaceum* and *T. mentagrophytes* rarely isolated	9
Haiti	Tinea capitis	55	*T. tonsurans* 35 (63.60%), *T. mentagrophytes* 8 (14.5%), *T. rubrum* 4 (7.3%), *M. audouinii* 7 (12.7%) and *M. gypseum* 1(1.8%)	10
Trinidad	Tinea capitis	No. of cases not mentioned	*T. tonsurans* (52.9%), *M. canis* (20.0%), *M. audouinii* (18.6%), *M. gypseum* (1.9%), *T. mentagrophytes* (1.4%) and *T. rubrum* (1.4%)	11
Jamaica	Tinea capitis	82	*T. tonsurans* 36 (43.9%), *M. audouinii* 31(37.8%), *T. mentagrophytes* 7 (8.5%), *Trichophyton sp* 2 (2.4%), *M. canis* 1(1.2%) and *M. gypseum* (1.2%)	12
Barbados	Tinea capitis	N	*T. mentagrophytes* and *E. floccosum*, data on frequency of these species not available	13
Puerto Rico	Tinea capitis	38	*M. canis* 14 (38.9%), *T. mentagrophytes* 7 (19.4%), *T. rubrum* 7(19.4%) and *M. gypseum* 5 (13.9%)	14
Puerto Rico	Tinea corporis and Tinea pedis	48	*T. rubrum* 42 (85.7%), *E. floccosum* 4 (8.1%), *T. mentagrophytes* 2 (4%) and *M. ferrugineum* 1 (2%)	15
Puerto Rico	All tineas due to dermatophytes=803	No. of cases not mentioned	*T. mentagrophytes* 350 (43.6%), *T. rubrum* 304 (37.9%), T tonsurans 70 (8.7%), *M. canis* 42 (5.2%), *E. floccosum* 26 (3.2%), *M. gypseum* 9 (1.1%), *M. aoudouini* 2 (0.2%)	16

Guiana was a 22 years-old woman with tumefaction of the scalp evolving over five years,[18] while the one from Dominican Republic was of eight years duration in a woman, the swelling evolving from purulent nodular lesions that occurred on the scalp 14 years ago.[19]

There is almost complete lack of information on the occurrence of dermatophytic infections in the Dutch Caribbean. Porbost *et al.*[20] listed one isolate of *T. mentagrophytes* (CBS 102.680) (earlier identified as *T. interdigitale*) recovered from pus of lesion in a man. This indicates that human infections due to *T. mentagrophytes* and other species of dermatophytes occur in the Dutch Caribbean but have not been studied or recognized.

A thorough search of literature did not reveal any publication of dermatophytosis (ringworm) in animals in the Caribbean, However, it may be mentioned here that two fungal isolates from ringworm lesions in dogs from the veterinary clinic in Ross University School of Veterinary Medicine, St. Kitts and Nevis, were identified as *M. gypseum* by the senior author of this paper.

Regarding natural occurrence of dermatophtyes, out of 163 soil samples examined from St. Kitts and Nevis, 39 (23.9%) were positive for *M. gypseum* complex.[21] In Bonaire, out of 76 soil samples examined 16 (21.0%) were positive M. *gypseum* (Perfect Stage, *Nannizia incurvata*), and 8 (10.5%) were positive for *M. fulvum* (PS *Nannizia fulva*.[22] Of the 46 soil samples examined from Jamaica, 16 (34.8%) yielded *M. gypseum*, and 4 (8.7%) were positive for *M. fulvum*.[23] Investigation of 110 soil samples from Anguilla yielded *M. fulvum* from 35 samples, and *M. gypseum* from 8 samples.[24] *M. gypseum* is the only dermatophyte recovered from soil in Barbados.[25]

Discussion

As is evident from the results of our literature search (Table 1), *Trichophyton tonsurans* is currently the major agent of tinea capitis in Haiti, Dominican Republic and French Guiana, while in Cuba it is *M. canis*. The prevalence of *T. rubrum* as the commonest agent of *tinea corporis*, *tinea pedis* and onychomycosis in French Guiana agrees with that reported from Europe, whereas the frequency of *T. tonsurans* in *tinea capitis* agrees with that in the Americas. There has been a gradual shift in the dominant agent of *tinea capitis* in Jamaica, it was *M. audouinii* in 1998 then replaced by *T. tonsurans*.[12] The report of an autochthonous case of *tinea capitis* due to *M. ferrugineum* in Puerto Rico is noteworthy.[15]

Preponderant occurrence of *M. fulvum* in Anguilla soils with rare isolation of *M. gypseum* is a significant observation. Very recently, a new species of dermatophyte, *Nannizia polymorpha* was isolated from a skin lesion of a patient from French Guiana.[25] There is need for further epidemiological studies on dermatophyosis and natural occurrence of dermatophytes in the environmental sources in the Caribbean.

