

Review

Dermatophytes: Diagnosis of dermatophytosis and its treatment

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The enzymatic ability of fungi to decompose keratin has long been interpreted as a key innovation in the evolution of animal dermatology. Dermatophytes are keratinophilic fungi which were originally saprophytic, but have adapted themselves to animal and human parasitism during the course of evolution. Dermatophytes are pathogens, which cause superficial mycosis. The dermatophytes have the capacity to invade keratinized tissue (skin, hair and nails) of humans and other animals to produce an infection. The mycoses caused by fungal infections of the skin and nails is widespread and common amongst all type of mycoses. During last decades, mycotic infections raised to more than 20-25% of the world's population. The review article contains the input of knowledge of various dermatophytes and the diseases caused by them, their identification at the molecular level and treatment strategies.

Key words: Dermatology, dermatophytes, mycoses, keratin.

INTRODUCTION

Earth has been documented as a natural territory for fungi which cover individual kingdom with evolution (Sharma et al., 2015). Dermatophytes are a group of morphologically and physiologically allied molds which have the hazard at the global plane as these are generally causative agent of fungal infections (Smith et al., 1998; Mihali et al., 2012). They hold two imperative properties: they are keratinophilic and keratinolytic agents (Kushwaha et al., 2000). They have an aptitude to digest keratin in their saprophytic circumstances and consume it as a substrate. The World Health Organization estimates universal occurrence of dermatomycoses to be related to 20% (Marques et al., 2000). The infections are universally present in those people who play sports (Maryan, 2009). Infections which are caused by dermatophytes are known

as dermatophytosis (Dei and Vernes, 1986). Dermatophytosis is caused by the genera *Microsporum*, *Trichophyton* and *Epidermophyton*. These organisms are pathogenic members of the keratinophilic (keratin digesting) soil fungi (Witzman and summerbell, 1995). *Microsporum* and *Trichophyton* are human and animal pathogens. *Epidermophyton* is a human pathogen. *Anthropophilic* species are responsible for the majority of human infections. The dermatophytes are a group of closely related fungi that have the capacity to invade keratinized tissue (skin, hair and nails) of humans (Maraki et al., 2007).

The dermatophytes are significantly varying in diverse level of the world. They increase at exterior temperature of 25-28°C and membrane mycosis is continued by warm

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and humid conditions (Male, 1990; Havlickova et al., 2008). For related reasons, dermatomycoses are moderately generally in tropical and subtropical regions (Nweze, 2010). In a special case, the developing countries as India contain infection by the members of the genus *Candida* (Rao, 1959). *Trichophyton concentricum* is present in the Far East, India and the Pacific's (Ameen, 2010; Lakshmipathy et al., 2010). *Microsporum audouinii*, *Trichophyton violaceum*, *Trichophyton soudanense* are studied in several parts of Africa (Woldeamanuel et al., 2005). Equally, *Microsporum canis*, *Trichophyton mentagrophytes*, *Trichophyton rubrum* survive in southern and central European countries as a universal causative agent of Tinea capitis, Tinea unguium and Tinea pedis (Tao-Xiang et al., 2005). Paracoccidioidomycosis is an exceptional disease worldwide but an ordinary deep presence in Brazil with Latin America (Almeida et al., 2003). The key occurrences of these particular dermatophytes are observed during a study on the sexually transmitted diseases (AIDS). *Trichophyton simii* and *Trichophyton mentagrophytes var. Erinacei* are enclosed to France, Italy and New Zealand (Quaife, 1996). In addition, the occurrence of dermatomycoses is superior in population with little socioeconomic status and also in close nearness of animals (Farzana, 2007; Mikali et al., 2012). However, flooring, clothing, linens, furniture and barber shop instruments, are the vital foundation of dermatophytes.

The dermatophytes have a saprophytic presence. They cause the surface infections through colonization individually of skin, hairs and nails in human beings known as ringworm, jock itch (Khaksari and Bassiri, 2009; Ryan et al., 2010). The colonies are equipped by generating the Arthrospores and conidia of the fungus (Lakshmipathy et al., 2010). Indication of dermatophytosis has a distinction basis in the affected region of the body, but one of their priorities is a universal indicator in humans (Nweze, 2010).

Primary infection starts through small skin break. These breaks are coming out through secretion of enzymes that digest keratin (Laham et al., 2011; Achterman and White, 2012; Mikaili et al., 2012). This enzyme is referred to as keratinase (Gupta and Ramnani, 2006). The excreted enzyme plays a vital role in the process of infection and considered as primary virulent factors (Sharma et al., 2012). As it, the *T. mentagrophytes var. Erinacei* present in the hedgehog caused the hedgehog ringworm to the public; especially to children (Quaife, 1996). These dermatophytes also cause the extremities, including Tinea manuum, Tinea corporis, nail infection (Philpot and Brown, 1992; Chang et al., 2009). *T. rubrum* causes infection in nails known as Onychomycosis (Achterman and White, 2012; Ahmad et al., 2010). Currently, Pmycosis infections are mounting at an alarming rate due to the increase in HIV/AIDS occurrence (Fentaw et al., 2010). This is also known as Paracoccidioidomycosis

which is produced by *Paracoccidioides brasiliensis* (Almeida et al., 2003). Another infection, ophthalmic Mycoses, is an agent of morbidity and blindness by *Cephalophora irregularis* (Thomas, 2003). The key component of the present compilation includes study of various dermatogens and diseases caused by them, their diagnosis and treatment strategies.

DERMATOGENS AND DISEASE

Tinea pedis or athlete's foot

Tinea pedis is universal infection observed in one in five adults and the occurrence boost up with age from adolescence (Havlickova et al., 2008). Infections are derived as the itching and shedding of skin scales holding viable infectious agent like arthroconidia of the fungus (Sharma et al., 2012). Swell up and cracked skin has also been exposed to raw tissue, pain and inflammation. This acute inflammation differentiates as the formation of vesicles, pustules. The chronic agents of Tinea pedis are *T. rubrum*, *T. mentagrophytes var. Interdigitale*, and *E. floccosum* (Weitzman and Summerbell, 1995). Tinea pedis is also known as "one hand two feet syndrome" which means the dermatophyte illness of both feet and one hand and found in patients of lower immunity competence, such as diabetics (Havlickova et al., 2008). Naturally, its influences is observed on the feet, accepting infection or spreading to additional areas of the body (Daniel, 2010).

Tinea cruris

Tinea cruris is also famed as crotch itch, crotch rot, eczema marginatum, gym itch, jock itch, jock rot, and ringworm of the groin (Rapini et al., 2007). Tinea cruris refers to dermatophytosis of the proximal medial thighs and buttocks (Sharma et al., 2012). It takes place frequently in men with exception of auxiliaries infections which are distinguished as a corresponding tiny pattern in the woman (Macura, 1993; Weitzman and Summerbell, 1995; Gupta et al., 2003; Havlickova et al., 2008). The causative beings are attacked on the stratum corneum and the lethal hair of the affected areas (Gupta et al., 2003). The fungus spores are transferred to the groin part by scratching from locating on underclothing or pants. Affected areas display as red, tan, rippling brown, peeling, or cracking skin. The universal causative agents are *T. rubrum*, *E. floccosum*, *M. magnum*, *T. mentagrophytes* and *T. raubitschekii* (Nweze, 2010; Sharma et al., 2012).