Mycetoma due to dermtophtytes is occasionally encountered, mainly observed on the scalp and nape of the neck, frequently with a history of a skin lesion leading to transcutaneous penetration of the fungus and mycetoma formation. Though several dermatophytes have been identified as etiological agents, mycetoma due to *M. canis* is rare with reports of only two cases in children, one each from Africa and Australia.[18] It is noteworthy that two cases of mycetoma, one each from French Guiana and from Dominican Republic[18,19] were traced in our literature search.

Majority of clinically used antifungal compounds have several drawbacks in terms of toxicity, efficacy and cost, and their frequent use has led to the emergence of resistant strains. The spread of multidrug-resistant strains of pathogenic fungi including dermatophytes has motivated several investigators to discover new classes of antifungals that inhibit these resistant mechanisms. Natural products from plants have played a central role in exploring novel drugs, making it noteworthy objective in in drug industry as well in health care.[26,27] There is also public concern to restrict the use of synthetic antimicrobial drugs because of their impact on agriculture and environment. This has also led to a search for medicinal plants and compounds isolated from them for their antifungal properties. Abed *et al.*[26] reviewed the numerous publications relating to compounds derived from plants with antimycotic activity. Verastegui *et al.*[27] investigated the antifungal activity of several plants in the vegetation of Mexico and southern USA for a variety of pathogenic fungi including dermatophytes. Okunji *et al.*[28] demonstrated strong antifungal activity of a spirostanol saponin (DM-1), isolated from the fruit pulp of *Dracaena mannii* (small-leaved dragon) a shrub common in West Africa, against 17 species of fungi including dermatophytes. the structure of DM-1 was characterized as 3β-0-[(α-L-rhamnopyranosyl (1 ← 2), α-L-rhamnopyranosyl (1←3))-β-D-glucopyranosyl]-17 α-hydroxyl-spirost-5-ene from the analysis of the spectra data and chemical reactions.[28] Vaijayanthimala *et al.*[29] tested the antifungal activity of 23 south Indian medicinal plants against clinical isolates of *Trichophyton rubrum* and *T. mentagrophytes*; alcoholic extracts of *Allium sativum* (Garlic), and *A. schoenoprasum* (chives) showed highest anti-dermatophytic activity. In another publication from south India, Balakumar *et* al[30] demonstrated significant in vitro antifungal activity of *Ocimum sanctum* (Tulsi) against clinical isolates of *T. rubrum*, *T. mentagrophytes*, *Epidermophyton floccosum* and *Microsporum gypseum*. *Ocimmum sanctum* being common in the Caribbean and grown in many home gardens holds particularly good promise for herbal therapy of dermatophytic infections in this region.

The Caribbean is regarded as one of the world's centers of biodiversity.[31] Information on screening of Caribbean plants on antimicrobial properties has been lacking. A study from Puerto Rico by Luciano-Montalvo *et al.*[32] screened thirteen plants locally known to have medicinal properties for antimicrobial activity against isolates of five pathogenic bacteria, namely *Staphylococcus aureus*, *S. saprophyticus*, *Escherichia coli*, *Hemophilus influenzae*, *Proteus vulgaris*, one of *Candida albicans*. a well-known pathogenic fungus. This study confirmed the traditional use of *Pityrogramma calomelanos* for the treatment of kidney infections associated with stones, and the bactericidal effects of *Tapeinochilus ananassae* against *P. vulgaris* and *S. saprophyticus* and that of *Syzygium jambos* against *S. aureus* and *S. saprophyticus*; however, there was no activity against *C. albicans*

There are many Caribbean medical schools with competent faculty staff in their departments of microbiology and biochemistry. It would be a laudable effort for them to investigate with possible international collaboration the antibacterial and antifungal properties of the local herbs, including the plant *Ocimum sanctum* (Tulsi) known to have significant anti-dermatophytic activity.[32] Hopefully this would lead to development of cost-effective, herbal therapy for fungal infections in the Caribbean region.

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