Tinea unguium

Tinea unguium is identified as Onychomycosis which is

caused by dermatophytes in nail (Harvey and Stoppler, 2011). Onychomycosis appear as exterior white onychomycosis (pits on outside of the nail) and subungual dermatophytosis (infection beneath the nail plate) (Sharma et al., 2012; Sharma et al., 2015). According to review of diseases of the foot 2003, 16 European countries establish that onychomycosis, is the most frequent fungal infection with prevalence at 27% (Burzykowski et al., 2003). Tinea unguium normally attach to the tip of the toenail and steadily spreads to the nail matrix (Hiroshi, 2007). It is usually observed in men but also in women as lines and ridges on nails during the pregnancy (Harvey and Stoppler, 2011; Nenoff et al., 2007). *Trichophyton rubrum* is the universal dermatophytes associated with *T. interdigitale*, *E. floccosum*, *T. violaceum*, *M. gypseum*, *T. tonsurans* and *T. Sudanese*. It also contains the *Candida* subspecies as *Candida albicans*, *Candida parapsilosis* and *Candida guilliermondii* (Weitzman and Summerbell, 1995; Havlickova et al., 2008; Vorvick et al., 2010). Normally, symptoms of disease are weakness, change in nail shape, breaking of the outside of the nail, lifting up of the nail, loss of shine (Nweze, 2010; Vorvick et al., 2010).

Tinea barbae

Tinea barbae is identified as "Barber's itch, ringworm of the beard, and "Tinea sycosis" (James and Werger, 2006). It is surface disease of the hair, in the beard and mustache region of men (Marcus et al., 2008; Rapini et al., 2007). Tinea barbae starts from the face and neck. It is mostly caused by shaving and abuse of steroids. The main clinical indications are classified into two forms as inflammatory and non-inflammatory. These symptoms depend on kind of fungus and patient's resistant response (Szepietowski et al., 2004). In general ways, the common symptoms of disease are loose and broken off hairs, kerion-like plaques, rash, itching and pimples near a hair follicle in the neck, and genital area (Szepietowski et al., 2008; Vorvick et al., 2010). Reddening and swelling also occur in the entire area with barbeque. Habitually, the zoophilic dermatophytes such as *T. mentagrophytes*, *T. verrucosum*, *T. megninii*, *T. rubrum* and *T. violaceum* are responsible for infection. *M. canis* and *T. mentagrophytes Varerinacei* also cause Tinea barbae, but these are exceptional (Marcus et al., 2008).

Tinea faciei

Tinea faciei is observed mostly on the non-bearded region as a glabrous membrane of the face (Rapini et al., 2007; Lin et al., 2004). Around 19% of all surface fungal infections is caused by Tinea faciei. Forces are in pediatric inhabitants with dermatomycoses (Akhlaghi et

al., 2005). Females are more frequently affected than males (Ghilardi et al., 2005). They appear usually as a red hives on the face containing small patches, lifted bumps, the upper lip and chin (Starova et al., 2010). The warning sign are typically pruritic enclosing to itch and burning, which expose to sunlight (Nweze, 2010). Most common agents of *T. faciei* are *T. tonsurans*, *T. verrucosum*, *T. mentagrophytes*, *M. canis* and *T. rubrum* (Lin et al., 2004; Starova et al., 2010).

Tinea incognito

Tinea incognito is mycosis of skin caused by the immunosuppressive factors such as *T. rubrum*, *T. mentagrophytes*, *E. floccosum*, *M. canis* and *M. gypseum*, *M. jasiel* (Walikowska et al., 2010). They illuminate personally into iatrogenic skin disease such as suppressed irritation, delay type immune reactions. Specific examples are bacterial infections such as tuberculosis, viral infections such as chicken-pox and fungal diseases such as ringworm, seborrheic dermatitis, psoriasis and eczema, but also erythematous migrans (Adrian and Ronald, 1968; Satana et al., 2011). Symptoms are skin atrophy, telangiectasia and florid growth on the feet, ankle, legs or groin (Habif, 1995).

Tinea nigra

Tinea nigra is termed "Tinea nigra palmaris or plantaris (Rapini et al., 2007). This illness is superficial dermatogens that fabricate to dark brown to black effortless patches on the palms of the hands and the soles of the feet (James and Berger, 2006). The infections, is mainly caused by the fungus *E. werneckii*, *H. werneckii*, *P. werneckii* *C. werneckii* (Gupta et al., 2003; Murray et al., 2005). Tinea nigra naturally occurs in children and young, adults female as the stratum corneum reveal abundant dark-colored branching hyphae and round to oval spores with some budding. The colonies are initially found in moist, shiny, black and yeast-like (Palmer et al., 1989).

DERMATOGENS AND DERMATOPHYTOSES

Psoriasis is a chronic cutaneous sickness of unknown causation (Espinoza et al., 1998). According to the hypothesis, various factors construct a "thinning of the walls of the small intestine" exclusively in the jejunum and the lower duodenum (Mcmillin et al., 1999). Photo therapies produce erythema, pruritus, wrinkling, solar elastosis and an increased risk of skin cancer (Pimpinelli et al., 2005). Systemic therapies such as acitretin, methotrexate, cyclosporine, hydroxyurea and thioguanine are associated with significant systemic toxicity and

closely monitored. This thinning allocates toxic product leakage from the intestinal tract into the circulation. These toxic substances ultimately locate their way into the superficial circulation and are eliminated through the skin, which produce the plaques of psoriasis (McMillin et al., 1999). The relation between psoriasis and mycosis is accordingly the pattern of lymphoid penetration in typical large-plaque psoriasis, is similar to small-plaque psoriasis but penetrate contain lymphocytes with cerebral form of nuclei called Lutzner cells or Sezary cells. These Sezary cells formation process is also observed in mycosis (Pimpinelli et al., 2005).

DIAGNOSIS OF DERMATOPHYTOSIS AND CAUSAL DERMATOGENS

Dermatophytes are fungi obtaining a mid-transmittable disease which are acquired from infected animals or birds and fomites. Detection of dermatophyte Texas is correlated to epidemiological apprehension. These are important to manage infection and public health issues associated with types of Dermatophytosis (Lin et al., 1992). Traditionally, the dermatophytosis is normally referred to as "tinea" or "ring-worm" infections (Lakshmipathy et al., 2010). Damp foot circumstances lead to irritated symptoms due to mixed infection by dermatophytes and bacteria. Tinea of the extremities, tinea cruris and onychomycosis caused by zoophiles are exceptional (Weitzman and Summerbell, 1995). In humans, pruritus is a widespread symptom. The skin lesion is usually characterized by inflammation with erythema, scaling and occasionally blister formation. The habitual signs of inflammatory reactions such as redness, swelling, heat and alopecia are distinguishing at the infection position (Lakshmipathy et al., 2010). The identification of dermatophytes is based on methods that focus on morphological, physiological, ecological and genetic features. Anthropophilic and zoophilic dermatophytes has mostly been recognized via internal transcribed spacer (ITS; sequencing of the rRNA gene) (Sharma and Swati, 2012).

Microscopy

The fungal dermatophytes are inspected by visual microscopy and environmental scanning electron microscopy for morphological and structural studies (Mihali et al., 2012). The sample is assembling from skin scrapings and a fungal culture on Sabouraud's agar media (Weitzman and Summerbell, 1995; Thomas, 2003). These scrapings and hairs mount in 25% KOH or NAOH with 5% glycerol and heated to emulsify lipids. After, it was observed under 3400 magnification for fungal configuration. Another used microscopy technique is the Congo red fluorescence microscopy technique.

These techniques permit a fast diagnosis of mycotic keratitis in patients. The Giemsa stain also a detectable source of fungal hyphae and yeast cells in tissue. Lacto phenol cotton blue, Gomori methenamine silver (GMS) and periodic acid-Schiff (PAS) are stains for detection of fungi in tissue (Thomas, 2003).

Culture

Culture is a precious accessory of microscopy which is crucial in all infections for treatment with systemic prescription. Identifying characters include colony pigmentation, texture and growth rate and distinctive morphological structures, such as micro conidia, macro conidia, spirals, pectinate branches, pedicels and nodular organs. Some usable media are as follows:

1. Urea agar or broth is used to assist gratitude of urea-negative species of *Trichophyton* genera. The experiment is utilized with a warning as the occurrence of poorly visible, antibiotic-resistant bacteria in *T. rubrum* colonies which may gain false-positive reactions.
2. BCP-milk solids-glucose agar is used to distinguish dermatophytes as *T. rubrum*, *T. mentagrophytes*, *T. soudanense*, *T. megninii*, *M. persicolor* and *M. equinum*, on the divergence of releasing ammonium ion from casein and the catabolite domination by glucose (Weitzman and Summerbell, 1995).
3. Potato flake agar or Cycloheximide amended potato glucose use of isolation, identification of *T. rubrum* by quick red pigmentation in germfree, usual isolates and with relatively antibiotic-susceptible contaminants.
4. Littman ox gall agar as restrictive media is preferred to diagnose a non dermatophytes infection.
5. Casamino acids-erythritol- albumin medium is used firstly by Fishcer and Kane. It is an extremely useable medium for isolating dermatophytes from heavily contaminated by bacteria or cycloheximide-tolerant such as *C. albicans*. This medium contains balanced egg albumin, which reduces yeasts such as *C. albicans* (Kunert, 2000)
6. Another isolation medium is Bromcresol purple (BCP)-casein-yeast extract agar which grows all dermatophytes but is designed for the rapid recognition of microcolonies of *T. verrucosum*.

Polymerase chain reaction (PCR)

Since the innovative molecular biology, the technique of PCR occupies enzymatic magnification of even minute quantities of a detailed DNA. It has the vast benefit to culture dermatophytes in easily and typical morphological performance (Sharma et al., 2012). Samples for which DNA can be extracted from include intraocular fluid as tears, any fresh tissue, paraffin-embedded tissue and

even stained or unstained cytology slides or tissue sections. The combination of broad-range PCR intensify to a product like 18S rRNA from all or most common fungi associated with human infection (Yeo and Wong, 2003). Amplification continued by restriction endonuclease analysis, sequencing, or hybridization to a series of genus and species-specific probes that show as possible preference in the effort to diagnose fungal infections (Chemaly and Procop, 2004). PCR is more sensitive than culture as a diagnostic aid in Mycoses (Thomas, 2003). Although PCR is more advantageous, it has extreme sensitivity and specificity that it cannot be used to monitor the patient's response to treatment. Another is the relatively high cost in comparison with the classical method (Sharma et al., 2012; Molyneux, 1959).

TREATMENT OF DERMATOPHYTOSIS

The basic treatments for all Tinea superficial infections excluding hairy regions are suitable use of antifungal agents (Hiroshi, 2007). The utilizable compounds have a molecular mass greater than 500 DA such as Amphotericin B (924.10 DA), Natamycin (665.75 DA) and Ketoconazole (531.44 DA). Amphotericin B and Miconazole are useable cream and sub conjunctive vaccination that extends the contact time between the antifungal and conjunctival tissue (Thomas, 2003). Paracoccidioido mycosis has systemic therapy with Griseofulvin, Terbinafine and Itraconazole, which work on Tinea capitis (Almeida et al., 2003). Tolnaftate is frequently used in uncomplicated cases of Tinea cruris with excellent results (Lakshmapathy et al., 2010). The most utilizable antifungal agents are as follows:

Polyenes

These are significant ocular antifungal armamentarium which attach to ergosterol, a sterol exclusive of the fungal cytoplasmic membrane.

Natamycin

It is used firstly as topical ophthalmic antifungal complex that agreed with the Food and Drug Administration of the United States (Thomas, 2003).

Amphotericin B

Amphotericin B is variably fungi static and occasionally fungicidal, depending on the concentration in serum and the vulnerability of the pathogens. Renal toxicity is estimated by monitoring the blood urea nitrogen and other systemic tests as headaches, chills, fever and anorexia. (Friedrich and Antanikian, 1996).

Ketoconazole

Ketoconazole is orally absorbable antifungal azoles. Oral ketoconazole therapy is effective in Tinea infection. Oral management of ketoconazole lead to side effects such as keratitis-ichthyosis-deafness syndrome (Rippon, 1982).

Itraconazole

The synthetic dioxolane triazole itraconazole is well fascinated after oral administration. It contains most universal objection of gastrointestinal disease.

Polyhexamethylene biguanide

PHMB is universal environmental biocides that performs on the cytoplasmic membrane of bacteria, fungi, Acanthamoeba.

Silver sulfadiazine

It liberated and combines to microbial DNA avoiding unzipping of the helix and inhibit the replication of microorganisms without disturbing the epithelial cell regeneration (Ghahfarokhi et al., 2004).

Prevention of dermatophytes infections must be considered in the etiologic area's infection agents through the hairbrush technique. Customs examination of scalps of young children should be performed at the opening of the school term. Good sanitation should be impressed upon those infected and must be instructed not to share headgear, combs and brushes. Barbershop instruments ought to be clean after use (Hoog, 1996). The sources of infection are recognized and treated via shield cloths (gloves, gowns and head covering) for health care (Hussain et al., 2012). Prevention of tinea may be improved by using good foot hygiene, including habitual washing of the feet, systematic drying and use of foot powder for avoiding moisture and occlusion by wearing sandals or other well-ventilated shoes (Veronese et al., 2001). Tinea pedis is controlled by educating infected individuals not to expose others by walking barefoot near swimming pools, locker rooms and public showers and by not sharing foot-gear. The frequent hosing of floors of public baths, swimming pools, etc., and discouraging antifungal foot dips near swimming pools may be helpful as preventive measures.

NATURAL REMEDIES TO FIGHT WITH DERMATOGENS

Nature provides preliminary needs of beings for self-care. Plant remedies have a strong efficacy against several

assorted diseases such as skin disease caused by fungi and moulds. Their essential oils are best candidature in presence of their cytotoxic aptitude against fungus (Sharma et al., 2014) The *Otacanthus azureus* (Linden) Ronse essential oil alone or in combination with azoles is a promising antifungal agent in the treatment for human dermatomycoses caused by filamentous fungi (Houel et al., 2013). The combination of ketoconazole and *P. graveolens*'s essential oil for treatment of infections caused by *Trichophyton* species reduce the minimum effective dose of ketoconazole, and thus minimize the side-effects of ketoconazole. (Shin and Lim, 2003) Similarly, A number of plant's essential oils have been search out as plant remedies of plant families, that is, Asteraceae, Liliaceae, Apocynaceae, Solanaceae, Caesalpinaceae, Rutaceae, Piperaceae, Sapotaceae, Caricaceae, Euphorbiaceae, Moraceae, Solaneaceae, Papaveraceae (Natarajan and Natarajan, 2009). For example, antifungal effect of *Hypercom perforatum*, *Eucalyptus globules* (88%), *Catharanthus roseus* (88%) *Ocimum sanctum* (85.50%), *Azadirachta indica* (84.66%), *Ricinus communis* (75%), *Lawsonia inermis* (74.33%) *Jatropha curcas* (10%) *Eucalyptus intertexta* and *Eucalyptus largiflorens* are determined more active against Epidermophyton, Microsporum and Trichophyton Genera (Ghasemi et al., 2014; Venugopal and Venugopal, 1994; Suklampoo et al., 2012; Scott et al., 2006) In cattles, bergamot oil could be proper candidates as disinfectant agents and could be used as active ingredient for dermatological applications (EL-Ashmawy et al., 2015).

KERATINASE TO TACKLE DERMATOGENS

Keratinase are proteolytic affiliate of decaying of keratin (Dubey and Varma, 1999). Keratin is tremendously strong proteins which have exclusive properties as well as inflexible and hard (Anbu et al., 2004). Keratins contain a high proportion of glycine and alanine where a side group of glycine is a single hydrogen atom where the alanine contains small and no charged methyl group. There are two key shapes of keratin, alpha-keratin and beta-keratin. Alpha-keratin is observed in humans and other mammals while beta-keratin is established in birds and reptiles (Sharma et al., 2012; Sharma, 2015). Few organisms are competent to break it and arise from soil and wastewater habitats which participate as a keratinolytic factor in decaying α -keratins with an incidence of disulphide and hydrogen bonds which are inadequately biodegradable (Babayi et al., 2004). In keratin, the disulphide and hydrogen bonds are occurring through amino acids like cysteine and methionine (Anbu et al., 2004). Molyneux (1959) attempted to isolate firstly keratin degrading bacteria (Ulfig, 2006). The molecular masses of the keratinase enzymes range from 20 to 60 KDa. They are mostly active in alkaline environments, with

optimal activity at temperatures up to 50°C (Mahboubi and Mohaddese, 2008). Rippon (1982) illustrates certain strain of *Microsporum* and *Trichophyton* which construct enzymes that dissolve the keratin and associated fibrous proteins established in hair, nails, skin, claws, feather, beak and hooves (Bronson et al., 1983). Ghahfarokhi et al. (2004) deliberated the result of essential oil, which characterizes the synergistic effect on dermatophytes as antifungal agents. Another statement regarding aqueous onion extracts confirm molecular changes such as configuration of resistant forms in *Trichophyton* from its inhibitory effects on the fungal species (Brasch and Graser, 2005).

The majority of keratinolytic and keratinophilic fungi are integrated in two bio-safety level categories: BSL-1 and BSL-2. The BSL-2 fungi belong to the dermatophytes and pose a higher risk to man than the BSL-1 (Fishcer and Kane, 1974). Effect of essential oils of plants against *Epidermophyton floccosum*, *Trichophyton mentagrophytes* and *Trichophyton rubrum* which were isolated from patients with dermatomycosis was studied. Among the tested oils, *Mentha viridis* (Mentha) and *Citrus aurantiifolia* (lemon) oils were found to possess complete anti-dermatomycotic activity (Mochizuki et al., 2003). Mint and mint oil yield is modified by biotic and abiotic factors (Bond et al., 1994). Essential oils of *Mentha piperata* and *Citrus maxima* display absolute inhibition of mycelial growth on deramatophtes which explain dominance in fungi toxic potency (Ishibashi, 1983). Keratinophilic fungi are present in the environment with variable patterns that depend on different factors such as human and animal presence (Sharma et al., 2015). Crude methanolic extract of *E. camaldulensis* inhibited the growth of *C. albicans*. It has also shown that an ethanolic leaf extract of *Eucalyptus camaldulensis* had marked fungicidal effect against clinical dermatophytes (Banerjee et al., 2011). Many environmental factors affect keratinolytic and keratinophilic fungi in sewage sludge. (Klemm, 2008). Finally it was investigated that the oil of *Mentha pulegium* L. has a potent antimicrobial activity and the Iranian *Mentha pulegium* L. oil belongs to piperitone/piperitenone type (Ajello and Getz, 1954). There is a possible prospect to search out new therapeutics that plants remedies generate which will be natural drug against mycological disease.

CONCLUSION

From the above collected review literature, it can be concluded that dermatophytes are fungal agents that use keratin to cause infections in birds, animals and human beings. The infections are mostly common in developing countries due to poor hygienic conditions, close proximity to animals and poor socio-economy, and the climatic support the growth of dermatophytes. A variety of diseases are caused by dermatophytes, namely athletes' foot,

ringworm, jock itch, etc. and these usually colonize through skin, hair and nails in human beings. These diseases are usually diagnosed using microscopy, culture techniques, PCR, etc. Treatment involves the use of various antifungal drugs, certain essential oils according to latest research, etc. However, the most important factor for control of tinea infections is maintenance of proper hygienic conditions as it is rightly said that “an ounce of prevention is always better than a cure”.

Conflict of interests

The authors did not declare any conflict of interest.

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